

ALL TRADES SPECIFICATIONS

FARMINGTON PUBLIC SCHOOLS
PROJECT NUMBER: 161664B
NOVEMBER 30, 2016
BID PACK #5

PROJECT

FARMINGTON PUBLIC SCHOOLS 2017 RENOVATIONS ELEMENTARY SCHOOLS

OWNER

Farmington Public Schools
32500 Shiawassee Road
Farmington, MI 48336

ARCHITECT

Wakely Associates, Inc.
30500 Van Dyke Ave., Suite M-7
Warren, Michigan 48093

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ELEMENTARY SCHOOLS

OWNER

FARMINGTON PUBLIC SCHOOLS
32500 SHIAWASSEE ROAD
FARMINGTON, MI 48336

ARCHITECT

WAKELY ASSOCIATES, INC.
30500 VAN DYKE, SUITE M-7
WARREN, MICHIGAN 48093
586-573-4100

CONSTRUCTION MANAGER

MCCARTHY & SMITH
24317 INDOPLEX CIRCLE
FARMINGTON HILLS, MI 48335
248-427-8400

STRUCTURAL

SNYDER & STALEY ENGINEERING
3085 BAY ROAD, SUITE B
SAGINAW, MI 48603
989-797-1710

MECHANICAL/ELECTRICAL

PETER BASSO ASSOCIATES
5145 LIVERNOIS
SUITE 100
TROY, MI 48098
248-879-5666

CIVIL

ANDERSON, ECKSTEIN & WESTRICK
51301 SCHOENHERR ROAD
SHELBY TOWNSHIP, MI 48315
586-726-1234

<u>TABLE OF CONTENTS</u>		<u>PAGES</u>
	Title Page	1
	Table of Contents	4
<u>DIVISION 0</u>	<u>BIDDING AND CONTRACT REQUIREMENTS</u>	
	"BY MCCARTHY & SMITH"	
	00851 Index of Drawings	5
<u>DIVISION 1</u>	<u>GENERAL REQUIREMENTS</u>	
	"BY MCCARTHY & SMITH"	
	01090 Reference Standards	7
	01100 Alternates	2
	01810 Commissioning Requirements	38
<u>DIVISION 2</u>	<u>SITE</u>	
	01575 Soil Erosion & Sedimentation Control	2
	02220 Demolition	8
	02230 Site Clearing	5
	02300 Earth Moving	11
	02411 Foundation Drainage System	3
	02480 Landscape Work	15
	02484 Topsoil	3
	02499 Landscape Maintenance & Warranty Standards	3
	02510 Water Utility Distribution Piping	4
	02630 Storm Utility Drainage Piping	8
	02740 Asphalt Paving	6
	02750 Concrete Paving	6
	02760 Paving Joint Sealants	4
	02761 Pavement Markings	5
	02765 Paving Specialties	4
	02767 SealMaster Asphalt Pavement Sealcoating for Parking Lots	6
	02810 Planting Irrigation	4
	02900 Planting	8
	02925 Cleanup and Restoration	2
	02951 Landscape Restoration	6
<u>DIVISION 3</u>	<u>CONCRETE</u>	
	03001 Concrete Work	14
<u>DIVISION 4</u>	<u>MASONRY</u>	
	04100 Mortar & Grout	4
	04300 Unit Masonry	15
	04720 Cast Stone	9

<u>DIVISION 5</u>	<u>METALS</u>	
	05120	Structural Steel 10
	05210	Steel Joists 5
	05310	Steel Decking 10
	05400	Cold Formed Metal Framing 6
	05500	Metal Fabrications 9
	05805	Expansion Joint Covers 5
<u>DIVISION 6</u>	<u>WOOD AND PLASTICS</u>	
	06100	Carpentry 6
	06402	Interior Architectural Woodwork 13
<u>DIVISION 7</u>	<u>THERMAL AND MOISTURE PROTECTION</u>	
	07160	Bituminous Dampproofing 4
	07200	Insulation 7
	07500	Membrane Roofing 10
	07600	Flashing & Sheet Metal 3
	07610	Standing Seam Metal Roofing System 7
	07840	Firestopping 6
	07910	Joint Fillers and Gaskets 5
	07920	Sealants and Caulking 12
<u>DIVISION 8</u>	<u>DOORS AND WINDOWS</u>	
	08112	Hollow Metal Work 11
	08151	Integrated Metal Door Systems 6
	08210	Wood Doors 7
	08410	FRP Doors-Alum. Framing Systems 9
	08520	Aluminum Windows- Fixed Window 7
	08520	Aluminum Windows- Sliding Window 8
	08710	Finish Hardware 18
	08800	Glass & Glazing 13
	08810	Fire Rated Glass & Framing System 8
<u>DIVISION 9</u>	<u>FINISHES</u>	
	09200	Exterior Plaster System 14
	09250	Gypsum Drywall 18
	09300	Tile Work 9
	09510	Acoustical Ceilings 6
	09540	Special Surfaces 5
	09550	Wood Floor Refinishing 3
	09614	ADA Replaceable Cast In Place Detectable Warning Surfaces 9
	09650	Resilient Flooring 6
	09680	Carpeting 13
	09900	Painting 14

<u>DIVISION 10</u>	<u>SPECIALTIES</u>	
	10100	Markerboards & Tackboards 4
	10160	Toilet Partitions 4
	10400	Identification Devices 6
	10436	Electronic Message Board 19
	10500	Metal Lockers 5
	10800	Toilet Accessories 7
	10999	Miscellaneous Specialties 3
<u>DIVISION 11</u>	<u>EQUIPMENT</u>	
	11063	Stage Curtains & Rigging-Longacre 11
	11063	Stage Curtains & Rigging: FHS-ReBid 18
	11400	Food Service Equipment-Woodcreek 53
	11480	Gymnasium Equipment 4
<u>DIVISION 12</u>	<u>FURNISHING AND SEATING</u>	
	12300	Plastic Laminate Casework 14
	12492	Window Treatment 3
	12492	Window Treatment- FHS: Re-Bid 3
<u>DIVISION 15</u>	<u>MECHANICAL</u>	
	15010	Mechanical General Requirements 15
	15050	Basic Mech. Materials & Methods 29
	15053	Common Work Results for HVAC 8
	15055	Motors 12
	15060	Hangers and Supports 20
	15070	Mechanical Vibration Controls 13
	15075	Mechanical Identification 12
	15080	Mechanical Insulation 39
	15110	General Duty Valves for Plumbing 13
	15112	General Duty Valves for HVAC 13
	15121	Pipe Flexible Connectors, Expansion Fittings and Loops 10
	15122	Meters and Gages 7
	15140	Domestic Water Piping 12
	15145	Domestic Water Piping Specialties 13
	15150	Sanitary Waste and Vent Piping 12
	15155	Drainage Piping Specialties 18
	15160	Storm Drainage Piping 9
	15181	Hydronic Piping 19
	15183	Refrigerant Piping 14
	15185	Hydronic Pumps 12
	15188	Piping Systems Flushing & Chemical Cleaning 7
	15189	HVAC Water Treatment 15
	15410	Plumbing Fixtures 11
	15415	Drinking Fountains & Water Coolers 6
	15629	Scroll Water Chillers 12

FARMINGTON PUBLIC SCHOOLS
 2017 RENOVATIONS-BID PACK #5
 ELEMENTARY SCHOOLS

161664B

NOVEMBER 30, 2016

15730	Unitary Rooftop Air Conditioners	12
15738	Ductless Split-System AC Units	7
15761	Heating and Cooling Coils	6
15764	Convection Heating Units	5
15768	Console Type Unit Ventilators	8
15770	Vertical Unit Ventilators	9
15790	Centrifugal Fan Cabinet Unit Heaters (Hot Water)	6
15815	Metal Ducts	23
15816	Nonmetal Ducts	8
15817	HVAC Casings	9
15820	Duct Accessories	18
15838	Power Ventilators	11
15855	Diffusers, Registers & Grilles	4
15900	Temperature Controls	38
15950	Testing, Adjusting & Balancing	32

DIVISION 16

ELECTRICAL

16010	Electrical General Requirements	13
16055	Overcurrent Protective Device Coordination and ARC Flash Study	12
16060	Grounding and Bonding	16
16073	Hangers & Supports for Electrical Systems	9
16120	Conductors & Cables	7
16130	Raceways and Boxes	12
16140	Wiring Devices	10
16145	Lighting Control Devices	12
16195	Electrical Identification	11
16289	Surge Protection Devices	6
16410	Encl. Switches & Circuit Breakers	11
16415	Transfer Switches	12
16420	Enclosed Controllers	11
16442	Panelboards	13
16491	Fuses	4
16511	Interior Lighting	16
16521	Exterior Lighting	14
16721	Fire Alarm	19
16726	School Intercom & Program Equipment	17
16730	Clock and Program Systems	4
16999	Electrical Testing	6

SECTION 00851 - INDEX OF DRAWINGS

TITLE SHEET

The following drawings, dated November 30, 2016, are issued for Farmington Public Schools, 2017 Renovations, Bid Pack #5, Elementary Schools, Farmington, Michigan. Architect's Project Number 161664B.

TITLE SHEET

SHEET NO. TITLE

ARCHITECTURAL DRAWINGS:

Farmington High School

G0.0 COVER SHEET, SHEET INDEX, LOCATION MAPS
A1.0FH COMPOSITE FLOOR PLAN
A1.13FH FLOOR PLAN AREA 'N'
A5.11FH ENLARGED PLANS AND DETAILS

Hillside Elementary

G0.0 COVER SHEET, SHEET INDEX, LOCATION MAPS
G4.1 GENERAL INFORMATION, SYMBOLS, & ABBREVIATIONS
G4.2 FLOOR PLAN KEY NOTES, REFLECTED CEILING PLAN KEY NOTES,
 & WALL TYPES
AS1.0HS SITE PLAN
A1.0HS LOWER LEVEL, FIRST FLOOR, AND SECOND FLOOR COMPOSITE
 PLANS
AD1.1HS AREA "A" - LOWER LEVEL DEMOLITION PLAN
AD1.2HS AREA "B" - DEMOLITION PLAN
AD1.3HS AREA "C" - DEMOLITION PLAN
AD1.4HS AREA "D" - SECOND FLOOR DEMOLITION PLAN
A1.1HS AREA "A" - LOWER LEVEL NEW WORK PLAN
A1.2HS AREA "B" - NEW WORK PLAN
A1.3HS AREA "C" - NEW WORK PLAN
A1.4HS AREA "D" - SECOND FLOOR NEW WORK PLAN
A2.1HS AREA "A" - LOWER LEVEL REFLECTED CEILING PLAN
A2.2HS AREA "B" - REFLECTED CEILING PLAN
A2.3HS AREA "C" - REFLECTED CEILING PLAN
A2.4HS AREA "D" - SECOND FLOOR REFLECTED CEILING PLAN
A7.1HS DOOR SCHEDULE & DETAILS
A7.2HS ROOM FINISH SCHEDULE
A8.1HS DISPLAY BOARD PLAN
A8.2HS SIGNAGE SCHEDULE
A8.3HS COMPOSITE FLOOR FINISH PLANS

Longacre Elementary

G0.0	COVER SHEET, SHEET INDEX, LOCATION MAPS
G4.1	GENERAL INFORMATION, SYMBOLS, & ABBREVIATIONS
G4.2	FLOOR PLAN KEY NOTES, REFLECTED CEILING PLAN KEY NOTES, & WALL TYPES
LS1.0LA	LIFE SAFETY
AS1.0LA	SITE PLAN
A1.0LA	COMPOSITE FLOOR PLAN
AD1.1LA	AREA "A" - DEMOLITION PLAN
AD1.2LA	AREA "B" - DEMOLITION PLAN
A1.1LA	AREA "A" - NEW WORK PLAN
A1.2LA	AREA "B" - NEW WORK PLAN
A2.1LA	AREA "A" - REFLECTED CEILING PLAN
A2.2LA	AREA "B" - REFLECTED CEILING PLAN
A3.0LA	ROOF PLAN
A4.0LA	BUILDING ELEVATIONS
A5.1LA	CLASSROOM ADDITION PLANS
A5.2LA	CLASSROOM ADDITION ELEVATIONS, SECTIONS, WALL SECTIONS & DETAILS
A5.3LA	FRONT OFFICE ADDITION PLANS, WALL SECTIONS & DETAILS
A5.4LA	DETAILS & INTERIOR ELEVATIONS
A7.1LA	DOOR SCHEDULE & DETAILS
A7.2LA	ROOM FINISH SCHEDULE
A8.1LA	DISPLAY BOARD PLAN
A8.2LA	SIGNAGE SCHEDULE
A8.3LA	TILE FLOORING PLAN

Wood Creek Elementary

G0.0	COVER SHEET, SHEET INDEX, LOCATION MAP
G4.1	GENERAL INFORMATION, SYMBOLS, & ABBREVIATIONS
G4.2	FLOOR PLAN KEY NOTES, REFLECTED CEILING PLAN KEY NOTES, & WALL TYPES
LS1.0WC	LIFE SAFETY PLAN
AS1.0WC	SITE PLAN
A1.0WC	COMPOSITE FLOOR PLAN
AD1.1WC	AREA "A" & AREA "B" - DEMOLITION PLANS
AD1.2WC	AREA "C" - DEMOLITION PLAN
A1.1WC	AREA "A" & AREA "B" - NEW WORK PLANS
A1.2WC	AREA "C" - NEW WORK PLAN
A2.1WC	AREA "A" & AREA "B" - REFLECTED CEILING PLANS
A2.2WC	AREA "C" - REFLECTED CEILING PLAN
A3.0WC	ROOF PLAN
A4.0WC	BUILDING ELEVATIONS
A5.1WC	ENLARGED KITCHEN PLAN
A5.2WC	ENLARGED STRUCTURAL PLANS
A7.1WC	DOOR SCHEDULE & DETAILS
A7.2WC	ROOM FINISH SCHEDULE
A8.1WC	DISPLAY BOARD PLAN
A8.2WC	SIGNAGE SCHEDULE
A8.3WC	COMPOSITE TILE FLOOR FINISH PLAN

CIVIL DRAWINGS

Hillside

C1.0 General Plan
C2.0 Paving Removal Plan
C3.0 Paving Plan
C4.0 Soil Erosion and Sedimentation Control Plan
C5.0 Soil Erosion and Sedimentation Control Plan

Longacre

C1.0L General Plan
C2.0L Paving Removal Plan
C3.0L Paving Plan
C4.0L Building Addition Bid ALT 1L
C5.0L Soil Erosion and Sedimentation Control Plan

Wood Creek

C1.0 General Plan
C2.0 Paving Removal Plan
C3.0 Paving Plan
C4.0 Building Addition Bid ALT 1
C5.0 Soil Erosion and Sedimentation Control Plan

FOOD SERVICE

FSE-1
FSE-2
FSE-3

Hillside

ELECTRICAL DRAWINGS:

E0.1HS ELECTRICAL STANDARDS AND DRAWING INDEX
E0.2HS ELECTRICAL STANDARD SCHEDULES
E0.3HS ELECTRICAL SITE PLAN - ALTERNATE E1H
ED1.0AHS AREA 'A' LOWER LEVEL ELECTRICAL DEMOLITION PLAN
ED1.1BHS AREA 'B' FIRST FLOOR ELECTRICAL DEMOLITION PLAN
ED1.1CHS AREA 'C' FIRST FLOOR ELECTRICAL DEMOLITION PLAN
ED1.2DHS AREA 'D' SECOND FLOOR ELECTRICAL DEMOLITION PLAN
E2.0AHS AREA 'A' LOWER LEVEL LIGHTING NEW WORK PLAN
E2.1BHS AREA 'B' FIRST FLOOR LIGHTING NEW WORK PLAN
E2.1CHS AREA 'C' FIRST FLOOR LIGHTING NEW WORK PLAN
E2.2DHS AREA 'D' SECOND FLOOR LIGHTING NEW WORK PLAN
E3.0AHS AREA 'A' LOWER LEVEL POWER NEW WORK PLAN
E3.1BHS AREA 'B' FIRST FLOOR POWER NEW WORK PLAN

E3.1CHS AREA 'C' FIRST FLOOR POWER NEW WORK PLAN
E3.2DHS AREA 'D' SECOND FLOOR POWER NEW WORK PLAN
E5.1HS ONE LINE DIAGRAM
E7.1HS ELECTRICAL DETAILS
E7.2HS ELECTRICAL DETAILS

MECHANICAL DRAWINGS:

M0.1HS MECHANICAL STANDARDS AND DRAWING INDEX
MD1.01AHS AREA 'A' LOWER LEVEL MECHANICAL DEMOLITION PLAN
MD1.1BHS AREA 'B' FIRST FLOOR MECHANICAL DEMOLITION PLAN
MD1.1CHS AREA 'C' FIRST FLOOR MECHANICAL DEMOLITION PLAN
MD1.2DHS AREA 'D' SECOND FLOOR MECHANICAL DEMOLITION PLAN
M2.0AHS AREA 'A' LOWER LEVEL PLUMBING NEW WORK PLAN
M2.1BHS AREA 'B' LOWER LEVEL PLUMBING NEW WORK PLAN
M2.1CHS AREA 'C' FIRST FLOOR PLUMBING NEW WORK PLAN
M2.2DHS AREA 'D' SECOND FLOR PLUMBING NEW WORK PLAN
M3.0AHS AREA 'A' LOWER LEVEL HVAC NEW WORK PLAN
M3.1BHS AREA 'B' FIRST FLOOR HVAC NEW WORK PLAN
M3.1CHS AREA 'C' FIRST FLOOR HVAC NEW WORK PLAN
M3.2DHS AREA 'D' SECOND FLOOR HVAC NEW WORK PLAN
M5.1HS MECHANICAL DETAILS
M7.1HS MECHANICAL SCHEDULES
M7.2HS MECHANICAL SCHEDULES
M8.1HS TEMPERATURE CONTROLS STANDARDS AND GENERAL NOTES
M8.2HS TEMPERATURE CONTROLS

Longacre

ELECTRICAL DRAWINGS:

E0.1LA ELECTRICAL STANDARDS AND DRAWING INDEX
E0.2LA ELECTRICAL STANDARD SCHEDULES
E0.3LA ELECTRICAL SITE PLAN - ALTERNATE E2L
ED1.1ALA AREA 'A' ELECTRICAL DEMOLITION PLAN
ED1.1BLA AREA 'B' ELECTRICAL DEMOLITION PLAN
E2.1ALA AREA 'A' LIGHTING NEW WORK PLAN
E2.1BLA AREA 'B' LIGHTING NEW WORK PLAN
E3.1ALA AREA 'A' POWER NEW WORK PLAN
E3.1BLA AREA 'B' POWER NEW WORK PLAN
E5.1LA ONE LINE DIAGRAM
E7.1LA ELECTRICAL DETAILS
E7.2LA ELECTRICAL DETAILS

MECHANICAL DRAWINGS:

M0.1LA MECHANICAL STANDARDS AND DRAWING INDEX
MD1.1ALA AREA 'A' MECHANICAL DEMOLITION PLAN
MD1.1BLA AREA 'B' MECHANICAL DEMOLITION PLAN
M2.1ALA AREA 'A' PLUMBING NEW WORK PLAN
M2.1BLA AREA 'B' PLUMBING NEW WORK PLAN
M3.1ALA AREA 'A' HVAC NEW WORK PLAN
M3.1BLA AREA 'B' HVAC NEW WORK PLAN
M6.1LA MECHANICAL DETAILS
M6.2LA MECHANICAL DETAILS
M7.1LA MECHANICAL SCHEDULES
M7.2LA MECHANICAL SCHEDULES
M8.1LA TEMPERATURE CONTROLS STANDARDS AND GENERAL NOTES
M8.2LA TEMPERATURE CONTROLS

Woodcreek

ELECTRICAL DRAWINGS:

E0.1WC ELECTRICAL STANDARDS AND DRAWING INDEX
E0.2WC ELECTRICAL STANDARD SCHEDULES
E0.3WC ELECTRICAL SITE PLAN - ALTERNATE E1W
ED1.1AWC AREA 'A' ELECTRICAL DEMOLITION PLAN
ED1.1BWC AREA 'B' ELECTRICAL DEMOLITION PLAN
E2.1AWC AREA 'A' LIGHTING NEW WORK PLAN
E2.1BWC AREA 'B' LIGHTING NEW WORK PLAN
E3.1AWC AREA 'A' POWER NEW WORK PLAN
E3.1BWC AREA 'B' POWER NEW WORK PLAN
E5.1WC ONE LINE DIAGRAM
E7.1WC ELECTRICAL DETAILS
E7.2WC ELECTRICAL DETAILS

MECHANICAL DRAWINGS:

M0.1WC MECHANICAL STANDARDS AND DRAWING INDEX
MD1.1AWC AREA 'A' MECHANICAL DEMOLITION PLAN
MD1.1BWC AREA 'B' MECHANICAL DEMOLITION PLAN
M2.1AWC AREA 'A' PLUMBING NEW WORK PLAN
M2.1BWC AREA 'B' PLUMBING NEW WORK PLAN
M3.1AWC AREA 'A' HVAC NEW WORK PLAN
M3.1BWC AREA 'B' HVAC NEW WORK PLAN
M5.1WC MECHANICAL DETAILS
M7.1WC MECHANICAL SCHEDULES
M7.2WC MECHANICAL SCHEDULES
M8.1WC TEMPERATURE CONTROLS STANDARDS AND GENERAL NOTES
M8.2WC TEMPERATURE CONTROLS

END OF SECTION 00851

SECTION 01090 - REFERENCE STANDARDS

PART 1 - GENERAL

1.01 SECTION INCLUDES:

- A. Quality assurance.
- B. Schedule of references.

1.02 QUALITY ASSURANCE:

- A. For products or workmanship specified by association, trade, or Federal Standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
- B. Conform to reference standard by date of issue current on date for receiving bids.
- C. Obtain copies of standards when required by Contract Documents.
- D. Maintain copy at job site during submittals, planning, and progress of the specific work, until Substantial Completion.
- E. Should specified reference standards conflict with Contract Documents, request clarification from Architect/Engineer before proceeding.
- F. The contractual relationship of the parties to the Contract shall not be altered from the Contract Documents by mention or inference otherwise in any reference document.

1.04 SCHEDULE OF REFERENCE:

- AA Aluminum Association
900 19th Street, N.W. - Suite 300
Washington, DC 20006
- AABC Associated Air Balance Council
1518 K Street N.W.
Washington, DC 20005
- AASHTO American Association of State Highway
and Transportation Officials
444 North Capitol Street, N.W. - Suite 249
Washington, DC 20001

FARMINGTON PUBLIC SCHOOLS
2017 RENOVATIONS-BID PACK #5
ELEMENTARY SCHOOLS

161664B

NOVEMBER 30, 2016

ACI American Concrete Institute
P.O. Box 9094
Farmington Hills, MI 48333-9094

ADC Air Diffusion Council
1901 N. Roselle Rd., Suite 800
Schaumburg, IL 60195

AF&PA American Forest & Paper Association
1111 19th Street, NW, Suite 800
Washington, DC 20036

AGC Associated General Contractors of America
2300 Wilson Blvd., Suite 400
Arlington, VA 22201

AI Asphalt Institute
2696 Research Park Drive
Lexington, KY 40511-8480

AIA American Institute of Architects
1735 New York Avenue, N.W.
Washington, DC 20006-5292

AISC American Institute of Steel Construction
One East Wacker Drive
Suite 3100
Chicago, IL 60601-2001

AISI American Iron and Steel Institute
1140 Connecticut Ave - Suite 705
Washington, DC 20036

AITC American Institute of Timber Construction
7012 S. Revere Parkway - Suite 140
Englewood, CO 80112

AMCA Air Movement and Control Association
30 West University Drive
Arlington Heights, IL 60004

ANSI American National Standards Institute
25 West 43rd Street, Fourth Floor
New York, NY 10036

APA American Plywood Association
Box 11700
Tacoma, WA 98411-0700

FARMINGTON PUBLIC SCHOOLS
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ELEMENTARY SCHOOLS

161664B

NOVEMBER 30, 2016

ARI Air Conditioning and Refrigeration Institute
4100 North Fairfax Drive - Suite 200
Arlington, VA 22203

ASHRAE American Society of Heating, Refrigeration and
Air Conditioning Engineers
1791 Tullie Circle, N.E.
Atlanta, GA 30329

ASME American Society of Mechanical Engineers
Three Park Avenue
New York, NY 10016-5990

ASTM American Society for Testing and Materials
100 Barr Harbor Drive
West Conshohocken, PA 19428-2959

AWI Architectural Woodwork Institute
46179 Westlake Drive, Suite 120
Potomac Falls, VA 20165

AWPA American Wood-Preservers' Association
P.O. Box 5690
Grandbury, TX 76049

AWS American Welding Society
550 N.W. LeJeune Road
Miami, FL 33126

AWWA American Water Works Association
6666 West Quincy Avenue
Denver, CO 80235

BIA Brick Institute of America
1350 Centennial Park Drive, Suite 301
Reston, VA 20191

CDA Copper Development Association
260 Madison Avenue - 16th Floor
New York, NY 10016

CLFMI Chain Link Fence Manufacturers Institute
10015 Old Columbia Road, Suite B-215
Columbia, MD 21046

CRSI Concrete Reinforcing Steel Institute
933 Plum Grove Road
Schaumburg, IL 60173-4758

CSSB Cedar Shake and Shingle Bureau
P.O. Box 1178
Sumas, WA 98295-1178

DHI Door and Hardware Institute
14150 Newbrook Drive, Suite 200
Chantilly, VA 20151

EJCDC Engineers' Joint Contract Documents Committee
American Council of Engineering Companies
1015 15th Street, N.W., 8th Floor
Washington, DC 20005

EJMA Expansion Joint Manufacturers Association
25 North Broadway
Tarrytown, NY 10591

FGMA Flat Glass Marketing Association
3310 Harrison
White Lakes Professional Building
Topeka, KS 66611

FM Factory Mutual System
Standards Laboratories Department
1151 Boston-Providence Turnpike
Norwood, MA 02062

FS Federal Specification
General Services Administration
Specifications and Consumer Information
Distribution Section (WFSIS)
1800 F Street, NW
Washington, DC 20405

GA Gypsum Association
810 First Street N.W. #510
Washington, DC 20002-4268

ICC International Code Council
5203 Leesburg Pike, Suite 600
Falls Church, VA 22041

IEEE Institute of Electrical and Electronics Engineers
345 East 47th Street
New York, NY 10017

IMIAC International Masonry Industry All-Weather Council
International Masonry Institute
815 15th Street, N.W.
Washington, DC 20005

MBMA Metal Building Manufacturer's Association
1300 Sumner Avenue
Cleveland, OH 44115-2351

MFMA Maple Flooring Manufacturers Association
60 Revere Drive
Northbrook, IL 60062

MIL Military Specification
Naval Publications and Forms Center
700 Robbins Avenue, Building 4, Section D
Philadelphia, PA 19111-5093

ML/SFA Metal Lath/Steel Framing Association
Division of National Association of Architectural Metal
Manufacturers (NAAMM MLIFSA)
600 South Federal Street, Suite 400
Chicago, IL 60605

NAAMM National Association of Architectural Metal
Manufacturers
800 Roosevelt Road, Building C, Suite 312
Glen Ellyn, IL 60137

NCMA National Concrete Masonry Association
2302 Horse Pen Road
Herndon, VA 22071-3499

NEBB National Environmental Balancing Bureau
8575 Grovement Circle
Gaithersburg, MD 20877

NEMA National Electrical Manufacturers' Association
1300 North 17th Street, Suite 1752
Rosslyn, VA 22209

NFPA National Fire Protection Association
#1 Battery March Park
Quincy, MA 02269-9101

NSWMA National Solid Wastes Management Association
4301 Connecticut Avenue, N.W., Suite 300
Washington, DC 20008-2304

NTMA National Terrazzo and Mosaic Association
201 North Maple, Suite 208
Purcellville, VA 20132

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2017 RENOVATIONS-BID PACK #5
ELEMENTARY SCHOOLS

161664B

NOVEMBER 30, 2016

PCA Portland Cement Association
5420 Old Orchard Road
Skokie, IL 60077

PCI Precast Prestressed Concrete Institute
175 W. Jackson Blvd.-Suite 1859
Chicago, IL 60604-9773

PS Product Standard
U.S. Department of Commerce
1401 Constitution Avenue, N.W.
Washington, DC 20230

RIS Redwood Inspection Service
Division of California Redwood Association
405 Enfrente Drive
Novato, CA 94949

SDI Steel Deck Institute
P.O. Box 25
Fox River Grove, IL 60021

SDI Steel Door Institute
c/o Wherry Associates
30200 Detroit Road
Cleveland, OH 44145-1967

SIGMA Sealed Insulating Glass Manufacturers Association
401 N. Michigan Avenue
Chicago, IL 60611

SJI Steel Joist Institute
3127 10th Avenue North
Myrtle Beach, SC 29577-6760

SMACNA Sheet Metal and Air Conditioning Contractors'
National Association
4201 Lafayette Center Drive
Chantilly, VA 20151-1209

SSPC Society for Protective Coatings
40 24th Street, 6th Floor
Pittsburgh, PA 15222-4656

TCNA Tile Council of North America, Inc.
100 Clemson Research Blvd.
Anderson, SC 29625

FARMINGTON PUBLIC SCHOOLS
2017 RENOVATIONS-BID PACK #5
ELEMENTARY SCHOOLS

161664B

NOVEMBER 30, 2016

TPI Turfgrass Producers International
2 East Main Street
East Dundee, IL 60118

UL Underwriters' Laboratories, Inc.
333 Pfingston Road
Northbrook, IL 60062-2096

WCLIB West Coast Lumber Inspection Bureau
6980 S.W. Varns Road
Tigard, OR 97223

WDMA Window & Door Manufacturers Associations
1400 W. Touhy Avenue, Suite 470
Des Plaines, IL 60018

WWPA Western Wood Products Association
522 SW Fifth Avenue, Suite 500
Portland, OR 97204-2122

PART 2 - PRODUCTS
Not Used

PART 3 - EXECUTION
Not Used

END OF SECTION 01090

SECTION 01100 - ALTERNATES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Attention is directed to Division 0, Bidding and Contract Requirements, and to Division 1, General Requirements, which are hereby made a part of this Section.

1.02 DESCRIPTION OF WORK:

- A. This section identifies each Alternate by number, and describes the basic changes to be incorporated into the work, only when the Alternate is made a part of the work by specific provisions in the Owner-Contractor Agreement.
- B. Alternate schedule below is part of the Bidding Documents and will be considered in selection of Contractors and awarding contracts.
- C. Unless otherwise provided, Owner will accept or reject alternates within one hundred twenty (120) days of date of contract. Owner reserves the right to reject any or all alternates.

1.03 ALTERNATES:

A. General:

- 1. The descriptions for each alternate listed in the schedule are primarily scope definitions, and do not necessarily detail the full range of materials and processes needed to complete the work as required.
- 2. Refer to applicable specification sections (Division 2 through 16), and to applicable drawings, for specific requirements of the work, regardless of whether references are so noted in description of each alternative.
- 3. Coordinate pertinent related work and modify surrounding work as required to properly integrate the work under each Alternate, and to provide the complete construction required by Contract Documents.
- 4. Referenced sections of specifications stipulate pertinent requirements for products and methods to achieve the work stipulated under each Alternate.

B. Schedule:

1. **Alternate No. 1:** Provide cost to provide all components and electrical supply for new ground sign for Hillside Elem as detailed on sheet AS1.0HS.
2. **Alternate No. 2:** Provide cost to remove existing marker and tack boards and provide new marker and tack boards on rear walls (Non-Projector walls) of classrooms at Hillside Elem. as indicated on the drawings.
3. **Alternate No. 3:** Provide cost to provide all components from the 2 Classroom addition for Longacre Elementary as detailed on drawings.
4. **Alternate No. E1W:** Provide new site and building lighting and rework the circuiting as required at Wood Creek Elem. so that it is controlled by the building automation system.
5. **Alternate No. E1L:** Provide new site and building lighting and rework the circuiting as required at Longacre Elem. so that it is controlled by the building automation system.
6. **Alternate No. E1H:** Provide new site and building lighting and rework the circuiting as required at Hillside Elem. so that it is controlled by the building automation system.

END OF SECTION 01100

SECTION 01810 - COMMISSIONING REQUIREMENTS

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUMMARY.....2
1.3 DEFINITIONS.....2
1.4 DESCRIPTION.....7
1.5 SUBMITTALS.....8
1.6 QUALITY ASSURANCE.....9
1.7 COORDINATION.....9
1.8 COMMISSIONING PLAN.....10
1.9 COMMISSIONING TEAM.....11
1.10 RESPONSIBILITIES11
1.11 EQUIPMENT/SYSTEMS TO BE COMMISSIONED19

PART 2 - PRODUCTS.....20
2.1 TEST EQUIPMENT.....20

PART 3 - EXECUTION.....21
3.1 MEETINGS.....21
3.2 STARTUP, CONSTRUCTION CHECKLISTS, AND INITIAL CHECKOUT...22
3.3 PHASED COMMISSIONING (IF REQUIRED).....26
3.4 PERFORMANCE TESTING.....26
3.5 DOCUMENTATION, NON-CONFORMANCE, AND APPROVAL OF TESTS....28
3.6 DEFERRED TESTING.....31
3.7 TRAINING OF OWNER PERSONNEL.....31
3.8 OPERATIONS AND MAINTENANCE MANUALS/DATA.....33

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to this section.
- B. Owner's Project Requirements and Basis of Design documents are included by reference for information only.
- C. Related Sections include the following:
 - 1. Division 01 Section "Coordination."
 - 2. Division 01 Section "Construction Progress Documentation."
 - 3. Division 01 Section "Submittal Procedures."

4. Division 01 Section "Closeout Procedures" for Project Records, Operation and Maintenance Manuals.

1.2 SUMMARY

- A. This section includes general requirements that apply to the implementation of the commissioning process without regard to specific systems, assemblies, and components.

1.3 DEFINITIONS

- A. Acceptance: A formal action, taken by a person with appropriate provider (which may or may not be contractually defined) to declare that some aspect of the project meets defined requirements, thus permitting subsequent activities to proceed.
- B. Approval: Acceptance that a piece of equipment or system has been properly installed and is functioning in the tested modes according to the Contract Documents.
- C. Basis of Design (BoD): A document that records the concepts, calculations, decisions, and product selections used to meet the Owner's project requirements and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.
- D. Checklists: Verification checklists that are developed and used during all phases of the commissioning process to verify that the Owner's project requirements are being achieved. This includes checklists for general verification, plus testing, training, and other specific requirements.
- E. Commissioning Authority (CxA): The entity identified by the Owner who leads, plans, schedules, and coordinates the commissioning team to implement the commissioning process.
- F. Commissioning Plan: An overall plan developed by the commissioning agent that provides the structure, schedule and coordination planning for the commissioning process.
- G. Commissioning Process: A quality-focused process for enhancing the delivery of a project. The process focuses upon verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed,

tested, operated, and maintained to meet the Owner's project requirements.

- H. Commissioning Process Activities: Components of the commissioning process.
- I. Commissioning Process Progress Report: A written document that details activities completed as part of the commissioning process and significant findings from those activities that is continuously updated during the course of a project. Usually it is incorporated into the commissioning plan as an ongoing appendix.
- J. Commissioning Team: The individuals who through coordinated actions are responsible for implementing the commissioning process.
- K. Construction Checklist: A form used by the Contractor to verify that appropriate components are on-site, ready for installation, correctly installed, and functional. Also refer to Checklists.
- L. Construction Documents: This includes a wide range of documents, which will vary from project to project, with the Owner's needs and with regulations, laws, and countries. Construction documents usually include the Project Manual (specifications), plans (Drawings) and general terms and conditions of the Contract.
- M. Continuous Commissioning Process: A continuation of the commissioning process well into the occupancy and operations phase to verify that a project continues to meet current and evolving Owner's project requirements. Continuous commissioning process activities are on-going for the life of the facility. Also refer to On-Going Commissioning Process.
- N. Contract Documents: This includes a wide range of documents, which will vary from project to project, with the Owner's needs and with regulations, laws, and countries. Contract Documents frequently include price agreements, construction management process, sub-contractor agreements or requirements, requirements and procedures for submittals, changes, and other construction requirements, timeline for completion, and the construction documents.

- O. Coordination Drawings: Drawings showing the work of all trades to illustrate that equipment can be installed in the space allocated without compromising equipment function or access for maintenance and replacement. These drawings graphically illustrate and dimension manufacturers' recommended maintenance clearances.
- P. Control System: A component of environmental, HVAC, security, and fire systems for reporting/monitoring and issuing of commands to/from field devices.
- Q. Data Logging: The monitoring and recording of flows, currents, status, pressures, etc., of equipment using stand-alone data recorders separate from the control system or the trending capabilities of control systems.
- R. Deferred Performance Tests (DPTs): Performance tests that are performed, at the discretion of the CxA, after substantial completion, due to partial occupancy, equipment, seasonal requirements, design, or other site conditions that disallow the test from being performed.
- S. Deficiency: A condition in the installation or function of a component, piece of equipment, or system that is not in compliance with the Contract Documents.
- T. Field Quality Control: Testing of equipment on-site, by factory personnel, or by the Contractor with or without the assistance of factory personnel, and with or without an Owner's representative present.
- U. Issues Log: A formal and ongoing record of problems or concerns, and their resolutions, which have been raised by members of the commissioning team during the course of the commissioning process.
- V. Nominal Group Technique: A formal, structured brainstorming process used to obtain the maximum possible ranked input from a variety of viewpoints in a short period of time. The typical approach is a workshop session where a question is presented, the attendees each record their responses on a piece of paper, the individual responses are recorded on a flip chart without discussion in a round robin fashion, all of the responses are discussed, and the participants rank their top five responses.
- W. Non-Compliance: See **Deficiency**.

- X. Non-Conformance: See **Deficiency**.
- Y. On-Going Commissioning Process: A continuation of the commissioning process well into the occupancy and operations phase to verify that a project continues to meet current and evolving Owner's project requirements. On-going commissioning process activities occur throughout the life of the facility. Some of these will be close to continuous in implementation, and others will be either scheduled or unscheduled (as needed). Also see **Continuous Commissioning Process**.
- Z. Owner's Project Requirements (OPR): A written document that details the functional requirements of a project and the expectations of how it will be used and operated. This includes project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information. (The term "Project Intent" is used by some Owners for their commissioning process Owner's project requirements or design.)
- AA. Over-ridden Value: Riding over a sensor value in the equipment's controls to observe the response of the equipment's operation. Also see **Simulated Signal**.
- BB. Phased Commissioning: Commissioning that is completed in phases as required by the phasing plan for the project and other scheduling issues.
- CC. Quality Based Sampling: A process for evaluating a sub-set (sample) of the total population. The sample is based upon a known or estimated probability distribution of expected values; an assumed statistical distribution based upon data from a similar product, assembly, or system; or a random sampling that has scientific statistical basis.
- DD. Re-Commissioning: An application of the commissioning process requirements to a project that has been delivered using the commissioning process. This may be a scheduled re-commissioning developed as part of an ongoing commissioning process, or it may be triggered by use change, operations problems, or other needs.
- EE. Retro-Commissioning: The commissioning process applied to an existing facility that was not previously commissioned. This guideline does not specifically address retro-commissioning. However, the same basic process needs to be followed from pre-design through occupancy and operations to optimize the

benefits of implementing the commissioning process philosophy and practice.

- FF. Seasonal Performance Tests: Performance tests that are deferred until the system(s) will experience conditions closer to their design conditions based on weather conditions.
- GG. Simulated Condition: Condition that is created for the purpose of testing the response of a system (e.g., raising/lowering the setpoint of a thermostat to see the response in a VAV box).
- HH. Simulated Signal: Disconnecting a sensor and using a signal generator to simulate a sensor value for the purpose of testing a full range of conditions.
- II. Source Quality Control: Testing of equipment at the factory, by factory personnel, with or without an Owner's representative present.
- JJ. Startup: The initial starting or activating of dynamic equipment, including completing construction checklists.
- KK. Systems Manual: A system-focused composite document that includes the operation manual, maintenance manual, and additional information of use to the Owner during the occupancy and operations phase.
- LL. Test Procedure: A written protocol that defines methods, personnel, and expectations for tests conducted on components, equipment, assemblies, systems, and interfaces among systems. The test procedures are specified in the Technical Specifications sections of the Contract Documents. Performance testing covers the dynamic functions and operations of equipment and systems using manual or monitoring methods. Performance testing is the dynamic testing of systems under full operation. Systems are tested under various modes, such as during low cooling loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all the control system's sequences of operation and components are verified to respond as the sequences state.

- MM. Training Plan: A written document that details the expectations, schedule, budget, and deliverables of commissioning process activities related to training of project operating and maintenance personnel, users, and occupants.
- NN. Verification: The process by which specific documents, components, equipment, assemblies, systems, and interfaces among systems are confirmed to comply with the criteria described in the Owner's Project Requirements.
- OO. Trending: The monitoring, by a building automation system (BAS) or other electronic data gathering equipment, and analyzing of the data gathered over a period of time.
- PP. Vendor: Supplier of equipment.
- QQ. Warranty Period: Refer to the Conditions of the Contract and individual Specification Sections.

1.4 DESCRIPTION

- A. Commissioning: Commissioning is a quality-oriented process for achieving, verifying, and documenting that the performance of facilities, systems, and assemblies meet defined objectives and criteria. The Commissioning process begins at project inception (during the pre-design phase) and continues through the life of the facility. The commissioning process includes specific tasks to be conducted during each phase in order to verify that design, construction, and training meets the Owner's project requirements.
- B. Commissioning Team: The members of the commissioning team consist of the contracted commissioning authority (CxA), the Owner's Representative/Construction Manager (CM), the General Contractor (GC), the Architect and Engineers (A/E), the mechanical subcontractor (MC), the electrical subcontractor (EC), the testing and balancing (TAB) subcontractor, the control subcontractor (CC), the facility operating staff, and any other installing subcontractors or suppliers of equipment. The CxA is hired by the Owner directly. The CxA directs and coordinates the project commissioning activities and the reports to the Owner. All team members work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents.

C. Commissioning shall:

1. Verify that applicable equipment and systems are installed according to the Contract Documents, manufacturer's recommendations, and industry accepted minimum standards and that they receive adequate operational checkout by installing Contractors.
2. Verify and document proper performance of equipment and systems.
3. Verify that O&M documentation left on site is complete.
4. Verify that the Owner's operating personnel are adequately trained.

- D. The commissioning process does not take away from or reduce the responsibility of the system designers or installing Contractors to provide a finished and fully functioning product.

1.5 SUBMITTALS

- A. The CxA will provide appropriate Contractors with a specific request for the type of submittal documentation the CxA requires facilitating the commissioning work. These requests will be integrated into the normal submittal process and protocol of the construction team. At minimum, the request will include the manufacturer and model number, the manufacturer's printed installation and detailed startup procedures, full sequences of operation, O&M data, performance data, any performance test procedures, control drawings and details of Owner contracted tests. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the CxA. All documentation requested by the CxA will be included by the subcontractors in their O&M manual contributions.
- B. The CxA will review submittals related to the commissioned equipment for conformance to the Contract Documents as it relates to the commissioning process, to the performance of the equipment and adequacy for developing test procedures. This review is intended primarily to aid in the development of performance procedures and only secondarily to verify compliance with equipment specifications. The commissioning authority will notify the Owner/CM, PM or A/E as requested, of items missing or areas that are not in conformance with Contract Documents and which require resubmission.

- C. The CxA may request additional design narrative from the A/E and controls subcontractor, depending on the completeness of the OPR documentation and sequences provided with the Specifications.
- D. These submittals to the CxA do not constitute compliance for O&M manual documentation. The O&M manuals are the responsibility of the Contractor, though the CxA will review them.

1.6 QUALITY ASSURANCE

A. ASHRAE: Follow Guidelines:

- 1. 0-2005, "The Commissioning Process."
- 2. 1-1996, "The HVAC Commissioning Process."
- 3. 5-1994, "Commissioning Smoke Management Systems."

B. InterNational Electrical Testing Association: NETA Acceptance Testing Specifications (ATS) -1996

C. Instructor Qualifications: Factory-authorized service representatives, experienced in training, operation, and maintenance procedures for installed systems, subsystems, and equipment.

D. Test Equipment Calibration: Comply with test equipment manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately whenever instruments have been repaired following damage or dropping. Affix calibration tags to test instruments or have certificates readily available. Instruments shall have been calibrated within six months prior to use.

1.7 COORDINATION

A. Project Commissioning Team: The members of the project commissioning team will consist of the commissioning authority and any support personnel, the Construction Manager, the Owner's facility staff (FS) or designee, the General Contractor, subcontractors and/or vendors as required, and the Architect/Engineer (A/E).

B. Management: The CxA coordinates the commissioning activities through the Construction Manager. All members shall work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents. Refer to

Article "Commissioning Plan" for additional management details.

- C. Scheduling: The CxA, through the Owner or CM, will provide sufficient notice to the Contractor for scheduling commissioning activities with respect to the Owner's participation. The Contractor will integrate all commissioning activities into the overall project schedule. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite the commissioning process.
- D. Manufacturers' Field Services: CxA shall coordinate services of manufacturers' field representatives.

1.8 COMMISSIONING PLAN

- A. The CxA will develop the commissioning plan which shall be included in the project schedule after review by the Owner or CM. The following narrative provides a brief overview of the typical commissioning tasks during construction and the general order in which they occur.
 - 1. Commissioning during construction begins with an initial commissioning meeting conducted by the CxA where the commissioning process is reviewed with the project commissioning team members.
 - 2. Additional meetings will be required throughout construction, scheduled by the CxA, through the Owner or CM, with necessary parties attending to plan, scope, coordinate, schedule future activities and resolve problems.
 - 3. Equipment documentation is submitted to the CxA, through the Owner or CM, during normal submittals, including detailed startup procedures.
 - 4. The construction checklists are to be completed by the Contractor (or subcontractors), before and during the startup process.
 - 5. Construction checklists, TAB and startup must be completed before performance testing.
 - 6. Items of non-compliance in material, installation, or setup shall be corrected at no expense to the Owner.
 - 7. The Contractor ensures that the subcontractors' construction checklists are executed and documented and that startup and initial checkout are performed. The CxA verifies that the TAB, construction checklists and startup were completed according to the plans. This

includes the CxA reviewing TAB, checklists and startup plans. This also includes witnessing startup of selected equipment. Any testing failure is to be corrected at no additional cost to the Owner, and a re-test is to be performed, observed, and documented.

8. The CxA develops and implements equipment and system performance test procedures. The forms and procedures are reviewed by the Owner, CM and A/E.
9. The performance tests are executed by the Contractor under the direction of the CxA with the assistance of the facility staff. All documentation is by the CxA.
10. The CxA reviews the O&M documentation for completeness and provides the commissioning record for the O&M manuals.
11. Commissioning should be completed before substantial completion.
12. The CxA develops procedures, reviews, coordinates, and implements the training provided by the Contractor.
13. Deferred testing is conducted as specified or required.

1.9 COMMISSIONING TEAM

A. Members appointed by Contractor(s): Individuals, each having authority to act on behalf of the entity they represent, explicitly organized to implement the commissioning process through coordinated actions. The commissioning team shall consist of, but not be limited to, representatives of each Contractor, including project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.

B. Members appointed by Owner:

1. CxA - An entity identified by the Owner who leads, plans, schedules, and coordinates the commissioning team to implement the commissioning process. Owner will engage the CxA under a separate contract.
2. Representatives of the facility user and operation and maintenance personnel.
3. Architect and engineering design professionals.

1.10 RESPONSIBILITIES

A. The general responsibilities of various parties in the commissioning process are provided in this Article. The specific responsibilities are in the Technical Specifications.

B. All Parties:

1. Follow the commissioning plan.
2. Attend initial commissioning meeting and additional meetings as necessary.

C. Architect (of A/E):

1. Construction Phase:

- a. Prepare BoD documents for review and distribution by the Owner.
- b. Attend the commissioning scoping meeting and selected commissioning team meetings.
- c. Perform normal submittal review, construction observation, as-built drawing preparation, project punchlist preparation, etc., as contracted.
- d. Provide any design narrative documentation requested by the CxA.
- e. Coordinate resolution of system deficiencies identified during commissioning, according to the Contract Documents.
- f. Prepare and submit final as-built design intent documentation for inclusion in the O&M manuals. Review the O&M manuals.

D. Mechanical and Electrical Designers/Engineers (of the A/E):

1. Construction Phase:

- a. Perform normal submittal review, construction observation, as-built drawing preparation, project punchlist preparation, etc., as contracted. One site observation should be completed just prior to system startup.
- b. Provide any design narrative and sequences documentation requested by the CxA. The designers shall assist (along with the Contractors) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
- c. Attend commissioning scoping meetings and other selected commissioning team meetings.
- d. Participate in the resolution of system deficiencies identified during commissioning, according to the Contract Documents.

- e. Prepare and submit the final as-built design intent and operating parameters documentation for inclusion in the O&M manuals. Review the O&M manuals.
2. Occupancy and Operations Phase:
 - a. Participate in the resolution of non-compliance, non-conformance and design deficiencies identified during commissioning during warranty-period commissioning.
- E. Commissioning Authority (CxA):
1. The Contractors will provide all tools or the use of tools to start, check-out and test equipment and systems, except for specified testing with portable data-loggers, which shall be supplied and installed by the CxA.
 2. The CxA will verify the execution of commissioning process activities using random sampling. The sampling rate may vary from 1 to 100 percent. Verification will include, but is not limited to, equipment submittals, construction checklists, training, operating and maintenance data, tests, and test reports to verify compliance with the OPR. When a random sample does not meet the requirement, CxA will report the failure in the "Issues Log."
 3. Construction Phase:
 - a. Coordinates and directs the commissioning activities in a logical, sequential and efficient manner using consistent protocols and forms, centralized documentation, clear and regular communications and consultations with all necessary parties, frequently updated timelines and schedules and technical expertise.
 - b. Coordinate the commissioning work and, with the Owner/CM, help integrate commissioning activities into the master schedule.
 - c. Revise the Construction Phase Commissioning Plan as necessary.
 - d. Plan and conduct a commissioning scoping meeting and other commissioning meetings.
 - e. Request and review additional information required to perform commissioning tasks, including O&M materials, Contractor startup and checkout procedures.
 - f. Before startup, gather and review the current control sequences and interlocks and work with Contractors and design engineers until sufficient clarity has

- been obtained, in writing, to be able to write detailed testing procedures.
- g. Review normal Contractor submittals applicable to systems being commissioned for compliance with commissioning needs, concurrent with the A/E reviews.
 - h. Write and distribute construction checklists. Prepare and maintain completed construction checklist log.
 - i. Develop an enhanced startup and initial systems checkout plan with subcontractors.
 - j. Perform site visits, as necessary, to observe component and system installations. Attend selected planning and job-site meetings to obtain information on construction progress. Review construction meeting minutes for revisions/substitutions relating to the commissioning process. Assist in resolving any discrepancies.
 - k. Witness part of the HVAC piping test and flushing procedure, sufficient to be confident that proper procedures were followed. Document this testing and include the documentation in O&M manuals. Notify Owner/CM of any deficiencies in results or procedures.
 - l. Witness part of the ductwork testing and cleaning procedures, sufficient to be confident that proper procedures were followed. Document this testing and include the documentation in O&M manuals. Notify Owner's project manager of any deficiencies in results or procedures.
 - m. Review construction checklist completion by selected site observation and spot checking.
 - n. Recommend approval of systems startup by reviewing startup reports and by selected site observation.
 - o. Review TAB execution plan.
 - p. Oversee sufficient testing of the control system prior to use by TAB, before TAB is executed.
 - q. Recommend approval of air and water systems balancing by spot testing, by reviewing completed reports and by selected site observation.
 - r. With necessary assistance and review from installing Contractors, write the performance test procedures for equipment and systems, including energy management control system trending, stand-alone data logger monitoring or manual performance testing. Submit to CM for review.
 - s. Analyze any performance trend logs and monitoring data to verify performance.

- t. Coordinate and witness manual performance tests performed by installing Contractors. Coordinate retesting as necessary until satisfactory performance is achieved.
- u. Maintain a master Issues Log and a separate testing record. Provide the Owner/CM with written progress reports and test results with recommended actions.
- v. Review equipment warranties to ensure that the Owner's responsibilities are clearly defined.
- w. Oversee the training of the Owner's operating personnel.
- x. Compile and maintain a commissioning record and building systems book(s).
- y. Review the O&M manuals for compliance with the Contract requirements.
- z. Provide a final commissioning report (as described in this Section).

4. Occupancy and Operations Phase:

- a. Coordinate and supervise required seasonal or deferred testing and deficiency corrections.
- b. Return to the site at 10 months into the 12 month warranty period and review with facility staff the current building operation and the condition of outstanding issues related to the original and seasonal commissioning. Also interview facility staff and identify problems or concerns they have operating the building as originally intended. Make suggestions for improvements and for recording these changes in the O&M manuals. Identify areas that may come under warranty or under the original construction contract. Assist facility staff in developing reports, documents and requests for services to remedy outstanding problems.

F. Owner or Owner's Representative (CM):

1. Establish Contracts:

- a. Owner and Architect: Agreement for design.
- b. Owner and Contractor: Contract for construction.
- c. Owner and Commissioning Authority: Agreement for observation and review of the commissioning process.

2. Construction and Acceptance Phase:

- a. Facilitate the coordination of the commissioning work by the CxA, and, with the GC and CxA, ensure that commissioning activities are being scheduled into the master schedule.
- b. Provide utility services required for the commissioning process.
- c. Review the final "Commissioning Plan - Construction Phase."
- d. Attend a commissioning scoping meeting and other commissioning team meetings.
- e. Perform the normal review of Contractor submittals.
- f. Furnish a copy of all construction documents, addenda, change orders and reviewed submittals and shop drawings related to commissioned equipment to the CxA.
- g. Review the performance test procedures submitted by the CxA, prior to testing.
- h. When necessary, observe and witness startup and performance testing of selected equipment.
- i. Review commissioning progress and deficiency reports.
- j. Coordinate the resolution of non-compliance and design deficiencies identified in all phases of commissioning.
- k. Sign-off (final approval) on individual commissioning tests as completed and passing. Recommend completion of the commissioning process to the Project Manager.
- l. Assist in coordinating the training of Owner personnel.
- m. Provide the OPR documentation to the CxA and each Contractor for information and use.
- n. Provide the BoD documents, prepared by Architect and reviewed by Owner, to the CxA and each Contractor for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.
- o. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities.

3. Occupancy and Operations Phase:

- a. Assist the CxA as necessary in the seasonal or deferred testing and deficiency corrections required by the Specifications.
- b. Attend lessons learned session.

G. Owner's Project Manager (PM):

1. Construction Phase:

- a. Manage the Contract of the A/E and of the GC.
- b. Arrange for facility operating and maintenance personnel to attend various field commissioning activities and field training sessions.
- c. Provide final approval for the completion of the commissioning work.

2. Occupancy and Operations Phase:

- a. Ensure that any seasonal or deferred testing and any deficiency issues are addressed.
- b. Attend lessons learned session.

H. Contractor: Each Contractor and their subcontractors and vendors shall assign representatives with expertise and authority to act on their behalf and schedule them to participate in and perform commissioning process activities including, but not limited to, the following:

1. Construction Phase:

- a. Facilitate the coordination of the commissioning and incorporate commissioning activities (the Commissioning Plan) into the Overall Project Schedule (OPS).
- b. Integrate and coordinate commissioning process activities with the OPS.
- c. Provide detailed startup procedures.
- d. Include the cost of commissioning in the total Contract price.
- e. Ensure that all subcontractors and vendors execute their commissioning responsibilities according to the Contract Documents and the OPS.
- f. Provide copies of all submittals as required in Division 01 Section "Submittals" including all changes thereto. Attend and participate in commissioning team meetings held biweekly.
- g. No later than 60 days prior to startup of the first piece of major equipment, meet with the CxA, CM, A/E, and PM and Owner to finalize the detailed commissioning procedures/ schedule.
- h. Provide the training of Owner personnel.

- i. Review construction checklists provided by the commissioning authority.
 - j. Complete construction checklists as work is completed and provide to the CxA on a weekly basis.
 - k. Accomplish commissioning process test procedures.
 - l. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
 - m. Cooperate with the CxA for resolution of issues recorded in the "Issues Log".
 - n. Prepare O&M manuals, according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built/as-tested conditions.
2. Occupancy and Operations Phase:
- a. Ensure that subcontractors provide assistance for seasonal or deferred performance testing, performed by the CxA, according to the Specifications.
 - b. Ensure that subcontractors correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.
 - c. Perform all guarantee work for materials furnished under the contract for the time specified in the Contract, including all warranties and curing all latent defects within the time period provided in the Contract.
- I. Vendors/Subcontractors:
1. Provide all requested submittal data, including detailed startup procedures and specific responsibilities of the Owner to keep warranties in force.
 2. Assist in equipment testing per agreements with subcontractors and/or Contractor.
 3. Include cost of all special tools and instruments (only available from vendor, specific to a piece of equipment) required for testing, operating, and maintaining equipment according to these Contract Documents in the base bid price to the Contractor.
 4. Analyze specified products and verify that the A/E has specified the newest, most current equipment reasonable for this project's scope and budget.

5. Provide requested information regarding equipment sequence of operation and testing procedures.
6. Review construction checklists and test procedures for equipment installed by factory representatives.

1.11 EQUIPMENT/SYSTEMS TO BE COMMISSIONED

A. The following equipment/systems will be commissioned in this project:

1. Mechanical Systems:

- a. Heating systems.
 - 1) Boilers.
- b. Cooling systems.
 - 1) Refrigeration systems.
- c. Air handling systems.
 - 1) Blower coil units.
 - 2) Packaged units.
 - 3) Vertical unit ventilators.
 - 4) Combustion air units
 - 5) In-line return fans.
 - 6) Roof Mounted Air Handling Units
- d. Terminal systems.
 - 1) Terminal Units.
 - 2) Unit heaters.
 - 3) Cabinet unit heaters.
- e. Exhaust and stand alone systems.
 - 1) Ductless split systems.
 - 2) Exhaust fans.
- f. Plumbing systems.
 - 1) Domestic hot water.
 - 2) Pumping systems.

2. Electrical systems:

a. Normal Power Distribution.

- 1) Grounding and Bonding.
- 2) Enclosed Switches
- 3) Low Voltage Transformer.
- 4) Motor Control.
- 5) Switchboard/Panelboards.
- 6) Medium Voltage Transformers.
- 7) Wiring Devices.

b. Emergency Power Distribution.

- 1) Generators

c. Lighting Systems.

- 1) Daylighting Control.
- 2) Emergency Lighting Systems.
- 3) Lighting Controls.

d. Fire Alarm Systems.

e. Specialty electrical systems.

- 1) School intercom and program equipment.
- 2) Clock and program systems.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. All standard testing equipment required to perform startup and initial checkout and required performance testing shall be provided by the Contractor for the equipment being tested. This includes, but is not limited to, two-way radios, meters, and data recorders. Data recorders may be provided by the CxA at the option of the CxA,
- B. Special equipment, tools, and instruments required for testing equipment according to these Contract Documents shall be included in the Contractor's base bid price and shall be turned over to the Owner at Project close-out.

- C. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance within the tolerances specified in the specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration to NIST traceable standards to an accuracy of 0.5 deg F and a resolution of plus or minus 0.1 deg F. Pressure sensors shall have an accuracy of plus or minus 2.0 percent of the value range being measured (not full range of meter).

PART 3 - EXECUTION

3.1 MEETINGS

- A. Initial Meeting: Within 10 days of the Notice to Proceed (NTP), the CxA, through the Owner/CM, will schedule, plan and conduct an initial commissioning meeting. The Contractor and Contractor's responsible parties are required to attend.
- B. Training Preparation Conference: Before operation and maintenance training, CxA shall convene a training preparation conference to include Owner's operation and maintenance personnel, [each] Contractor, and subcontractors. In addition to requirements specified in Division 01 Section "Demonstration and Training," perform the following:
 - 1. Review the OPR and BoD.
 - 2. Review installed systems, subsystems, and equipment.
 - 3. Review instructor qualifications.
 - 4. Review instructional methods and procedures.
 - 5. Review training module outlines and contents.
 - 6. Review course materials (including operation and maintenance manuals).
 - 7. Inspect and discuss locations and other facilities required for instruction.
 - 8. Review and finalize training schedule and verify availability of educational materials, instructors, audiovisual equipment, and facilities needed to avoid delays.
 - 9. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.
- C. Miscellaneous Meetings: Other meetings will be planned and conducted by the CxA as construction progresses. These meetings will cover coordination, deficiency resolution, and planning issues. These meetings will be held at least

monthly, until the final 3 months of construction, when they may be held as frequently as one per week.

3.2 STARTUP, CONSTRUCTION CHECKLISTS, AND INITIAL CHECKOUT

- A. The following procedures apply to all equipment/systems to be commissioned, according to Article "Equipment/Systems to be Commissioned."
- B. General: Construction checklists are important to verify that the equipment and systems are fully connected and operational. It ensures that performance testing (in-depth system checkout) may proceed without unnecessary delays. The construction checklists for a given system must be successfully completed and approved prior to startup and formal performance testing of equipment or subsystems of the given system.
- C. Startup and Checkout Plan: The CxA will assist the project commissioning team members responsible for startup of any equipment. The primary role of the CxA in this process is to ensure that there is written documentation that each of the manufacturer-recommended procedures has been completed. The CxA shall provide construction checklists and startup shall be identified in the commissioning scoping meeting and on the checklist forms
 - 1. The construction checklists are provided in with the Cx Manual. These checklists indicate required procedures to be executed as part of startup and initial checkout of the systems and the party responsible for their execution.
 - 2. The Contractor shall determine which trade is responsible for executing and documenting each of the line item tasks and transmit the checklists to the responsible subcontractors. Each form may have more than one trade responsible for its execution.
 - 3. The Contractor/subcontractor with assistance from the CxA responsible for the purchase of the equipment shall develop the full startup plan by combining the manufacturer's detailed startup and checkout procedures and the construction checklists.
 - 4. The Contractor/subcontractor shall submit the full startup plan to the CxA for review and approval.
 - 5. The CxA will review and approve the procedures and the documentation format for reporting. The CxA will return

the procedures and the documentation format to the Contractor, through the CM.

6. The Contractor will transmit the full startup plan to the subcontractors for their review and use.

D. Sensor and Actuator Calibration: All field-installed temperature, relative humidity, CO, CO₂, refrigerant, O₂, and/or pressure sensors and gages, and all actuators (dampers and valves) on all equipment shall be calibrated. Verify that all locations are appropriate and away from causes of erratic operation. Submit to the CxA through the CM the calibration methods and results. All test instruments shall have had a certified calibration within the last 6 months to NIST traceable standards, and comply with all local, state and/or federal requirements/certifications, as required. Sensors installed in the unit at the factory with calibration certification provided need not be field calibrated. Provide bench testing as required at the direction of the CxA.

1. Sensor Calibration Methods:

- a. All Sensors: Verify that all sensor locations are appropriate and away from causes of erratic operation. Verify that sensors with shielded cable, are grounded only at one end. For sensor pairs that are used to determine a temperature or pressure difference, make sure they are reading within 0.2 deg F of each other for temperature and within a tolerance equal to 2 percent of the reading, of each other, for pressure. Tolerances for critical applications may be tighter.
- b. Sensors Without Transmitters: Standard Application. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or BAS) is within the tolerances in the table below of the instrument-measured value. If not, install offset in BAS, calibrate or replace sensor.
- c. Sensors With Transmitters: Standard Application. Disconnect sensor. Connect a signal generator in place of sensor. Connect ammeter in series between transmitter and BAS control panel. Using manufacturer's resistance-temperature data, simulate minimum desired temperature. Adjust transmitter potentiometer zero until 4 mA is read by the ammeter. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the

BAS. Record all values and recalibrate controller as necessary to conform with specified control ramps, reset schedules, proportional relationship, reset relationship and P/I reaction. Reconnect sensor. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or BAS) is within the tolerances in the table below of the instrument-measured value. If not, replace sensor and repeat. For pressure sensors, perform a similar process with a suitable signal generator.

- d. Critical Applications: For critical applications (process, manufacturing, etc.) more rigorous calibration techniques may be required for selected sensors. Describe any such methods used on an attached sheet.

e. Tolerances, Standard Applications

<u>Sensor</u>	<u>Required Tolerance</u> (+/-)	<u>Sensor</u>	<u>Required Tolerance</u> (+/-)
Cooling coil, chilled and condenser water temps	0.4F	Flow rates, water	4% of design
AHU wet bulb or dew point	2.0F	Relative humidity	4% of design
Hot water coil and boiler water temp	1.5F	Combustion flue temps	5.0F
Outside air, space air, duct air temps	0.4F	Oxygen or CO ₂ monitor	0.1 % pts
Wathour, voltage & amperage	1% of design	CO monitor	0.01 % pts
Pressures, air, water and gas	3% of design	Natural gas and oil flow rate	1% of design
Flow rates, air	10% of design	Steam flow rate	3% of design
		Barometric pressure	0.1 in. of Hg

- f. Valve and Damper Stroke Setup and Check EMS Readout:
 For all valve and damper actuator positions checked, verify the actual position against the BAS readout. Set pumps or fans to normal operating mode. Command valve or damper closed, visually verify that valve or damper is closed and adjust output zero signal as required. Command valve or damper open, verify position is full open and adjust output signal as required. Command valve or damper to a few intermediate positions. If actual valve or damper position doesn't reasonably correspond, replace actuator or add pilot positioner (for pneumatics).

- g. Closure for Heating Coil Valves (NO): Set heating setpoint 20 deg F above room temperature. Observe valve open. Remove control air or power from the valve and verify that the valve stem and actuator position do not change. Restore to normal. Set heating setpoint to 20 deg F below room temperature. Observe the valve close. For pneumatics, by override in the EMS, increase pressure to valve by 3 psi (do not exceed actuator pressure rating) and verify valve stem and actuator position does not change. Restore to normal.
- h. Closure for Cooling Coil Valves (NC): Set cooling setpoint 20 deg F above room temperature. Observe the valve close. Remove control air or power from the valve and verify that the valve stem and actuator position do not change. Restore to normal. Set cooling setpoint to 20 deg F below room temperature. Observe valve open. For pneumatics, by override in the EMS, increase pressure to valve by 3 psi (do not exceed actuator pressure rating) and verify valve stem and actuator position does not change. Restore to normal.

E. Execution of Construction Checklists and Startup:

- 1. Four weeks prior to the scheduled startup, the Contractor shall coordinate startup and checkout with the CM, A/E, and CxA. The execution and approval of the construction checklists, startup, and checkout shall be directed and performed by the Contractor, subcontractor or vendor. Signatures are required of the applicable subcontractors for verification of completion of their work.
- 2. The Owner/CM, and A/E as necessary, shall observe, at minimum, the procedures for each piece of primary equipment, unless there are multiple units, in which case a sampling strategy may be used. The CxA will observe all testing.
- 3. For lower-level components of equipment, (e.g., sensors, controllers), the CxA shall observe a sampling of the startup procedures.
- 4. The subcontractors and vendors shall execute startup and provide the CxA and A/E, through the Owner/CM, with a signed and dated copy of the completed startup and construction checklists.
- 5. Only individuals of the Contractor (technicians, engineers, tradesmen, vendors, etc.) who have direct knowledge and witnessed that a line item task on the

construction checklist was actually performed shall check off that item. It is not acceptable for witnessing supervisors to fill out these forms.

F. Deficiencies, Non-Conformance, and Approval in Checklists and Startup (Master Issues Log):

1. The Contractor shall ensure that the subcontractors clearly list any outstanding items of the initial startup and construction checklist procedures that were not completed successfully, on an attached sheet. The form and any outstanding deficiencies shall be provided, through the Owner/CM, to the CxA within two days of test completion.
2. The CxA will review the report and issue either a non-compliance report or an approval form, through the CM, to the Contractor. The installing subcontractors or vendors shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner, shall notify the Owner/CM as soon as outstanding items have been corrected, and resubmit an updated startup report with a Statement of Correction on the original non-compliance report. When satisfactorily completed, the CxA will recommend approval of the execution of the checklists and startup of each system.
3. Items left incomplete, which later cause deficiencies or delays during performance testing may result in backcharges to the Contractor. Refer to Article "Performance Testing" for details.

3.3 PHASED COMMISSIONING (IF REQUIRED)

- A. The project requires TAB, startup and performance testing to be executed in phases. Phasing shall be coordinated with the Owner/CM, CxA, and A/E and be reflected in the overall project schedule and commissioning schedule by the Contractor. Final performance testing of all systems will be as required by the phasing plan. The performance testing of the "systems as a whole" will be performed before final turnover of the entire project.

3.4 PERFORMANCE TESTING

- A. Requirements: The performance testing shall demonstrate that each system is operating according to the documented design intent and Contract Documents. Performance testing facilitates bringing the systems from a state of individual

substantial completion to full dynamic operation. Additionally, during the testing process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems.

- B. Coordination and Scheduling: The Contractor shall provide sufficient notice, regarding their completion schedule for the construction checklists and startup of all equipment and systems to allow the performance testing to be scheduled. The commissioning team shall oversee, witness, and document the performance of all equipment and systems. The CxA in association with the Contractor/subcontractors and facility staff shall execute the tests. Performance testing shall be conducted after the construction checklists, and startup has been satisfactorily completed. The control system shall be sufficiently tested prior to use, to verify performance of other components or systems. The air balancing and water balancing shall be completed before performance testing of air or water related equipment or systems. Testing proceeds from components to sub-systems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems shall be checked.
- C. Development of Test Procedures: Before test procedures are finalized, the Contractor shall provide to the A/E and the CxA all requested documentation and a current list of changes affecting equipment or systems, including an updated points list, program code, control sequences, and testing parameters. Using the testing parameters and requirements in the technical Specifications, the CxA shall update/develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Each Contractor/subcontractor or vendor, as appropriate, shall provide assistance to the CxA in developing the final procedures. Prior to finalization, the A/E shall review and concur with the test procedure.
- D. Test Methods:
1. Performance testing and verification may be achieved by manual testing or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by stand-alone data loggers. The CxA may substitute specified methods or require an additional method to be executed other than what was specified, with the approval of the A/E and Owner/CM. The CxA will

determine which method is most appropriate for tests that do not have a specified method.

2. Simulated Conditions: Simulating conditions shall be allowed, though timing the testing to experience actual conditions is encouraged wherever practical.
3. Overridden Values: Overriding sensor values to simulate a condition, such as overriding the outside air temperature reading in a control system to be something other than it really is, is acceptable.
4. Simulated Signals: Using a signal generator which creates a simulated signal to test and calibrate transducers and DDC constants is generally recommended over using the sensor to act as the signal generator via simulated conditions or overridden values.
5. Altering Setpoints: Rather than overriding sensor values, and when simulating conditions is difficult, altering setpoints to test a sequence is acceptable.
6. Indirect Indicators: Relying on indirect indicators for responses or performance shall be allowed only after visually and directly verifying and documenting, over the range of the test parameters, that the indirect readings through the control system represent actual conditions and responses.
7. Setup: Each performance test shall be performed under conditions that simulate actual conditions as closely as is practically possible. The Contractor/subcontractor(s) assisting the CxA in executing the test shall provide all necessary materials, system modifications, etc., to produce the necessary flows, pressures, temperatures, etc., necessary to execute the test according to the specified conditions. At completion of the test, the Contractor/subcontractor(s) shall return all affected equipment and systems to their normal operating settings.

E. Test Equipment: Refer to Part 2 for test equipment requirements.

F. Problem Solving: The burden of responsibility to solve, correct, and retest malfunctions/failures is with the Contractor, with A/E approval as required.

3.5 DOCUMENTATION, NON-CONFORMANCE, AND APPROVAL OF TESTS

A. Documentation: The CxA shall witness and verify the documentation of the results of all performance tests. The CxA shall complete all documentation for performance testing.

B. Non-Conformance:

1. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CxA. In such cases the deficiency and resolution will be documented on the procedure form or on an attached sheet.
2. As tests progress and a deficiency is identified, the CxA shall discuss the issue with the commissioning team, and the Contractor.
 - a. When there is no dispute concerning the deficiency and the Contractor accepts responsibility to correct it:
 - 1) The CxA will document the deficiency and the Contractor's response and intentions. After the day's work, the CxA will submit the non-compliance reports to the CM. The Contractor corrects the deficiency, signs the statement of correction at the bottom of the non-compliance form certifying that the equipment is ready to be retested and sends it back to the CxA.
 - 2) The Contractor shall reschedule the test; and the test repeated.
 - b. If there is a dispute about a deficiency, regarding whether or not it is a deficiency:
 - 1) The dispute shall be documented on the non-compliance form with the Contractor's response.
 - 2) Resolutions are made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive authority is with the A/E. Final acceptance authority is with the Construction Manager.
 - 3) The CxA documents the resolution process.
 - 4) Once the interpretation and resolution have been decided, the Contractor corrects the deficiency, signs the statement of correction on the non-compliance form and provides it to the CxA, through the CM. The Contractor shall reschedule the test and the test shall be repeated until satisfactory performance is achieved.
3. Cost of repeating a performance test is the Contractor's.
4. The Contractor shall submit in writing to the CM at least as often as commissioning meetings are being scheduled,

the status of each outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreement and proposals for their resolutions.

- a. The CxA retains the original non-conformance forms until the end of the project.
- b. Retesting shall not be considered a justified reason for a claim of delay or for a time extension by the Contractor.

C. Failure Due to Manufacturer Defect: If 10 percent (or three, whichever is greater) of identical pieces of equipment fail to perform to the Contract Documents (mechanically or substantively) due to a manufacturing defect, not allowing it to meet its submitted performance specification, all identical units may be considered unacceptable by the A/E or CxA. In such case, the Contractor shall provide the Owner with the following:

1. Within one week of notification from the Owner/CM, the Contractor or manufacturer's representative shall examine all other identical units making a record of the findings. The findings shall be provided to the CM within two weeks of the original notice.
2. Within two weeks of the original notification, the Contractor or manufacturer shall provide a signed and dated, written explanation of the problem, cause of failures, etc., and all proposed solutions. The proposed solutions shall not significantly exceed the specification requirements of the original installation.
3. The A/E will determine whether a replacement of all identical units or a repair is acceptable.
4. Two examples, where applicable, of the proposed solution shall be installed by the Contractor and the A/E shall be allowed to test the installations for up to one week, upon which the A/E will decide whether to accept the solution.
5. Upon acceptance, the Contractor and/or manufacturer shall replace or repair all identical items, at their expense. The replacement/repair work shall proceed with reasonable speed beginning within one week from the time parts can be obtained.

D. Approval: The CxA notes each satisfactorily demonstrated function on the test form. Final approval of the performance test by the Owner is made after review by the CxA and CM, following recommendations by the A/E.

3.6 DEFERRED TESTING

- A. Unforeseen Deferred Tests: If any check or test cannot be completed due to the project completion level, required occupancy condition or other deficiency, execution of checklists and performance testing may be delayed upon approval of the CxA and CM. These tests will be conducted in the same manner as the seasonal tests as soon as possible. Services of necessary parties will be negotiated.
- B. Seasonal Testing: During the warranty period, seasonal testing (tests delayed until weather conditions are closer to the system's design) shall be completed as part of this contract. The CxA shall coordinate this activity through the Owner/CM. Tests will be executed, documented by the CxA and deficiencies should be corrected by the appropriate Contractor/ subcontractors with the CxA witnessing. Any final adjustments to the O&M manuals and as-builts due to the testing shall be made by the Contractor.

3.7 TRAINING OF OWNER PERSONNEL

- A. The Contractor shall provide training coordination, scheduling of subcontractors, and ensure that training is completed. All training shall be coordinated, through the CM, with the CxA.
- B. The Contractor shall ensure that each subcontractor and vendor (mechanical, plumbing, fire, electrical, specialty, etc.) shall have the following responsibilities:
 - 1. Provide, to the CxA through the CM, a training plan 60 days before the planned training covering the following elements:
 - a. Equipment.
 - b. Intended audience.
 - c. Location of training.
 - d. Objectives.
 - e. Subjects covered (description, duration of discussion, special methods, etc.).
 - f. Duration of training on each subject.
 - g. Instructor for each subject.
 - h. Methods (classroom lecture, manufacturer's quality video, site walk-through, actual operational demonstrations, written handouts, etc.).

2. Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of equipment that makes up the system.
3. Training shall normally start with classroom sessions followed by hands-on demonstration/training on each piece of equipment.
4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system shall be repaired or adjusted as necessary and the demonstration repeated at another scheduled time, if necessary.
5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.
6. The controls subcontractor shall attend sessions other than the controls training, as specified, to discuss the interaction of the controls system as it relates to the equipment being discussed.
7. The training sessions shall follow the outline in the table of contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
8. Training shall include:
 - a. Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
 - b. A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include startup, operation in all modes possible, shutdown, seasonal changeover and any emergency procedures.
 - c. Discussion of relevant health and safety issues and concerns.
 - d. Discussion of warranties and guarantees.
 - e. Common troubleshooting problems and solutions.
 - f. Explanatory information included in the O&M manuals.
 - g. Discussion of any peculiarities of equipment installation or operation.
 - h. Classroom sessions shall include the use of overhead projections, slides, video/audio-taped material as might be appropriate.

1. Quantity: Six (Unless more are required by the technical specifications).
2. Format: 8-1/2 x 11 three-ring loose-leaf binders, 3-inch maximum, and electronic format that is compatible with Owner's system. Each binder shall be clearly labeled on the spine. Use as many binders as required. Do not overload binders. Dividers with permanently marked tabs of card stock shall separate each section and sub section. Tab labels shall not be handwritten. A separate manual or chapter shall be provided for each applicable system as follows:
 - a. Hydronic pumps.
 - b. Domestic hot and cold water systems.
 - c. Piping systems.
 - d. Ductwork systems.
 - e. Fans.
 - f. Motors.
 - g. Lighting Controls.
 - h. Energy management systems.
 - i. Unit heaters.
3. There shall be a title page and table of contents in the front of each binder for each binder's contents. In each binder, there shall be a main tab for each Specification Section. Behind the section number tab there shall be the equipment ID tag sub-tab for each piece of major equipment (or group, if small or numerous). These sub-tabs shall be similar to the specification number tabs but of a different color. Behind each equipment name tab shall be the following sections, in the given order, divided by a double weight colored sheet labeled with the title of the section.
 - a. Contractor: The first page behind the equipment tab shall contain the name, address and telephone number of the manufacturer and installing Contractor and the 24-hour number for emergency service for all equipment in this section, identified by equipment.
 - b. Submittal and Product Data: This section shall include all reviewed submittal data, cut sheets, data base sheets and appropriate shop drawings. If submittal was not required for approval, descriptive product data shall be included.
 - c. Operation and Maintenance Instructions: These shall be the manufacturer's published data with the model

and features of this installation clearly marked and edited to omit reference to products or data not applicable to this installation. This section shall include data on the following:

- 1) Model number, serial number and nameplate data for each piece of equipment and any subcomponent.
- 2) Installation, startup and break-in instructions.
- 3) All starting, normal shutdown, emergency shutdown, manual operation and normal and emergency operating procedures and data, including any special limitations.
 - a) Step-by-step procedure for system startup, including a pre-start checklist. Refer to controls and indicators by nomenclature consistent with that used on panels and in control diagrams.
 - b) Sequence of operation, with detailed instruction in proper sequence, for each mode of operation (i.e., day-night; staging of equipment).
 - c) Emergency Operation: If some functions of the equipment can be operated while other functions are disabled, give instructions for operations under these conditions. Include here only those alternate methods of operations (from normal) which the operator can follow when there is a partial failure or malfunctioning of components, or other unusual condition.
 - d) Shutdown Procedure: Include instructions for stopping and securing the equipment after operation. If a particular sequence is required, give step-by-step instructions in that order.
- 4) O&M and installation instructions that were shipped with the unit.
- 5) Preventative and corrective maintenance, with service procedures and schedules:
 - a) Provide a schedule for preventive maintenance in a printed format and an electronic format compatible with Owner's system. State, preferably in tabular form,

- the recommended frequency of performance for each preventive maintenance task, cleaning, inspection and scheduled overhauls.
- b) Cleaning: Provide instructions and schedules for all routine cleaning and inspection with recommended lubricants.
 - c) Inspection: If periodic inspection of equipment is required for operation, cleaning or other reasons, indicate the items to be inspected and give the inspection criteria for: motors; controls; filters and any other maintenance items.
 - d) Provide instructions for minor repairs or adjustments required for preventive maintenance routines. Identify test points and give values for each. Include sensor calibration requirements and methods by sensor type.
 - e) Corrective maintenance instructions shall be predicated upon a logical effect-to-cause troubleshooting philosophy and a rapid replacement procedure to minimize equipment downtime.
 - f) Troubleshooting: Troubleshooting tables, charts, or diagrams shall be used to present specified procedures. A guide to this type shall be a three-column chart. The columns shall be titled: "Malfunction," "Probable Cause" and "Recommended Action."
 - g) Repair and Replacement: Indicate repair and replacement procedures most likely to be required in the maintenance of the equipment.
- 6) Safety Precautions: This subsection shall comprise a listing of safety precautions and instructions to be followed before, during and after making repairs, adjustments or routine maintenance.
- 7) Manufacturers' brochures (including controls): Manufacturers' descriptive literature covering devices and equipment used in the system, together with illustrations, exploded views and renewal parts lists. Manufacturers' standard brochures and parts list shall be corrected so

that information applying to the actual installed equipment is clearly defined.

- 8) Supply any special tools required to service or maintain the equipment.
- 9) Performance data, ratings and curves.
- 10) Warranty and guarantee, which clearly lists conditions to be maintained to keep warranty in effect and conditions that would affect the validity of the warranty.
- 11) Service contracts issued.

- d. Supplemental Data. Prepare written text and/or special drawings to provide necessary information, where manufacturer's standard printed data is not available and information is necessary for a proper understanding and operation and maintenance of equipment or systems, or where it is necessary to provide additional information to supplement data included in the manual or project documents.
- e. Control Diagrams/Drawings. Include the as-built control diagrams/drawings for the piece of equipment and its components, including full points list, full print out of all schedules and set points after testing and acceptance of the system, and copies of all checkout tests and calibrations performed by the Contractor (not commissioning tests).
- f. Specifications. This section is comprised of the component or system Specification Section copied and inserted complete with all addenda.
- g. System Description. This section shall include the individual equipment portion of the overall system Design Basis Narrative.

E. Commissioning Record in O&M Manuals.

1. The CxA is responsible to compile, organize and index the following commissioning data by equipment into labeled, indexed and tabbed, three-ring binders and deliver it to the GC, to be included with the O&M manuals.
 - a. Commissioning Plan.
 - b. System reports including design narratives and criteria including sequences. Each system shall contain the startup plan and report, approvals, corrections, construction checklists, completed performance tests, trending and analysis, training plan and recommended recommissioning schedule.

- c. Final Commissioning Report including an executive summary, list of participants and roles, brief building description, overview of commissioning and testing scope and a general description of testing and verification methods. For each piece of commissioned equipment, the report should contain the disposition of the commissioning authority regarding the adequacy of the equipment, documentation and training meeting the Contract Documents in the following areas:
- 1) Equipment meeting the equipment specifications.
 - 2) Equipment installation.
 - 3) Performance and efficiency.
 - 4) Equipment documentation and design intent.
 - 5) Operator training.
- d. All outstanding non-compliance items shall be specifically listed. Recommendations for improvement to equipment or operations, future actions, commissioning process changes, etc. shall also be listed. Each non-compliance issue shall be referenced to the specific performance test, inspection, trend log, etc. where the deficiency is documented. The performance and efficiency section for each piece of equipment shall include a brief description of the verification method used (manual testing, BAS trend logs, data loggers, etc.) and include observations and conclusions from the testing.

END OF SECTION 01810

SECTION 01575- EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Temporary erosion and sedimentation control measures.

1.02 QUALITY ASSURANCE

- A. Preinstallation Conference: Conduct conference at Project site with applicable subcontractors, the civil engineer of record, the Owner, and any applicable governing officials.

1.03 PROJECT CONDITIONS

- A. Review the soil erosion control plan prior to beginning any earthwork.
- B. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied facilities when installing erosion controls. Coordinate all measures with applicable government authorities having jurisdiction over the connecting, adjacent, or surrounding roadways.
- C. Utility Locator Service: Notify utility locator service for area where Project is located before installing erosion or sediment control measures.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Seed, sod, and or ground covers as indicated on the Drawings.
- B. Erosion/Sediment control devices or Best Management Practices, (BMP's) as indicated on the Drawings.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Review the Soil Erosion and Sedimentation Control plan all other applicable Drawings, etc.

3.02 IMPLEMENTATION AND DOCUMENTATION

- A. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- B. Update, maintain, alter, or add temporary erosion and sediment controls in conjunction with the Soil Erosion and Sedimentation Control plan and ongoing earthwork activities as required for the Project.
- C. Maintain an up-to-date Site Plan in the field office.
- D. Install permanent erosion measures such as pavement and lawn areas as soon as practically possible to minimize temporary pollution control measures.
- E. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
- F. Ensure that a proper Notice of Termination (NOT) is filed with the governing authority, if required.

3.03 CLOSEOUT DOCUMENTS

- A. Before retainage can be released, the Contractor must provide the Owner with the final Soil Erosion permit approval from the Authority Having Jurisdiction.

END OF SECTION 01575

SECTION 02220 - DEMOLITION

PART 1 - GENERAL

1.1 REGULATORY REQUIREMENTS

- A. Conform to applicable codes for demolition of structures, safety of adjacent structures, dust control, and disposal of materials.
- B. Obtain required permits from authorities.
- C. Notify affected utility companies prior to starting work and comply with their requirements.
- D. Conform to applicable regulatory procedures when discovering hazardous or contaminated materials.
- E. Rules, regulations or laws of any controlling Governmental Agency shall govern, when they are more stringent than the requirements of this Section.

1.2 DESCRIPTION

- A. Provide all labor, materials, and equipment necessary for the completion of all Demolition as shown on the Drawings and specified herein.
- B. All on and offsite Work included consists of but is not limited to:
 - 1. Demolition in part or in whole of existing buildings, footings, foundations, structures, and facilities together with subsequent removal of resulting debris.
 - 2. Removal of existing sidewalks, drives, curbs and pavement, as noted.
 - 3. Removal, disconnecting or capping off of existing utilities, underground structures, septic tanks, disposal fields, etc.

4. Removal or clearing of landscaping, trees, brush, debris, and miscellaneous Site elements as indicated on the Drawings, or as required for new construction.
5. Removal from Site and disposal of all excess and unusable material.

1.3 DEFINITIONS

- A. Remove: Remove items from existing construction and legally dispose of them off-site.
- B. Remove and Reinstall: Carefully remove items indicated from existing construction, prepare them for reuse, and reinstall them where indicated. Prior to reinstalling the item, the Contractor shall make a determination as to its soundness. Items which exhibit signs of wear or deterioration shall only be discarded on agreement with the Construction Manager, Architect and Owner.
- C. Remove and Salvage: Remove items from existing construction and deliver them to owner.

1.4 QUALITY ASSURANCE

- A. The Contractor shall visit the Site so that a full understanding of the difficulties and restrictions for execution of the Contract are made. Verify the location of all pertinent items. No additional compensation will be allowed for failure to be so informed.
- B. The Contractor shall submit a schedule indicating proposed sequence of operations for selective demolition Work to the Construction Manager for review prior to commencing Work. Include coordination for shutoff, capping, and continuation of utility services as required, together with details for dust and noise control protection.
- C. Comply with regulatory requirements and notification regulations before beginning selective demolition.

D. Comply with hauling and disposal regulations of authorities having jurisdiction. A receipt indicating acceptance of hazardous wastes from a landfill facility licensed to accept such materials shall be submitted to the owner.

1.4 JOB CONDITIONS

A. Existing structures, utilities, drives, walks, etc., have been shown on the plans in their approximate location, others may exist and may be found upon visiting the site. It shall be the responsibility of the Contractor to accurately locate all facilities and to determine their extent. If such facilities obstruct the progress of the Work and are not indicated to be removed or relocated, they shall be removed or relocated only as directed by the Owner.

B. Owner assumes no responsibility for the actual condition of items or structures to be demolished.

C. Contractor shall investigate the possibility of existing septic tanks and drain fields near the location of existing foundations, prior to demolition. In the event that any possible septic tanks exist, this Contractor shall make further investigations, as necessary, to locate the septic tank and drain fields. Any septic tank and drain field found to exist shall be removed in accordance with the requirements of State and Local Health Departments.

D. Protect trees, plants, and natural features which are to remain as final landscaping.

E. Replace to new conditions any pavement or public right-of-way that is disturbed by the Work under this Section. All pavement replacement work in public rights-of-way shall be performed to the proper satisfaction of the governmental agencies having jurisdiction thereover.

F. If cutting torches are used, take all necessary precautions to prevent setting of fires, including the use of fireproof tarpaulins and fire extinguishing apparatus adjacent to cutting area.

- G. Notify utility companies if removal or relocation of any existing utilities is required.
- H. Promptly repair damages caused to adjacent facilities by demolition Work.
- I. Do not close, block, or otherwise obstruct access to existing streets, sidewalks, driveways, and other adjacent occupied or used facilities during demolition. Any proposed closures shall have written permission from the authority having jurisdiction.
- J. Maintain existing utilities and protect them against damage during demolition operations.
 - 1. Do not interrupt utilities serving occupied or used facilities, except when authorized in writing by authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to governing authorities.
 - 2. Maintain fire protection services during demolition operations.
- K. Environmental Controls: Use water sprinkling, temporary enclosures, and other methods to limit dust and dirt migration. Comply with governing regulations pertaining to environmental protection.
 - 1. Do not use water when it may create hazardous or objectionable conditions such as ice, flooding, and pollution.
- L. Underground Storage Tank Removal (if present): Contact all State, Federal and local agencies as may be required and determine the governing agencies requirements and provide agency contact information to the owner prior to construction.
 - 1. Completely remove all tanks, equipment lines, foundations and surrounding soils. Keep owner informed

as to the progress of the work and notify immediately of any irregularities.

1.5 DRAINAGE MAINTENANCE

- A. During the entire course of operations, all existing drainage ways, both into and from the Project area shall be maintained in a functional condition.
- B. At all times during the clearing operation, the exposed areas of subgrade shall be maintained in a condition compatible with positive drainage of the Work area. Failure to maintain such drainage shall be considered adequate cause for the Construction Manager to order temporary suspension of the Work.
- C. Cut drainage swales and provide temporary grading to carry storm water away from the demolition area. No water will be permitted to stand in open excavations.

PART 2 - PRODUCTS

- A. Use repair materials identical to existing materials. If identical materials are unavailable, use new materials whose performance is equal to or surpasses that of the existing material.
- B. Comply with material and installation requirements specified in the individual sections of this contract.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Locate, identify, and protect all known utilities which are to remain. If utilities are uncovered that are not shown on the plans, notify the owner and cease work in the immediate areas until instructed to how to proceed.

- B. Provide interior and exterior shoring, bracing, or support to prevent movement, settlement, or collapse of structures to be demolished and adjacent facilities to remain.
1. Cease operations and notify the Construction Manager, Architect and Owner immediately if safety of structure or adjacent structures appear to be endangered. Take precautions to support structure and **DO NOT** resume operations until a determination is made for continuing operations.
 2. Provide bypass connections as necessary to maintain continuity of service to occupied areas of building.
- C. Check with the water and sewer departments, Gas Company, and private utility companies to assure that all utilities and services are inoperative prior to their removal.

3.2 DEMOLITION

- A. Perform demolition Work in a systematic manner. Use such methods as required to complete Work indicated on Drawings in accordance with demolition schedule and governing regulations.
1. Sawcut asphalt pavement full depth at limits indicated for removal.
 2. Concrete pavement shall be sawcut full depth and removed to the joint nearest the indicated removal limit or where specifically directed.
 3. Where piping is to be bulkheaded, provide a permanent, water-tight plug consisting of brick and concrete mortar, one foot thick or prefabricated plugs intended for this purpose.
 4. Maintain in operating conditions all active utilities, sewers and drains encountered.
 5. The Contractor shall use extreme caution in removing any structures and utilities above and below grade to

prevent damage to existing utilities which are to remain in service. Any existing utilities to remain, which are in any way damaged, shall be replaced at no additional cost to the Owner.

6. Conduct operations in such a manner as to minimize noise, dust and other disturbances.

3.3 DISPOSAL OF DEMOLISHED MATERIALS

A. Demolished material not indicated for turning over to the owner or specified for reuse, including rubble and other debris, shall become the property of the contractor and shall be removed daily from the project site and legally disposed of off the project site, at no expense to the Owner.

1. If hazardous materials are encountered during demolition operations, comply with applicable regulations, laws, and ordinances concerning removal, handling, and protection against exposure or environmental pollution.
2. Burning of materials shall not be permitted on Site.

3.4 CLEANUP AND REPAIR

- A. Upon completion of demolition Work, remove tools, equipment, and demolished materials from Site.
- B. Repair demolition performed in excess of that required. Return elements of construction and surfaces to remain to condition existing prior to start of operations. Repair adjacent construction damaged by demolition Work.

END SECTION 02220

SECTION 02230 - SITE CLEARING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting and capping or sealing site utilities.

1.02 MATERIAL OWNERSHIP

- A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.03 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- B. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
- C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

- D. Do not commence site-clearing operations until temporary erosion and sedimentation control measures are in place. See Division 31 Section "Erosion and Sedimentation Control"

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

- A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Division 31 Section "Earth Moving."
 - 1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly flag trees and vegetation to remain or to be relocated.
- C. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.02 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Refer to Division 31 Section "Erosion and Sedimentation Controls."

3.03 TREE PROTECTION

- A. Erect and maintain temporary fencing around tree protection zones before starting site clearing. Remove fence when construction is complete.
- B. Do not excavate within tree protection zones, unless otherwise indicated.

- C. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by the Owner.

3.04 UTILITIES

- A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.

- 1. Arrange with utility companies to shut off indicated utilities.

- B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

- 1. Notify Owner not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without written permission of Owner.

3.05 CLEARING AND GRUBBING

- A. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

- 1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density of 98 percent standard proctor.

3.06 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
- C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water.

3.07 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction. Unless otherwise indicated, remove existing improvements above- and below-grade with-in proposed building areas. Remove other existing improvements or foundations to a minimum of one foot below the proposed subgrade. Break up basement or below subgrade slabs that are to remain to allow for drainage.

3.08 DISPOSAL

- A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
 - 1. Submit schedule for recycling operations (if any) and obtain approval in writing from Owner. Separate recyclable materials produced during site clearing from other non-recyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

3.09 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent geotechnical engineering testing agency to witness filling operations of depressions caused by clearing and grubbing. Coordinate scheduled filling operations with the Owner's testing agency.

END OF SECTION 02230

FARMINGTON PUBLIC SCHOOLS
2017 RENOVATIONS-BID PACK #5
ELEMENTARY SCHOOLS

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NOVEMBER 30, 2016

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SECTION 02300 - EARTH MOVING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Preparing subgrades for slabs-on-grade, walks, pavements, lawns and grasses, and exterior plants.
2. Excavating and backfilling for buildings and structures.
3. Drainage course for slabs-on-grade.
4. Subbase course for concrete paving.
5. Subbase and base course for asphalt paving.
6. Excavating and backfilling for utility trenches
7. Re-spreading of topsoil.

1.02 SUBMITTALS

- A. Certified Test Reports: Indicate compliance with compaction requirements.

1.03 DEFINITIONS

- A. Backfill: Soil material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

- B. Base Course: Course placed between the subbase course and hot-mix asphalt paving.

- C. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.

- D. Borrow Soil: Satisfactory soil imported from off-site or on site borrow pit for use as fill or backfill.

- E. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

- F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Owner. Authorized additional excavation and replacement material will be paid for according to Contract provisions changes in the Work.
 2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Owner. Unauthorized excavation, as well as remedial work directed by Owner, shall be without additional compensation.
- G. Fill: Soil materials used to raise existing grades.
- H. Flowable Fill or Controlled Low Strength Material (CLSM): A self-compacting alternative to granular backfill material that is not concrete and has a compressive strength between 50 and 200 psi.
- I. Lean Concrete: Concrete of low cementitious material content.
- J. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- K. Subbase Course: Course placed between the subgrade and base course for hot-mix asphalt pavement, or course placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.
- L. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.
- M. Topsoil: Fertile soil meeting requirements of ASTM D 5268 with a pH range of 5.5 to 7 and a minimum of 2 percent organic material content. Clean soil per planting soil requirements in Section 329000 "Planting."

- N. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.04 QUALITY ASSURANCE

- A. Imported (borrow) soil must be tested and certified, by the Owner's testing agency, as suitable material, free of any environmental contaminates. Coordinate imported materials and their source with Division 31 Section "Erosion and Sedimentation Control". The Contractor will be liable for any and all clean-up costs associated with unapproved, imported materials.

1.05 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by the Owner and then only after arranging to provide temporary utility services according to requirements indicated.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Provide ASTM D 2487 or AASHTO M 145 classified soil materials according to geotechnical engineer's written recommendations.
- C. Satisfactory Soils: Recommended materials free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
 - 1. Satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction will be considered unsatisfactory soil materials.

D. Provide granular soils materials according to local department of transportation (DOT) regulations or as follows:

1. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
2. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.
3. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
4. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.
5. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

2.02 ACCESSORIES

- A. Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Comply with geotechnical engineer's written recommendations.

- B. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- C. Preparation of subgrade is specified in Division 31 Section "Site Clearing."
- D. Protect and maintain erosion and sedimentation controls, which are specified in Division 31 Section "Erosion and Sedimentation Control" during earthwork operations.

3.02 EXCAVATION

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. No changes in the Contract Sum or the Contract Time will be authorized except for rock excavation or removal of obstructions not specifically indicated in the Contract Documents.
 - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
 - 2. Authorized additional excavation and replacement material will be paid for according to Contract provisions.
- B. Excavation for Structures: Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections
- C. Excavation for Pavements: Excavate surfaces under pavements to indicated lines, cross sections, elevations, and subgrades.
- D. Excavation for Utility Trenches: Excavate trenches to indicated gradients, lines, depths, and elevations or as required by authorities having jurisdiction. Reference trench detail CSD-2.

1. Trench Width: Provide a minimum clearance of 9 inches on each side of pipe or conduit with a desired maximum clearance of 12 inches on each side. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.
2. Trench Bottoms: Provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
 - a. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material, 4 inches deeper elsewhere, to allow for bedding course as required by authorities having jurisdiction.

3.03 SUBGRADE INSPECTION

- A. Proof-roll subgrade below the building slabs and pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades. Proof-roll in presence of Owner's testing agency.
- B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Owner's testing agency, without additional compensation.

3.04 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations, wall footings, utility pipe, or other construction as approved by the Owner's testing agency.

3.05 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover or

temporarily stabilize as specified in Division 31 Section "Erosion and Sedimentation Control"

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.06 UTILITY TRENCH BACKFILL

- A. General: Backfill trenches as indicated on Drawings.
- B. Place backfill on subgrades free of mud, frost, snow, or ice.
- C. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- D. Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings.
- E. Provide concrete encasement for piping or conduit less than 24 inches below surface of roadways only when indicated on the Drawings or as required by authorities having jurisdiction.
- F. Place and compact initial backfill of subbase material or satisfactory soil.
 1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing and Owner's testing agency.
- G. Place and compact final backfill as indicated on Drawings to final subgrade elevation.
- H. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.07 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations. Comply geotechnical engineer's written recommendations in Division 00 Section "Geotechnical Data."

3.08 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content or as directed by Owner's Testing Agency.
 - 1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
 - 2. Remove and replace, or scarify and air dry, at no additional cost to the Owner, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight. See Division 31 Section "Dewatering"

3.09 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698, Standard Proctor:

1. Under structures, building slabs, future expansion areas, steps, walkways, and pavements, scarify and recompact top 8 inches of existing subgrade and each layer of backfill or fill soil material at 98 percent.
2. Under lawn or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.

3.10 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
- B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
 1. Lawns and Unpaved Areas: Plus or minus 1 inch.
 2. Pavements and Walks: Plus or minus 1/2 inch.
 3. Coordinate re-spreading or placement of topsoil/planting soil with landscape contractor and section 32 9000 "Planting."
- C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.11 SUBBASE AND BASE COURSES

- A. Place subbase and base course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place subbase and base course under pavements and walks as follows:
 1. Shape subbase and base course to required crown elevations and cross-slope grades.
 2. Compact subbase and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 98 percent of maximum dry unit weight according to ASTM D 698, Standard Proctor.

3.12 DRAINAGE COURSE

- A. Place drainage course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
 - 1. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
 - 2. Compact each layer of drainage course to required cross sections and thicknesses to not less than 98 percent of maximum dry unit weight according to ASTM D 698.

3.13 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing. Coordinate scheduled earth moving work with the Owner's testing agency.
- B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
- C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by the Owner's testing agency.
- D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable.
- E. Provide other field tests, such as bearing ratio of subgrades, subbases, and bases for paving, as required by authorities having jurisdiction.

- F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest, at the Contractor's cost, until specified compaction is obtained.

3.14 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
- C. Where settling occurs before Project warranty period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

3.15 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION 02300

SECTION 02411 - FOUNDATION DRAINAGE SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK:

- A. The extent of foundation drainage system work is shown on the drawings.
- B. Related Work Specified Elsewhere:
 - 1. Connecting foundation drainage: Division 15.
 - 2. Drainage fill course under slabs on grade: Section 02620.

1.3 QUALITY ASSURANCE:

- A. Codes and Standards:
 - 1. Perform foundation drainage work in compliance with applicable requirements of governing authorities having jurisdiction.

1.4 SUBMITTALS:

- A. Certification:
 - 1. Submit two (2) copies of Certification signed by the foundation drainage system installer that installed materials conform to specified requirements and system was successfully checked and tested prior to covering with filtering and drainage fill.

PART 2 - PRODUCTS

2.01 DRAINAGE PIPE AND FITTINGS:

- A. Furnish drainage pipe complete with bends, reducers, adapters, couplings, collars and joint materials.
- B. Porous Concrete Pipe: ASTM C 654, "Standard-Strength" unless otherwise indicated.

2.02 SOIL MATERIALS:

- A. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense composite.
- B. Drainage Fill: Uniformly graded mixture of natural or crushed gravel, crushed stone, and natural sand with 100% passing a 1-1/2'' sieve and 0-5% passing a No. 50 sieve.
- C. Filtering Material: Uniformly graded mixture of natural or crushed gravel, crushed stone, and natural sand, with 100% passing a 1/2'' sieve and 0-5% passing a No. 50 sieve.

PART 3 - EXECUTION

3.01 INSPECTION:

- A. Examine the areas and conditions under which foundation drainage system is to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in an acceptable manner.

3.02 INSTALLATION:

- A. Impervious Fill:
 - 1. Place impervious fill material on the subgrade under drainage system. Place and compact impervious fill 6'' deep and 12'' wide.
- B. Filtering Material:
 - 1. Place a supporting layer of filtering material over compacted subgrade where drainage pipe is to be laid to a compacted depth of not less than 4''.
 - 2. After testing of drain lines, place additional filtering material to a 4'' depth around sides and top of drains.
- C. Laying Drain Pipe:
 - 1. Lay drain pipe solidly bedded in filtering material. Provide full bearing for each pipe section throughout its length, to true grades and alignment, and continuous slope in the direction of flow.

D. Testing Drain Lines:

1. Test or check lines before backfilling to assure free flow. Remove obstructions, replace damaged components and retest system until satisfactory.

E. Drainage Fill:

1. Place drainage fill over drain lines after satisfactory testing and covering of drain lines with filtering material. Completely cover drain lines to a width of at least 6'' on each side and 12'' above top of pipe, unless more coverage is indicated on the drawings. Place fill material in layers not exceeding 3'' in loose depth and compact each layer placed.
 - a. Overlay drainage fill material with one layer of 15-lb. asphalt or tar-saturated felt overlapping edges at least 4''.

END OF SECTION 02411

SECTION 02480 - LANDSCAPE WORK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Attention is directed to Division 0, Bidding and Contract Requirements, and to Division 1, General Requirements, which are hereby made a part of this Section.

1.02 DESCRIPTION OF WORK:

- A. The extent of the landscape development work is shown on the drawings and in schedules.
- B. Sub-grade Elevations: Elevation, filling and grading required to establish elevations shown on the drawings are not specified in this Section. Refer to Section 02300, Earthwork.

1.03 QUALITY ASSURANCE:

- A. Subcontract the landscape work to a single firm specializing in landscape work.
- B. Source Quality Control:
 - 1. General: Ship landscape materials with certificates of inspection as required by governmental authorities. Comply with governing regulations applicable to landscape materials.
 - 2. Do not make substitutions. If specified landscape material is not obtainable, submit to Architect proof of non-availability and proposal for use of equivalent material. When authorized, adjustment of contract amount will be made.
 - 3. Analysis and Standards: Package standard products with manufacturer's certified analysis. For other materials, provide analysis by recognized laboratory made in accordance with methods established by the Association of Official Agricultural Chemists, wherever applicable or as further specified.

4. Trees: Provide trees grown in a recognized nursery in accordance with good horticultural practice. Provide healthy, vigorous stock free of disease, insects, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, or disfigurement.
 - a. Sizes: Provide trees of the sizes shown or specified. Trees of larger size may be used if acceptable to the Architect, and if sizes of roots or balls are increased proportionately.
5. Inspection: Architect reserves the right to inspect trees either at place of growth, or at site before planting for compliance with requirements for names, variety, size, and quality.

1.04 SUBMITTALS:

A. Certification:

1. Submit two (2) copies of certificates of inspection as required by governmental authorities, and manufacturer's or vendors certified analysis for soil amendments and fertilizer materials. Submit other data substantiating that materials comply with specified requirements.

B. Planting Schedule:

1. Submit three (3) copies of planting schedule showing scheduled dates for each type of planting in each area of site.

C. Maintenance Instructions:

1. Submit two (2) copies of typewritten instructions recommending procedures to be established by the Owner for the maintenance of landscape work for one (1) full year. Submit prior to expiration of required maintenance period(s).

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Packaged Materials:

1. Deliver packaged materials in containers showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery and while stored at the site.

B. Plant Materials:

1. Sod: Time delivery so that sod will be placed within 24 hours after stripping. Protect sod against drying and breaking of rolled strips.
2. Trees: Provide freshly dug trees. Do not use trees which have been in cold storage or heeled-in. Do not prune prior to delivery. Do not bend or bind-tie trees in such manner as to damage bark, break branches, or destroy natural shape. Provide protective covering during delivery.
3. Dig Balled and Burlapped (BB) plants with firm, natural balls of earth of diameter not less than that specified, and of sufficient depth to include all the fibrous feeding roots. No plant moved with a ball will be accepted if the ball is cracked or broken before or during planting operations, except on special approval.
4. Deliver trees after preparations for planting have been completed and plant immediately. If planting is delayed more than six (6) hours after delivery, set trees in shade, protect from weather and mechanical damage, and keep roots moist.
5. Do not remove container grown stock from containers until planting time.
6. Label at least one (1) tree of each variety with a securely attached waterproof tag bearing legible designation of botanical and common name.

1.06 JOB CONDITIONS:

- A. Proceed with and complete the landscape work as rapidly as seasonal limitations for each kind of landscape work required.
- B. Utilities: Determine location of underground utilities and perform work in a manner which will avoid possible damage. Hand excavate, as required, to minimize possibility of damage to underground utilities. Maintain grade stakes set by others until removal is mutually agreed upon by all parties concerned.

- C. Excavation: When conditions detrimental to plant growth are encountered such as rubble fill, adverse drainage conditions, or obstructions, notify Architect before planting.
- D. Planting Schedules: Prepare a proposed planting schedule. Schedule the dates for each type of landscape work during the normal seasons for such work in the area of the site. Correlate with specified maintenance periods to provide maintenance until occupancy by the Owner. Once accepted, revise dates only as approved in writing, after documentation of reasons for delays.
- E. Coordination with Lawns: Plant trees after final grades are established and prior to planting of lawns, unless otherwise acceptable to the Architect. If planting of trees occurs after lawn work, protect lawn areas and promptly repair damage to lawns resulting from planting operations.

1.07 WARRANTY:

- A. Warranty lawns through the specified maintenance period, and until final acceptance.
- B. Warranty trees for a period of one (1) year after date of acceptance against defects, including death and unsatisfactory growth, except for defects resulting from neglect by Owner, abuse or damage by others, or unusual phenomena or incidents which are beyond Landscape Installer's control.
- C. Remove and replace trees or other plants found to be dead or in unhealthy condition during warranty period. Plant missing trees and plants. Make replacements during growth season following end of warranty period. Furnish and plant replacements which comply with requirements shown and specified. Also, replace trees which are in doubtful condition at end of warranty period; unless, in the opinion of the Architect, it is advisable to extend warranty period for a full-growing season. The Architect will make another inspection at the end of extended warranty period, if any, to determine acceptance or rejection. Only one replacement will be required at end of warranty period, except for losses or replacement due to failure to comply with specified requirements.

PART 2 - PRODUCTS

2.01 TOPSOIL:

- A. Provide new topsoil which is fertile, friable, natural loam, surface soil, reasonably free of subsoil, clay lumps, brush, weeds, and other litter, and free of roots, stumps, stones larger than 2" in any dimension, and other extraneous or toxic matter harmful to plant growth.
 - 1. Provide all new topsoil; do not use any on site.

2.02 SOIL AMENDMENTS:

- A. Lime: Natural limestone containing not less than 85% of total carbonates, ground so that not less than 90% passes a 10-mesh sieve, and not less than 50% passes a 100-mesh sieve.
- B. Peat Humus: FS Q-P-166 and with the texture and ph range suitable for the intended use.
- C. Bonemeal: Commercial, raw, finely ground, 4% nitrogen and 20% phosphoric acid.
- D. Superphosphate: Soluble mixture of treated minerals; 20% available phosphoric acid.
- E. Commercial Fertilizer: Complete fertilizer of neutral character with some elements derived from organic sources and containing the following percentages of available plant nutrients:
 - 1. For trees, provide fertilizer with not less than 10% available phosphoric acid and from 3% to 5% total nitrogen, and from 3% to 5% soluble potash.
 - 2. For lawns, provide fertilizer with not less than 4% phosphoric acid and not less than 2% potassium, and the percentage of nitrogen required to provide not less than 1 lb. of actual nitrogen per 1000 sq.ft. of lawn area. Provide nitrogen in a form that will be available to the lawn during the initial period of growth.

2.03 PLANT MATERIALS:

- A. Name and Variety: Provide plant materials true to name and variety established by the American Joint Committee on Horticultural Nomenclature "Standardized Plant Names" Second Edition, 1942. Substitutions or indigenous local specie may be proposed if still deciduous or evergreen as required. Substitutions must be same size or larger. Comply with all other requirements acceptable to the Architect.
- B. Quality: Provide trees and other plants complying with the recommendations and requirements of ANSI 760; "Standard for Nursery Stock" and as further specified.
- C. Measurements: Measure all trees when their branches are in normal position. Height and spread dimensions indicated refer to the main body of the plant, not from branch or root tip to tip. Determine caliper as follows:
 - 1. For 4" and smaller, measure diameter of trunk 6" above grade.
 - 2. For larger than 4", measure diameter of trunk 12" above grade.
- D. Do not cut leaders or otherwise damage by unnecessary cutting.
- E. Deciduous Trees: Provide trees of height and caliper listed or shown and with branching configuration recommended by ANSI Z60.1 for type and species required. Provide single stem trees except where special forms are shown or listed. Ball and burlap (BB) deciduous trees.

2.04 GRASS MATERIALS:

- A. Sod: Provide strongly rooted sod not less than two (2) years old and free of weeds and undesirable native grasses. Provide only sod capable of growth and development when planted (viable, not dormant) and in strips not more than 18" long. Provide sod composed principally of Kentucky Bluegrass (*Poa Pratensis*) or its equivalent, as acceptable to the Architect.

2.05 SEED:

- A. Seed shall be a mixture composed of the following:

Seeding shall be specified as one of these two mixtures:

Improved Kentucky Bluegrass Mixture

Touchdown Kentucky
Bluegrass 6#/1000 Sq. Ft.

Barron Kentucky
Bluegrass 6#/1000 Sq. Ft.

Grass shall be fresh, new crop seed. The Contractor shall furnish the Owner the dealer's guaranteed statement of the composition of the mixture and the percentages of purity and germination and a copy of the State Certification for the seed.

- B. Hydro-Seed Option:

The Contractor is advised that he may use hydro-seeding or hydro-mulching operations in lieu of mechanical seeding if he so desires.

2.06 MISCELLANEOUS LANDSCAPE MATERIALS:

- A. Anti-Desiccant: Emulsion type, film-forming agent similar to Dowax by Dow Chemical Co. or Wilt-Prof by Nursery Specialty Products, Inc., designed to permit transpiration but retard excessive loss of moisture from plants. Deliver in manufacturer's fully identified containers and mix in accordance with manufacturer's instructions.
- B. Wrapping: Tree-wrap tape not less than 4" wide, designed to prevent bore damage and winter freezing fabricated from bituminous lined two-ply paper.
- C. Stakes and Guys: Provide stakes and deadmen of sound new hardwood, treated softwood, or redwood, free of knot holes and other defects. Provide wire ties and guys of 2-strand, twisted, pliable galvanized iron wire not lighter than 12 USWG with zinc-coated turnbuckles. Provide net 2-ply fabric black rubber hose not less than 1/2" hose size, cut to required lengths to protect tree trunks from damage by wires.

- D. Plastic Sheet: Black, weather resistant polyethylene sheeting complying with FS L-P-512, Type III, 0.008" (6 mils) thick.
- E. Mulch: For uses other than with hydro-seeding, operations shall be hay or straw, not chopped in short lengths. Mulch used with hydro-seeking operations shall be a wood cellulose fiber containing no growth or germination inhibiting factors. Rate of application for wood cellulose fiber mulch in hydro-seeking operations shall be 1500 pounds per acre, or 35 pounds per 1000 square feet.

2.07 PREPARATION OF PLANTING SOIL:

- A. Before mixing, clean topsoil of roots, plants, sods, stones, clay lumps, and other extraneous materials harmful or toxic to plant growth.
- B. Mix specified soil amendments and fertilizers with topsoil as provided herein. Delay mixing of fertilizer if planting will not follow placing of planting soil within a few days. Prepare mix on site using four parts topsoil to one part peat, and add 5 lbs. super phosphate to each cubic yard. Completely mix mechanically and add fertilizer as directed by the Architect.
- C. For pit type back fill, mix planting soil prior to back filling and stockpile at the site.
- D. For planting beds, mix planting soil either prior to planting or apply on surface of topsoil and mix thoroughly before planting.
 - 1. Mix lime with dry soil prior to mixing of fertilizer.

PART 3 - EXECUTION

3.01 INSPECTION:

- A. Installer must examine the subgrade, verify the elevations, observe the conditions under which work is to be performed, and notify the Contractor of unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 PREPARATION:

- A. Layout individual tree locations and areas for multiple plantings. Stake locations and outline areas and secure Architect's acceptance before start of planting work. Make minor adjustments as may be requested.
- B. Preparation for Planting Lawns:
 - 1. Loosen subgrade of lawn areas to minimum depth of 4". Remove stones over 1-1/2" in any dimension, and sticks, roots, rubbish, and other extraneous matter. Limit preparation to areas which will be planted promptly after preparation.
 - 2. Spread topsoil to minimum depth required to meet lines, grades, and elevations shown, but not less than 4" after light rolling and natural settlement.
 - 3. Place approximately 1/2 of total amount of topsoil required. Work into top of loosened subgrade to create a transition layer and then place remainder of topsoil.
 - 4. Allow for sod thickness in areas to be sodded.
 - 5. Grade lawn areas to smooth, even surface with loose, uniformly fine texture. Roll and rake and remove ridges and fill depressions as required to meet finish grades. Limit fine grading to areas which can be planted immediately after grading.
 - 6. Apply fertilizer by mechanical spreading at a rate of not less than 20 lbs. per 1,000 sq. ft.. Blend with top 1" of soil.
 - 7. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface moisture to dry before planting lawns. Do not create a muddy soil condition.
 - 8. Restore lawn areas to specified condition if eroded or otherwise disturbed after fine grading and prior to planting.
 - 9. Preparation of Unchanged Grades: Where lawns are to be planted in areas that have not been altered or disturbed by excavating, grading, or stripping operations, prepare soil for lawn planting as follows: Till to a depth of not less than 6"; apply soil

amendments and initial fertilizers as specified; remove high areas and fill in depressions; till soil to a homogenous mixture of fine texture, free of lumps, clods, stones, roots, and other extraneous matter.

- a. Prior to preparation of unchanged areas, remove existing grass, vegetation and turf. Dispose of such material outside of Owner's property; do not turn over into soil being prepared for lawns.

C. Preparation of Planting Beds:

1. Loosen subgrade of planting bed areas to a minimum depth of 6" using a cultimulcher or similar equipment. Remove stones over 1-1/2" in any dimension, and sticks, stones, rubbish, and other extraneous matter.
2. Spread planting soil mixture to minimum depth required to meet lines, grades and elevations shown after light rolling and natural settlement. Place approximately 1/2 of total amount of planting soil required. Work into top of loosened subgrade to create a transition layer, then place remainder of the planting soil.

D. Excavation for Trees:

1. Excavate pits, beds and trenches with vertical sides and with bottom of excavation slightly raised at center to provide proper drainage. Loosen hard subsoil in bottom of excavation.
2. For balled and burlapped, (BB) trees, make excavations at least twice as wide as the ball diameter and equal to the ball depth, plus the following allowance for setting of ball on a layer of compacted back fill. Allow for 4" setting layer of planting soil mixture.
3. Dispose of subsoil removed from landscape excavations. Do not mix with planting soil or use as back fill.
4. Fill excavations for trees with water and allow to percolate out before planting.

3.03 PLANTING:

A. Planting Trees:

1. Set balled and burlapped (BB) stock on layer of compacted planting soil mixture, plumb and in center of pit or trench with top of ball at same elevation as adjacent finished landscape grades. Remove burlap from sides of balls; retain on bottoms. When set, place additional soil mixture back fill around base and sides of ball, and work each layer to settle back fill and eliminate voids and air pockets. When excavation is approximately 2/3 full, water thoroughly before placing remainder of back fill. Repeat watering until no more is absorbed. Water again after placing final layer of back fill.
2. Dish top of back fill to allow for mulching.
 - a. For spring planting, provide additional back fill berm around edge of excavations to form shallow saucer to collect water.
3. Mulch pits, trenches, and planted areas. Provide not less than 4" and finish level with adjacent finish grades using shredded bark.
4. Apply anti-desiccant using power spray to provide an adequate film over trunks, branches, stems, twigs, and foliage.
 - a. If deciduous trees are moved in full-leaf, spray with anti desiccant at nursery before moving and again two (2) weeks after planting.
5. Prune, thin out and shape trees in accordance with standard horticultural practice. Prune trees to retain required height and spread. Unless otherwise directed by the Architect, do not cut tree leaders, and remove only injured or dead branches from flowering trees, if any.
6. Remove and replace excessively pruned or misformed stock resulting from improper pruning.
7. Paint cuts over 1/2" in size with standard tree paint or compound covering exposed, living tissue. Use paint which is waterproof, antiseptic, adhesive, elastic, and free of kerosene, coal tar, creosote, and other substances harmful to plants. Do not use shellac.

8. Wrap trunks of all deciduous trees taller than 8'. Start at ground and cover trunk to height of second limbs and secure at every second wrap.
 9. Inspect tree trunks for injury, improper pruning, and insect infestation, and take corrective measures required before wrapping.
 10. Guy and stake trees immediately after planting as follows:
 - a. Guy three (3) ways securing wire to 2" x 4" x 30" stakes set two (2) feet in the ground.
- B. Sodding New Lawns:
1. Lay sod within 24 hours from time of stripping. Do not plant dormant sod or if ground is frozen.
 2. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod strips; do not overlap. Stagger strips to offset joints in adjacent courses. Work from boards to avoid damage to subgrade or sod. Tamp or roll lightly to ensure contact with subgrade. Work sifted soil into minor cracks between pieces of sod; remove excess to avoid smothering of adjacent grass.
 3. Secure sod on slopes with wood pegs to prevent slippage.
 4. Water sod thoroughly with a fine spray immediately after planting.
- C. Mechanical Seeding:
1. Seeding: The Contractor shall seed all areas with grass seed as specified, sowing evenly with an approved mechanical seeder at the rate specified in 2.05A. Sow one-half the seed in one direction and the other half at right angles to the first seeding. To cover the seed and firm the soil, the seed bed shall then be lightly rolled with a cultipacker. In areas inaccessible to the cultipacker, the seeded ground shall be lightly raked and rolled in two directions with water ballast roller. Extreme care shall be taken during seeding and raking to insure that no change shall occur in the finished grades and that the seed is not raked from one spot to another. If the areas are seeded by a large mechanical seeder which

works the seed into the soil and at the same time rolls the seed bed, it is not necessary to roll the seed bed separately.

2. Mulching: After sowing, mulch shall be spread evenly at the rate of 2 tons per acre over newly seeded areas. The mulch shall be applied in a uniform layer, loose enough to allow sunlight to penetrate and air to circulate, yet sufficient to shade the soil and reduce erosion. The mulch shall be held in place by crimping, cultipacking, spraying with asphalt emulsion, or any other means satisfactory with the Owner.

D. Hydraulic Seeding (option):

1. The Contractor shall seed with hydraulic seeding equipment, using fertilizer and mulch of the type and at the rate previously specified. Slurry shall be distributed uniformly over the area at the designated application rate. areas inaccessible to such equipment may be fertilized and seeded by hand.

3.04 MISCELLANEOUS LANDSCAPE WORK:

- A. Place wood chip mulch beds where shown. Compact soil sub grades and lay 6 mil carbonated polyethylene film over compacted subgrade prior to placing mulch.

3.05 MAINTENANCE:

- A. Begin maintenance immediately after planting.
- B. Maintain trees and other plants until final acceptance, but in no case less than 30 days after planting.
- C. Maintain trees and other plants by pruning, cultivating, and weeding as required for healthy growth. Restore planting saucers. Tighten and repair stake and guy supports, and reset trees to proper grades or vertical position as required. Restore or replace damaged wrapping. Spray as required to keep trees free of insects and disease. Feed trees as specified and as may be required.

D. Feeding Program:

1. Feed all trees at least one time prior to final acceptance. Schedule feeding as follows:
 - a. For Spring and early Summer planting, feed shortly after installation.
 - b. For late Summer and Fall planting, feed the following Spring.
2. Rake back mulch, apply fertilizer, and replace mulch. Fertilize with 10-6-4 analysis fertilizer, applying uniformly over cultivated ground area surrounding each plant. Apply fertilizer at the following rates:
 - a. Shade trees - 2 lbs. per inch or caliper.
 - b. Small trees - 1 lb. per inch of caliper.

E. Maintain lawns as indicated in Section 02499 "Landscape Maintenance and Warranty Standards".

1. Maintain lawns by watering, fertilizing, weeding, mowing, trimming, and other operations such as rolling, regrading and replanting as required to establish a smooth, acceptable lawn free of eroded or bare areas.

3.06 CLEAN UP AND PROTECTION:

- A. During landscape work, store materials and equipment where directed. Keep pavements clean and work area in an orderly condition.
- B. Protect landscape work and materials from damage due to landscape operations, operations by other contractors, trades and trespassers. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged landscape work as directed.

3.07 INSPECTION AND ACCEPTANCE:

- A. When the landscape work is completed including maintenance, the Architect will, upon request, make an inspection to determine acceptability.

- B. Where inspected landscape work does not comply with the requirements, replace rejected work and continue specified maintenance until reinspected by the Architect and found to be acceptable. Remove rejected plants and materials promptly from the project site.

END OF SECTION 02480

SECTION 02484 - TOPSOIL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Attention is directed to Bidding and Contract Requirements, General and Supplemental Requirements, which are hereby made a part of this Section.

1.02 DESCRIPTION OF WORK:

- A. Extent of Topsoil Work is shown on drawings and by provisions of this section.
- B. Topsoil for lawn work shall be as stripped from site or provided by the Contractor from off-site sources at no extra cost to the Owner.

C. Related Work Specified Elsewhere:

- 1. Section 02300: Earthwork
- 2. Section 02485: Seeding

1.03 QUALITY ASSURANCE:

- A. Testing and Inspection: For supplied and stockpiled topsoil only. Performed by a qualified independent testing laboratory, under the supervision of a registered professional engineer, specializing in soils engineering.

- B. Provide and pay for testing and inspection during topsoil operations. Laboratory, inspection services and Soil Engineer shall be acceptable to the Landscape Architect.

- 1. Recommended testing laboratory:
A & L Agricultural Laboratories, Inc.
3505 Conestoga Drive
Fort Wayne, IN 46808
(219) 483-4759

- C. Test representative material samples for proposed use.

- D. Topsoil: (Supplied and stockpiled)
 - 1. pH factor
 - 2. Mechanical analysis
 - 3. Percentage of organic content

- E. Recommendations on type and quantity of additives required to establish satisfactory pH factor and supply of nutrients to bring nutrients to satisfactory level for planting.
- F. Submit test reports.
- G. Topsoil: Existing on site from stockpile - proposed for use.

1.04 PROJECT CONDITIONS:

- A. Known underground and surface utility lines are indicated on the drawings.
- B. Protect existing trees, plants, lawns and other features designated to remain as part of the landscaping work.
- C. Promptly repair damage to adjacent facilities caused by topsoil operations. Cost of repair at Contractor's expense.
- D. Promptly notify the Landscape Architect of unexpected sub-surface conditions.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Topsoil: Supplied and stockpiled topsoil proposed for use must meet testing criteria results specified and conform to adjustments as recommended by soil test and Landscape Architect.
- B. Existing topsoil: Existing topsoil from on stockpile shall be utilized. All processing, cleaning and preparation of this stored topsoil to rend it acceptable for use is the responsibility of the Contractor.
- C. Provide additional topsoil as required to complete job at unit cost. Topsoil must meet testing criteria results specified. All processing, cleaning nad preparation of this stored topsoil to render it acceptable for use is the responsibility of this Contractor.

- D. Supplied and stockpiled topsoil, shall be fertile, friable and representative of local productive soil, capable of sustaining vigorous plant growth and free of clay lumps, subsoil, noxious weeds or other foreign matter such as stones, roots, sticks and other extraneous materials: not frozen or muddy. Ph of soil to range between 5.0 and 7.5.
- E. Crowning/mounding to be free flowing in shape and design, and to blend into existing grades gradually.

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Examine rough grades and installation conditions. Do not start topsoil work until unsatisfactory conditions are corrected.

3.02 FINISH GRADING:

- A. Perform topsoiling within contract limits, including adjacent transition areas, to new elevations, levels, profiles, and contours indicated. Provide uniform levels and slopes between new elevations and existing grades.
- B. Grade surfaces to assure areas drain away from building structures and to prevent ponding and pockets of surface drainage.
- C. Lawn and planting areas: Supply and spread topsoil to 4" minimum compacted depth in lawn areas or as indicated on drawings.
- D. Regardless of finish grading elevations indicated, it is intended that grading be such that proper drainage of surface water will occur and that no low areas created to allow ponding. Contractor to consult with Owner or Landscape Architect regarding minor variations in grade elevations before rough grading is completed.

3.03 CLEANING:

- A. Upon completion of earthwork operations, clean areas within contract limits, remove tools and equipment. Site shall be clear, clean, free of debris and suitable for site work operations.

END OF SECTION 02484

SECTION 02499 - LANDSCAPE MAINTENANCE AND WARRANTY STANDARDS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Attention is directed to Bidding and Contract Requirements, and to General and Supplemental Conditions, hereby made a part of this Section.

1.02 DESCRIPTION OF WORK:

- A. The requirements of this Section include a one year warranty period from date of acceptance of installation.
- B. Related Work Specified Elsewhere:
 - 1. Section 02480: Landscape Work

1.03 ACCEPTANCE OF INSTALLATION:

- A. At the completion of all landscape installation, or pre-approved portions thereof, the Landscape Contractor shall request in writing an inspection for acceptance of installation in which the Landscape Contractor, Landscape Architect and Owner's Representative shall be present. After this inspection a "Punch List" will be issued by the Landscape Architect and/or Owner's Representative shall re-inspect the project and issue a written statement of acceptance of installation and establish the beginning of the project warranty period.
- B. Landscape work may be inspected for acceptance in parts agreeable to Owner's Representative and Landscape Architect provided work offered for inspection is complete, including maintenance as required.
- C. For work to be inspected for partial acceptance, Contractor shall provide a drawing outlining work completed, and supply a written statement requesting acceptance of this work completed to date.

1.04 PROJECT WARRANTY:

- A. The project warranty period begins upon written acceptance of the project installation by Landscape Architect and Owner's Representative.

- B. The Landscape Contractor shall guarantee seeded areas through construction and for a period of one year after date of acceptance of installation against defects including death and unsatisfactory growth, except for defects resulting from neglect by Owner, abuse or damage by others, or unusual phenomena or incidents which are beyond Landscape Contractor's control.

1.05 MAINTENANCE:

- A. To insure guarantee standards, the following maintenance procedures shall be executed during construction and for the full project warranty period.
- B. Maintenance of Seeded Lawn Areas:
 - 1. The Contractor shall establish a dense lawn of permanent grasses, free from lumps and depressions or any bare spots, none of which is larger than one foot of area up to a maximum of 3% of the total seeded lawn area. Any part of the seeded lawn that fails to show a uniform growth and/or germination shall be reseeded until a dense cover is established.
 - 2. If seeded in fall or if not considered acceptable at that time, continue maintenance the following spring until acceptable lawn is established.
 - 3. The Contractor shall provide a minimum of two cuttings of the lawn or more as necessary until the inspection and acceptance of installation by the Owner's Representative and Landscape Architect. When the lawn reaches 3 inches in height it shall be cut to 2 inches in height. When meadow lawn reaches 6" in height it shall be cut to 4" in height.
 - 4. The Owner assumes cutting responsibilities following the acceptance of installation by the Owner's Representative and the Landscape Architect.
 - 5. After acceptance of installation, and for the duration of the project warranty period the Landscape Contractor shall continue all other maintenance procedures including fertilizing and weeding, and other operations such as rolling, regrading, replanting, and applying herbicides, fungicides, insecticides as required to establish a smooth, acceptable lawn free of eroded or bare areas.

6. Repair, rework, and reseed all areas that have washed out, and eroded, or do not substantially germinate.
7. At conclusion of project warranty period and after receiving written final acceptance by Owner's Representative and Landscape Architect, the Owner shall assume all seeded lawn maintenance responsibilities.

1.06 FINAL ACCEPTANCE:

- A. At the conclusion of the project warranty period the Landscape Contractor shall request a project inspection for final acceptance in which the Landscape Contractor, Landscape Architect and Owner's Representative shall be present. After this inspection a "Punch List" will be issued by the Landscape Architect. Upon completion of all punch list items, the Landscape Architect and Owner's Representative shall reinspect the project and issue a written statement of final acceptance. Upon final acceptance the Owner assumes all maintenance responsibilities for the landscape of the project.

PART 2 AND 3 - PRODUCTS AND EXECUTION

Not Applicable.

END OF SECTION 02499

SECTION 02510 - WATER UTILITY DISTRIBUTION PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. The material and installation requirements of the Authority Having Jurisdiction supersede the following specification.
- B. Section includes:
 - 1. Domestic water and fire suppression lines.
 - a. Terminate within the building as indicated on the Drawings.

1.02 SUBMITTALS

- A. Product Data: For each material specified.

1.03 QUALITY ASSURANCE

- A. Comply with governing codes and regulations. Provide products of acceptable manufacturers which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Domestic Water Lines: Provide piping manufactured from the following materials. Do not provide domestic water and fire suppression lines in materials outside of size limits specified:
 - 1. Polyvinyl chloride (PVC) Water Pipe (Up to 2 inches diameter): ASTM D2241, SDR 21, class 200 and AWWA M23, latest revision.
 - a. Joints: ASTM D-3139 for push-on joints and ASTM F477 for gaskets.
 - 1) 2-inch Pipe: Bell-end with gasket.

- 2) Less than 2-inch Pipe: Solvent cement joints.
 2. Polyethylene (PE) Water Pipe (Up to 3 inches diameter), AWWA C901 "Polyethylene (PE) Pressure Pipe and Tubing, 1/2-inch through 3-inch for Water Service," minimum pressure rating of 200 psi.
 3. Copper Pipe (Up to 3 inches diameter): Type "K."
 - a. Joints: Sweat silver soldered on 2 inch and above.
 4. Polyvinyl Chloride (PVC) (4 inches to 12 inches diameter): AWWA C900, DR 18 150 PSI rating, trade name
 - a. Basis of Design Product: Blue Brute.
 - b. Push on type joints: ASTM D-3139
 5. Ductile Iron (DI) (3 inches to 12 inches diameter): AWWA C150 for a minimum 150 psi working pressure plus 100 psi surge pressure. Manufacture DI pipe per AWWA C151 with standard asphaltic coating on the exterior and cement-mortar lining on the interior.
 - a. Joints: Conform to AWWA Specification C111, mechanical or push-on type with plain rubber gaskets.
 - b. Fittings: Conform to AWWA Specification C110, Class 250, cast iron or ductile iron short body pattern with bituminous coating inside and outside with ends as required for the joints specified herein.
- B. Water meter: Local utility company standard.
- C. Fire Hydrants: Provide fire hydrant(s) in accordance with the requirements of the authority having jurisdiction. The following shall be used if the local authority does not specify.
1. Conform to AWWA Specification C502 with a 5-inch minimum valve opening, 6-inch AWWA Specification C111 mechanical joint inlet connection, 3-ft. bury, two 2-1/2-inch National Standard fire hose thread nozzles, one 4-inch standard pumper connection nozzle, 1-inch square operating nut with nut caps, and clockwise direction of opening. Factory painted on the outside

below grade line with black asphalt paint and above grade line with red paint.

2. Factory painted on the outside below grade line with black asphalt paint and above grade line with red paint.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Before commencing pipe installation, field verify building tie-in locations/inverts, tap locations/inverts, and all utilities crossings. Notify Owner of any conflicts.

3.02 INSTALLATION

- A. Install materials and systems in accordance with manufacturer's instructions, local governing authorities/codes, and approved submittals and in proper relation with adjacent construction. Coordinate with work of other sections.
- B. Excavate and backfill utility trenches as specified in Division 31 Section "Earth Moving" and the trench detail on the Drawings. Do not enclose, cover, or put into service any piping systems before inspection and approval is obtained. Verify minimum burial depths and separation requirements with the local frost depths, codes, and authorities. Minimum cover over top of pipes shall be 30-inches unless otherwise specified by authorities.
- C. Test for proper operation.
 1. Test pipe work to pressure and leakage tests equal to the design working pressure of the pipe and maintain specified pressure for not less than two hours.
 2. Leakage shall not exceed that permitted by AWWA Specification C600 for mechanical joint and push-on joint pipe.
 3. Locate and repair leaks and repeat tests until test results are satisfactory and in compliance to this section.

- D. Sterilizing: Clean and sterilize the system in accordance with local authority or to the requirements below.
1. After tests have been approved, and prior to placing the pipe lines in service, sterilize piping with a liquid chlorine or chlorine bearing compound similar to "HTH" which has a strength of not less than 50 ppm.
 2. Inject chlorine or chlorine solution into the pipelines through corporation stops installed at proper locations in the pipe line, or by other approved means.
 - a. Corporation stops will be left in place with the outlets plugged.
 3. Do not, under any circumstances, open the sectionalizing valves between the existing mains and the new mains until the bacterial analysis of the mains involved has been approved by the applicable local and/or state authorities. Time of initial opening and final closing will be recorded and given daily to said authorities.

3.03 FIELD QUALITY CONTROL

- A. Test new piping systems and parts of existing systems (that have been altered, extended, or repaired) for leaks and defects per pipe manufacturer's recommendations and requirements of local authorities having jurisdiction.
1. Do not enclose, cover, or put into service any piping systems before inspection and approval is obtained.
 2. Replace any defective areas found during inspections and testing and repeat the process until results are acceptable.
 3. Project Completion Reports: Provide copies of test reports to the Owner, for each system or line, witnessed by either local authorities having jurisdiction or the Owner's testing agency per the test requirements.

END OF SECTION 02510

SECTION 02630 - STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Gravity-flow, nonpressure storm drainage outside the building, with the following components:
 - a. Cleanouts.
 - b. Precast concrete manholes.

1.02 PERFORMANCE REQUIREMENTS

- A. Gravity-Flow, Nonpressure, Drainage-Piping Pressure Rating: 10-foot head of water.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For manholes and catch basins. Include plans, elevations, sections, details, and frames and covers.
- C. Field quality-control test reports

1.04 QUALITY ASSURANCE

- A. Storm Sewer piping and installation shall conform to the standard specifications of the local water district requirements.

PART 2 - PRODUCTS

2.01 PIPE AND FITTINGS

- A. Polyvinyl Chloride (PVC): ASTM D 3034, SDR-23 utilizing elastomeric gasket joints.
- B. Polyvinyl Chloride (PVC) corrugated pipe with smooth interior per ASTM F 949 (4-inches to 36-inches) with

elastomeric gasket joints, trade name A-2000 by Contech or equal.

- C. Reinforced Concrete Pipe (RCP) CL-IV: AASHTO M-170 with bell and spigot rubber gasket type joints or ASTM C76 (confirm class type with depth of pipe and traffic loads). Provide heavy duty RCP in paved areas when less than 2 feet of cover is available.

2.02 NONPRESSURE-TYPE PIPE COUPLINGS

- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.
- B. Sleeve Materials:
 - 1. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 3. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- C. Unshielded Flexible Couplings: Elastomeric sleeve with corrosion-resistant-metal tension band and tightening mechanism on each end.
- D. Shielded Flexible Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
- E. Ring-Type Flexible Couplings: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.03 CLEANOUTS

- A. Gray-Iron Cleanouts: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.

1. Top-Loading Classification(s): Heavy duty.
2. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

2.04 MANHOLES

- A. Standard Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.

2.05 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318/318R, ACI 350R, and the following:
 1. Cement: ASTM C 150, Type II.
 2. Fine Aggregate: ASTM C 33, sand.
 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 4. Water: Potable.
- B. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water-cementitious materials ratio.
 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

2.06 CATCH BASINS

- A. Standard Precast Concrete Catch Basins: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
- B. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include 24-inch ID by 7- to 9-inch riser with 4-inch minimum width flange, and 26-inch-diameter flat grate with small square or short-slotted drainage openings.
 1. Grate Free Area: Approximately 50 percent, unless otherwise indicated.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Before commencing pipe installation, field verify building tie-in locations/inverts, tap locations/inverts, and all utilities crossings. Notify Owner of any conflicts.

3.02 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Excavate and backfill utility trenches as specified in Division 31 Section "Earth Moving" and the trench detail on the Drawings.
- C. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
- D. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- E. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- F. Install gravity-flow, nonpressure drainage piping according to the following:
 - 1. Install piping pitched down in direction of flow, at minimum slope of 2 percent, unless otherwise indicated.
 - 2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use

corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.

3. Install piping below frost line.
4. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
5. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.

- G. Clear interior of piping and manholes of dirt and superfluous material as work progresses.

3.03 PIPE JOINT CONSTRUCTION

- A. Where specific joint construction is not indicated, follow piping manufacturer's written instructions.
- B. Join gravity-flow, nonpressure drainage piping according to the following:
1. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
 2. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
 3. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-gasket joints.
 4. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.04 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
1. Use heavy-duty, top-loading classification cleanouts in all areas.

- B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches deep.
- C. Set cleanout frames and covers in concrete pavement with tops flush with pavement surface.

3.05 MANHOLE INSTALLATION

- A. General: Install manholes, complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C 891.
- C. Set tops of frames and covers flush with finished surface of manholes that occur in pavements.

3.06 CATCH BASIN INSTALLATION

- A. Set frames and grates to elevations indicated.

3.07 CONNECTIONS

- A. Make connections to existing piping and underground manholes.
 - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.

3.08 FIELD QUALITY CONTROL

- A. Test new piping systems and parts of existing systems (that have been altered, extended, or repaired) for leaks and defects per pipe manufacturer's recommendations and requirements of local authorities having jurisdiction.
 - 1. Do not enclose, cover, or put into service any piping systems before inspection and approval is obtained.
 - 2. Replace any defective areas found during inspections and testing and repeat the process until results are acceptable.

3. Project Completion Reports: Provide copies of test reports to the Owner, for each system or line, witnessed by either local authorities having jurisdiction or the Owner's testing agency per the test requirements.

B. Visual Inspection

1. After approximately 24 inches of backfill and after completion of final grade (paving or landscaping installed), inspect the interior pipe runs for alignment and deflection (less than 7-1/2 percent). Utilize lamps and mirrors if necessary.
2. For pipes 30 inches in diameter and greater, project completion reports may consist of visual and interior measurements (conducted under proper safety guidelines) that are witnessed by local authorities or the owner's testing agency. Reports must indicate that any pipe deflection is less than 7-1/2 percent of the pipe diameter.

C. Mandrel Testing

1. Conduct for all pipes under 30 inches in diameter and provide project completion reports witnessed by local authorities having jurisdiction or the Owner's testing agency.
2. Install and backfill pipe runs to subgrade elevation (preferably to final grade elevation) at least 30 days prior to mandrel testing.
3. Flush and clean lines prior to utilizing a 5-point mandrel of a size not less than 92.5 percent of the pipe diameter.

D. Pressure, Infiltration, or Exfiltration Testing

1. Perform tests as required by local authorities having jurisdiction or manufacturer and provide test reports witnessed by the local authority having jurisdiction or the Owner's testing agency.
2. For low pressure piping, at no time should the internal pipe pressure exceed PSI rating of pipe.

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2017 RENOVATIONS-BID PACK #5
ELEMENTARY SCHOOLS

161664B

NOVEMBER 30, 2016

E. For pressure piping, do not exceed manufacturer's
recommendations.

END OF SECTION 02630

SECTION 02740 - ASPHALT PAVING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes
 - 1. Hot-mix asphalt paving.
 - 2. Hot-mix asphalt patching and overlays.

1.02 SUBMITTALS

- A. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
- B. Material Certificates: For each paving material, from manufacturer.

1.03 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer shall be registered with and approved by authorities having jurisdiction or the DOT of the state in which Project is located.
- B. Regulatory Requirements: Comply with state or local DOT for asphalt paving work.
- C. Asphalt-Paving Publication: Comply with AI MS-22, "Construction of Hot Mix Asphalt Pavements," unless more stringent requirements are indicated.

1.04 PROJECT CONDITIONS

- A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp or if the following conditions are not met:
 - 1. Tack Coat: Minimum surface temperature per requirements of asphalt course.
 - 2. Asphalt Base and Surface Course: Minimum surface temperature of 40 deg F and rising at time of placement.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Coarse Aggregate: MDOT 902.09.A.
- B. Fine Aggregate: MDOT 902.09.B.
- C. Mineral Filler: MDOT 902.11.
- D. Asphalt Binder: MDOT 904.03.A. - PG58-22
- E. Tack Coat: MDOT 904.03.C. - SS1H

2.02 MIXES

- A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction; designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types"; and complying with the following requirements:
 - 1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
 - 2. Base Course: LVSP
 - 3. Surface Course: LVSP
 - 4. Provide mixes with a history of satisfactory performance in geographical area where Project is located.

PART 3 - EXECUTION

3.01 COLD MILLING

- A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.

3.02 PATCHING

- A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12

inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

- B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd.
- C. Patching: Fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact flush with adjacent surface.
- D. Joint/Crack Treatment: Install joint sealant, emulsion, or "gutter seal" type products as specified in Section 321373 "Paving Joint Sealants" to seal joints of patched surfaces.

3.03 SURFACE PREPARATION

- A. Proof-roll subbase as specified in Division 31 Section "Earth Moving."
- B. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
- C. Tack Coat: Apply when overlaying existing pavement, on adjacent horizontal surfaces such as curbs, and between base and surface courses when the two courses are not installed in a continuous installation.
 - 1. Apply at a rate of 0.05 to 0.15 gal./sq. yd.
 - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.04 HOT-MIX ASPHALT PLACING

- A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents

segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Spread mix at minimum temperature of 250 deg F.
2. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.05 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

3.06 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.
2. Install and compact longitudinal joints to achieve a uniform density of pavement.

A. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

- B. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
 - 1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.
- C. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- D. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
- E. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- F. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.07 INSTALLATION TOLERANCES

- A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
 - 1. Base Course: Plus or minus 1/4 inch.
 - 2. Surface Course: Plus 1/4 inch, no minus.
- B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
 - 1. Base Course: 1/4 inch.
 - 2. Surface Course: 1/8 inch.

3.08 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections. Coordinate Work with the Owner's testing agency.

- B. Replace and compact hot-mix asphalt where core tests were taken.
- C. Additional testing and inspection work to correct or repair unsatisfactory work will be at the expense of the Contractor.
- D. Remove and replace or install additional hot-mix asphalt, at the Contractor's expense, where test results or measurements indicate that it does not comply with specified requirements.

3.09 DISPOSAL

- A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

END OF SECTION 02740

SECTION 02750 - CONCRETE PAVING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Exterior cement concrete pavement for the following:
 - a. Parking lots.
 - b. Curbs and gutters.
 - c. Walkways.
 - d. Concrete pads

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete pavement mixture.

1.03 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment.
- B. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.

PART 2 - PRODUCTS

2.01 STEEL REINFORCEMENT

- A. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.
- B. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.
- C. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed.
- D. Plain Steel Wire: ASTM A 82, as drawn.

E. Deformed-Steel Wire: ASTM A 496.

F. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice."

2.02 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout the Project:

1. Portland Cement: ASTM C 150, Type I.

B. Normal-Weight Aggregates: ASTM C 33, Class 4S coarse aggregate, uniformly graded. Provide aggregates from a single source.

C. Air-Entraining Admixture: ASTM C 260.

D. Water-Reducing Admixture: ASTM C-494, Type A.

2.03 RELATED MATERIALS

A. Clear Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

B. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber not greater than 1/2 inch.

2.04 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, with the following properties:

1. Compressive Strength (28 Days): 3500 psi.

2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.50.

3. Slump Limit: 4-6 inches except 8 inches acceptable for concrete having HRWR admixture (superplasticizer).

4. Air Content: 4.5 to 7.5 percent.

- B. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Proof-roll subbase as specified in Division 31 Section "Earth Moving."

3.02 PAVEMENT SUBBASE COURSE:

- A. Place aggregate base course material on prepared subgrade as specified in Division 31 Section "Earth Moving."

3.03 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.04 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

3.05 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints.

- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
- D. Contraction Joints: Sawcut joints, 1/8 inch wide sectioning concrete into areas as indicated. Sawcut contraction joints for a depth equal to at least one-fourth of the concrete thickness.
- E. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

3.06 CONCRETE PLACEMENT

- A. Moisten subbase to provide a uniform dampened condition at time concrete is placed.
- B. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- C. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- D. Screed pavement surfaces with a straightedge and strike off.
- E. Commence initial floating using bull floats or darbies to impart an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

3.07 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float

surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

3.08 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- D. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound or a combination of these methods.

3.09 PAVEMENT TOLERANCES

- A. Comply with tolerances of ACI 117 and as follows:
 1. Elevation: 1/4 inch.
 2. Thickness: Plus 3/8 inch, no minus.
 3. Surface: Gap below 10-foot-long, unlevelled straightedge not to exceed 1/4 inch.
 4. Joint Spacing: 3 inches.
 5. Contraction Joint Depth: Plus 1/4 inch, no minus.
 6. Joint Width: Plus 1/8 inch, no minus.

3.10 REPAIRS AND PROTECTION

- A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.
- B. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement.

FARMINGTON PUBLIC SCHOOLS
2017 RENOVATIONS-BID PACK #5
ELEMENTARY SCHOOLS

161664B

NOVEMBER 30, 2016

- C. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 02750

SECTION 02760 - PAVING JOINT SEALANTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Expansion and contraction joints within pavement, walks and curbs.
2. Joints between cement concrete and asphalt pavement.
3. Joints between concrete or asphalt and building walls, columns or structures.

1.02 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples: For each type and color of joint sealant required.

PART 2 - PRODUCTS

2.01 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.

1. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

2.02 JOINT SEALANTS

A. Sealant for Expansion and Contraction Joints within Cement Concrete Pavement and Between Concrete Walks, Pads, Paving, and Building Walls, Columns, and Structures: Cold applied two-part pourable urethane joint sealant, Type M, Grade P, Class 25, Use T

1. Products:

- a. Sonneborn, Div. of ChemRex, Inc.; Sonoborn SL 2
- b. Pecora Corporation; Dynatrol II-SG.
- c. Tremco; Vulkem 245
- d. Sika Corporation; Sikaflex - 2c SL

2. Color: Match Concrete.

- B. Sealant for Joints Larger Than 1/4 inch Between Cement Concrete and Asphalt Pavement or Within Asphalt Pavement (Including Longitudinal Joints, Cracks or Butt Joints.): Polymeric hot applied single-component formulation complying with ASTM D 3405.

1. Products:

- a. Carlisle Coatings and Waterproofing; CCW MiraSEAL EJS
- b. Meadows, W. R., Inc.; Sealtight Hi-Spec.

2. Color: Black

2.03 JOINT-SEALANT BACKER MATERIALS

- A. General: Provide joint-sealant backer materials as required that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.

- B. Provide one of the following types of backer materials as applicable:

1. Round Backer Rods for Cold- and Hot-Applied Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.
2. Backer Strips for Cold- and Hot-Applied Sealants: ASTM D 5249; Type 2; of thickness and width required to control sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

3. Round Backer Rods for Cold-Applied Sealants: ASTM D 5249, Type 3, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.
- B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience.
- C. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- D. Install backer materials to support sealants during application and at position required to produce optimum sealant movement capability. Do not leave gaps between ends of backer materials. Do not stretch, twist, puncture, or tear backer materials. Remove absorbent backer materials that have become wet before sealant application and replace them with dry materials.
- E. Install sealants at the same time backings are installed to completely fill recesses provided for each joint configuration and to produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.
- G. Protect applied sealant from traffic and other damage until sealants cured enough not to track. Provide

FARMINGTON PUBLIC SCHOOLS
2017 RENOVATIONS-BID PACK #5
ELEMENTARY SCHOOLS

161664B

NOVEMBER 30, 2016

temporary barricades or other protective measures
recommended by the manufacturer.

END OF SECTION 02760

SECTION 02761 - PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

Furnishing and applying permanent pavement markings.

1.2 DESCRIPTION

- A. Provide all materials, labor, equipment, and services necessary to complete all traffic lane and parking lot striping as indicated in the Construction Documents.
- B. Work includes, but not limited to painting of letters, markings, stripes on the pavement surface applied in accordance with this Section and at the locations shown on the Plans or as directed by the Architect/Engineer.

1.3 QUALITY ASSURANCE

- A. All work under this section shall be performed in accordance with the current 2003 MDOT Standard Specifications for Construction, unless otherwise indicated on the drawings.
- B. All physically handicapped / barrier free markings shall be in accordance with current ADA requirements and the current Michigan Barrier Free Graphics Design Manual.
- C. Each paint container shall be clearly marked showing the name and address of manufacturer, description of material, date of packaging, and volume and weight of contents.
- D. Use only personnel completely trained and experienced in installation of materials and equipment.

1.4 SUBMITTALS

- A. Manufacturer's literature: Submit descriptive product data of materials, installation methods and procedures.
- B. Certification of compliance: Furnish a certification from manufacturer that material for this project has been sampled, tested and complies with requirements of specifications.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. The paint shall meet the specifications set forth in Section 920 of the 2003 MDOT Standard Specifications for Construction, unless otherwise indicated on the drawings.
- B. Color shall be as Specified on the Plans or as follows:

<u>Striping Item</u>	<u>Color</u>	<u>Stripe Width</u>
Stop Bars	White	12"
Traffic Lanes	Yellow	4"
Bus Lanes	White	4"
Standard Parking Stalls	Yellow	4"
Barrier Free Parking Stalls	Blue	4"
No Parking Areas	Yellow	6"
Barrier Free Access Areas	Blue	4"
Curbs	As Noted on Plans	Paint Face of Curb

PART 3 - EXECUTION

3.1 WEATHER LIMITATIONS

- A. The painting shall be performed only when the existing surface is dry and clean, when the minimum atmospheric temperature is in accordance with Table 811-2 of the 2003 MDOT Standard Specifications for Construction, and when the weather is not excessively windy, dusty or foggy.

3.2 EQUIPMENT

- A. All equipment for the Work shall be approved by the Contractor and shall include the apparatus necessary to properly clean the existing surface, a mechanical marking machine, and such auxiliary hand painting equipment as may be necessary to satisfactorily complete the job.
- B. The mechanical marker shall be an approved self-propelled marking machine suitable for application of traffic paint. It shall produce an even and uniform film thickness at the required coverage and shall be designed so as to apply markings of uniform cross-sections and clear-cut edges without running or spattering and within the limits for straightness set forth herein.
- C. Suitable adjustments shall be provided on the sprayer/sprayers of a single machine or by furnishing additional equipment for painting the width required.

3.3 PREPARATION OF EXISTING SURFACE

- A. Immediately before application of the paint, the existing surface shall be cleaned, dry and entirely free from dirt, grease, oil, acids, laitance, or other foreign matter which could reduce the bond between the coat of paint and the pavement. Areas which cannot be satisfactorily cleaned by brooming and blowing shall be scrubbed as directed with a water solution of tri-sodium phosphate or an approved equal solution. After scrubbing, the solution shall be rinsed off and the surface dried prior to painting.
- B. Existing markings or stripes, which are to be abandoned or removed, shall be obliterated or obscured by the best methods suited for the purpose and to the satisfaction of the Owner.

3.4 LAYOUTS AND ALIGNMENT

- A. The Contractor is responsible for laying out proposed striping, which is to be approved by the Owner, before the Contractor is to proceed with the striping procedure. The Contractor is to insure that all subsequent striping meets the quality of the approved application.
- B. On those sections of pavements where no previously applied figures, markings, or stripes are available to serve as a guide, suitable layouts and lines of proposed stripes shall be spotted in advance of the paint application. Control points shall be spaced at such intervals as will ensure accurate location of all markings.
- C. The Contractor shall provide an experienced Technician to supervise the location, alignment, layout, dimensions and application of the paint.

3.5 APPLICATION

- A. Markings shall be applied at the locations and to the dimensions and spacing indicated on the Plans or as specified. Paint shall not be applied until the indicated alignment is laid out and the conditions of the existing surface have been approved by the Owner.
- B. The paint shall be mixed in accordance with the manufacturer's instructions before application. The paint shall be thoroughly mixed and applied to the surface of the pavement with the marking machine at its original consistency without the addition of thinner. If the paint is applied by brush, the surface shall receive two (2) coats; the first coat shall be thoroughly dry before the second coat is applied.
- C. Prior to marking of the pavement, fourteen (14) days shall elapse from the application of the bituminous seal coat, slurry seal or the placement of the HMA surface course.

D. In the application of straight stripes, any deviation in the edges exceeding 1/2-inch in 50-feet shall be obliterated and the marking corrected. The width of the markings shall be as designated within a tolerance of 5 percent (5%).

3.6 PROTECTION

A. After applications of the paint, all markings shall be protected while the paint is drying. The fresh paint shall be protected from injury or damage of any kind. The Contractor shall be directly responsible and shall erect or place suitable warning signs, flags, or barricades, protective screens or coverings as required. Markings defaced by traffic or pedestrians shall be reinstalled at the contractor's expense.

END OF SECTION 02761

SECTION 02765 - PAVING SPECIALTIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Pavement markings
 - 2. Metal bollards/posts.

1.02 SUBMITTALS

- A. Product Data: Manufacturer's printed product data for each product specified.
- B. Samples: For each product specified to match color.

1.03 JOB CONDITIONS

- A. Environmental Requirements: Apply marking paint in dry weather when temperature is 50 deg F or above and anticipated to remain above 50 deg F for four hours after completing application.

PART 2 - PRODUCTS

2.01 PAVEMENT MARKING PAINT

- A. Marking paint: High solids, water based acrylic paint containing ultraviolet resistant pigments.
 - 1. Products:
 - a. ICI Paints; Traffic Marking Paint, #4800
 - b. M.A.B. Paints; Zone Marking Latex Traffic Paint, #072 Line
 - c. Benjamin Moore and Co.; Safety and Zone Marking Latex, M58
 - d. Pittsburgh Paints; Zone & Traffic Marking Paint, #11-23
 - e. Porter Paint Co.; PorterGuard Acrylic Traffic Paint, #2408

f. The Sherwin Williams Co.; Promar Traffic Marking
Paint, B29 Series

2. Colors:

- a. Parking: Yellow.
- b. Traffic Lanes, Directions, Lettering, etc.: MUTCD
standard
- c. Fire Lane: Yellow.

2.02 METAL BOLLARDS

- A. Fabricate from ASTM A-53, Type E or S, Grade B,
Schedule 40 steel pipe.

PART 3 - EXECUTION

3.01 PAVEMENT MARKING

- A. Verify that new asphalt is complete and has been accepted
by Owner's Representative.
- B. Thoroughly clean surfaces free of dirt, sand, gravel, oil,
and other foreign matter. Protect adjacent curbs, walks,
and other items from paint application.
- C. Sweep and clean surface to eliminate loose material and
dust.
- D. Apply paint with mechanical equipment to produce pavement
markings, of dimensions indicated, with uniform, straight
edges. Apply at manufacturer's recommended rates.
- E. Apply stripes straight and even in accordance with
Drawings.
- F. Remove overspray, spills, or drips from surfaces other
than those requiring marking paint.
- G. Barricade marked areas until paint is dried and ready for
traffic.

3.02 METAL BOLLARDS/POSTS

- A. Anchor bollards in place with concrete footings as
indicated on Drawings. Place concrete and vibrate or tamp

for consolidation. Support and brace bollards in position until concrete has cured.

- B. Fill bollards solidly with concrete, mounding top surface to shed water.

END OF SECTION 02765

FARMINGTON PUBLIC SCHOOLS
2017 RENOVATIONS-BID PACK #5
ELEMENTARY SCHOOLS

161664B

NOVEMBER 30, 2016

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SealMaster Asphalt Sealcoating

Phone: 800-395-7325, 419-626-4375

Website: www.sealmaster.net

E-mail: info@sealmaster.net

Engineering Specification: SealMaster Polymer Modified
MasterSeal (PMM)-Quick Spec.

SECTION 02767 - ASPHALT PAVEMENT SEALCOATING FOR PARKING LOTS

Specifier's Notes: This Asphalt Pavement Sealcoating Specification is furnished as a guide for specifying Asphalt Repair, Sealcoating and Striping of Asphalt Pavement Parking Lots. It is written in the CSI 3-Part Format and must be edited to suit the particular needs and budgetary requirements of a given project and its respective location.

If you need more specific information regarding a product visit www.sealmaster.net or contact your local SealMaster Representative at 1-800-395-7325. SealMaster Representatives are also available to answer any questions you may have regarding your specific project.

PART 1 - GENERAL

1.01 SUMMARY

- A. Asphalt Pavement Sealcoating

1.02 REFERENCE STANDARDS

- A. American Society for Testing Materials (ASTM)
 - 1. D 2939-03 Standard Test Methods for Emulsified Bitumens Used as Protective Coatings
 - 2. The following ASTM test methods: D140, D466, D529, D244, C88, C131, C117, C127, C123, D1310, D2170, D95, D402, D2171, D5, D113, D2042, D711, D969, D1475, D3960, D2486, E70, D562, D3583, D3236, D5249, D6690, B117, D977

- B. South Coast Air Quality Management District
 - 1. SCAQMD Method 304 - Determination of Volatile Organic Compounds (VOC) In Various Materials.

- C. Federal Specifications for Waterborne Traffic and Airfield Marking Paints
 - 1. TT-P-1952E Types I, II, and III
 - 2. TT-P-1952D
 - 3. TT-P-1952B

1.03 SUBMITTALS

- A. Product Data
 - 1. Submit manufacturer's Product Data Sheet.

1.04 PROJECT/SITE CONDITIONS

- A. Ambient Conditions
 - 1. Both surface and ambient temperature must be a minimum of 50°F and rising before applying cold applied crack fillers, oil spot primers, pavement sealers or traffic paints (materials). Ambient and surface temperature shall not drop below 50°F for a 24 hour period following application of materials.
 - 2. Apply materials during dry conditions when rain is not imminent or forecast for at least 24 hours after application.

- B. Pavement/Surface Conditions
 - 1. Newly placed (paved) asphalt pavement surfaces should be allowed to cure a minimum of four (4) weeks under ideal weather conditions (70°F) before applying coatings.
 - 2. New pavement surfaces shall be free of residual oils or chemicals associated with the placement of new asphalt pavement.
 - 3. Aged pavement surfaces shall be cleaned and prepared as recommended in this specification under PART 3 Sections 3.1 thru 3.7 of this specification.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. SealMaster Pavement Products and Equipment. SealMaster has a nationwide network of manufacturing and distribution facilities. Phone: 800-395-7325. Website: www.sealmaster.net. E-mail: info@sealmaster.net.

2.02 MATERIALS

- A. SealMaster CrackMaster Parking Lot Grade (Hot Pour Rubberized Crack Sealant)
- B. SealMaster Trowel Grade Crack Filler
- C. SealMaster Asphalt Binder Plus
- D. SealMaster Polymer Modified MasterSeal

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine pavement surface prior to performing work
- B. Notify architect or project engineer of any adverse or unacceptable conditions that would affect successful repair efforts or application of materials
- C. Do not commence work until unacceptable conditions are corrected

3.02 SURFACE PREPARATION

- A. Surface must be clean and free from all loose material and dirt. Remove grass along edge of pavement to find true edge of pavement. Power blowers, mechanical sweeping devices and push brooms are acceptable cleaning methods.

3.03 CRACK REPAIR

A. Hot Applied Crack Sealant/Filling Materials and Methods

1. Cracks must be free from dust, dirt, vegetation and moisture. Clean cracks with mechanical wire brush followed by a compressed air heat lance to remove loose debris and moisture.
2. For all cracks up to 1" wide apply either SealMaster CrackMaster Parking Lot Grade crack sealant or SealMaster Crackmaster Supreme crack sealant.
3. SealMaster CrackMaster Parking Lot Grade crack sealant shall be melted in a conventional oil-jacketed unit equipped with an agitator.
4. Apply heated CrackMaster Parking Lot Grade crack sealant using a pump and wand system, a crack banding unit or a pour pot.
5. Contractor or other Entity Responsible for performing work shall refer to Manufacturer's Product Data Sheet for more detailed application instructions for CrackMaster Parking Lot Grade Crack Sealant.

3.08 POLYMER-MODIFIED MASTERSEAL (PMM) APPLICATION

A. Applying SealMaster Polymer-Modified MasterSeal

1. Remove all loose material and dirt from pavement surface. Remove grass along edge of pavement to find true edge of pavement. Power blowers, mechanical sweeping devices and push brooms are acceptable cleaning methods.
2. Equipment used to apply Polymer-Modified MasterSeal shall have continuous agitation or mixing capabilities to maintain homogeneous consistency of pavement sealer mixture throughout the application process. Spray equipment shall be capable of mixing and spraying pavement sealer with sand added. Self-propelled squeegee equipment with mixing capability shall have at least 2 squeegee or brush devices (one behind the other) to assure adequate distribution and penetration of sealer into pavement surface. Hand squeegees and brushes shall be acceptable in areas where practicality prohibits the use of mechanized equipment.

3. Polymer-Modified MasterSeal (PMM) shall be mixed in accordance with the following mix design (based on 100 gallons of PMM for ease of calculation):
 - Polymer-Modified MasterSeal (PMM).....100 gallons
 - Sand (40 to 70 mesh AFS fineness gradation).....200-400 lbs.

Note: If required, a small amount of water may be added to facilitate application of mixed material.
4. Apply two coats of mixed PMM and Sand at a rate of .11 to .13 gallon per square yard per coat to entire pavement area. Allow first coat to dry thoroughly before applying second coat.
5. Apply a third coat of mixed PMM and Sand at a rate of .11 to .13 gallon per square yard to high traffic areas including parking area entrances, exits and drive lanes (or as specified in additional diagrams or drawings). Allow second coat to dry thoroughly before applying a third coat to these areas.
6. Allow final coat of pavement sealer to dry 24 hours prior to applying SealMaster 100 % Acrylic Water based Traffic Paint.

END OF SECTION 02767

FARMINGTON PUBLIC SCHOOLS
2017 RENOVATIONS-BID PACK #5
ELEMENTARY SCHOOLS

161664B

NOVEMBER 30, 2016

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SECTION 02810 - PLANTING IRRIGATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Landscape irrigation system

1.02 PERFORMANCE REQUIREMENTS

- A. Irrigation zone control shall be automatic operation with controller and automatic control valves.
- B. Delegated Design: Design 100 percent coverage irrigation system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Wiring Diagrams: For power, signal, and control wiring.
- C. Delegated-Design Submittal: For irrigation systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. As-Built Drawings: Two sets of drawings indicating actual location of piping, valves, sprinkler heads, wiring and zones.

1.04 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.05 WARRANTY

A. Special Warranty: Installer agrees to repair or replace planting irrigation components and accessories that fail in materials and workmanship within specified warranty period.

1. Warranty Periods from Date of Store Opening: 12 months.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. Manufacturer:

1. Hunter Industries, Inc.
2. LR Nelson Corp.
3. Rain Bird Sprinkler Mfg. Corp.
4. The TORO Co., Irrigation Div.

2.02 PIPES, TUBES AND FITTINGS

A. Pressure Pipe:

1. Polyvinyl chloride PVC plastic pipe complying with ASTM-D 1785, Schedule 40 or ASTM D2241, SDR 21, class 200 and AWWA M23, latest revision.
2. Polyethylene (PE) Water Pipe, AWWA C901 "Polyethylene (PE) Pressure Pipe and Tubing, 1/2-inch through 3-inch for Water Service."

B. Circuit Pipe (downstream from circuit valves): with PVC plastic pipe, ASTM D 2241, SDR 26, 160 psi or ASTM D 1785, Schedule 40.

2.03 VALVES

A. Valves: Flow range 5.0 to 180.0 gpm.

1. Basis of Design: Toro 252 Series solenoid valves.

B. Backflow Preventer: Manufacturers standard to suit project conditions.

2.04 SPRINKLERS AND ACCESSORIES

- A. Sprinkler Heads: Manufacturers standard, to provide uniform coverage at available water pressure.
- B. Drip Tubing/Accessories: Manufacturers standard, self-cleaning, self-flushing pressure compensating components and polyethylene tubing with 12-inch or 18-inch dripper spacing.

2.05 CONTROLLERS

- A. Automatic Controls: Provide exterior/interior boxes with locking covers.
 - 1. Transformers as required for low voltage system.
 - 2. Wiring: Not less than 14 gauge. Provide direct burial type for buried wire. Use waterproof wire nuts throughout.
 - 3. Circuit Control with switch for manual or automatic control of each circuit.
 - 4. Timing Device: 24 hour, 7 day and even/odd interval watering adjustment, with provision for manual or semi-automatic operation and hard wired rain sensor which will suspend watering when ground is wet from rain.
- B. Rain Sensors: Provide hard wired units.
 - 1. Products:
 - a. Hunter Industries, Inc.; "Rain-Clik"
 - b. LR Nelson Corp.; "Rain-Trip"
 - c. Rain Bird Sprinkler Mfg. Corp.; "RSD Series Rain Sensor"
 - d. The TORO Co., Irrigation Div.; "TWRS - Wireless RainSensor"

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Provide minimum water coverage as follows:
 - 1. Turf area 100 percent.
 - 2. Other planting areas 100 percent.

- B. Run under pavements and walks. Do not cut pavements or walks. All water lines under sidewalks or paving shall be sleeved. All wiring under paving shall be installed in conduit.
- C. Use dielectric fittings whenever dissimilar metals are joined.
- D. Testing: Perform operational testing and train store personnel on proper use.
- E. Place copy of zone map, with all zone valve locations shown and approved irrigation plan, in protective jacket, with the main control panel.
- F. Use pressure compensating dripper systems or pressure compensating low trajectory nozzles only in locations where water has high iron content and only at areas adjacent to buildings to prevent water spray and rust from staining buildings.
- G. Provide a 3/4-inch diameter blow down drain tee to allow water to be blown from irrigation system.

END OF SECTION 02810

SECTION 02900 - PLANTING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Seeding and Sodding
 - 2. Trees and Plants

1.02 SUBMITTALS

- A. Certification of grass seed and seed mixture for turfgrass sod.

1.03 QUALITY ASSURANCE

- A. USA Standard for Nursery Stock shall govern the quality of plant materials.
- B. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory.
- C. Turf and plants are subject to the approval of the Owner. Approval of plants at the nursery does not alter the right of rejection at the project site.

1.04 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner, or incidents that are beyond Contractor's control.
 - b. Structural failures including plantings falling or blowing over.

2. Warranty Periods from Date of Final Completion: 12 months.

1.05 MAINTENANCE SERVICE

- A. Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after turf and plants are installed and continue until plantings are acceptably healthy and well established but for not less than one full growing season days from date of store opening.

PART 2 - PRODUCTS

2.01 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Species: State-certified seed.

2.02 PLANT MATERIAL

- A. General: Furnish plants as indicated on Drawings, nursery-grown, true to genus, species, variety, cultivar, stem form, shearing, and other features complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
- B. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

2.03 PLANTING SOILS

- A. Planting Soil: ASTM D 5268 topsoil, with pH range of 5.5 to 7, a minimum of 2 percent organic material content. Verify suitability of soil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clods,

clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth.

1. Supplement with inorganic and organic soil amendments as required.
2. Topsoil source may be surface soil stockpiled on site, imported topsoil, or existing in-place surface soil amended to produce topsoil as specified.

2.04 MULCHES

- A. Organic Mulch: Shredded hardwood
- B. Mineral Mulch: Rounded riverbed gravel

PART 3- EXECUTION

3.01 PREPARATION

- A. All debris and compacted subsoil shall be removed from the planter area to a minimum depth of 4 inches below the top of curb.
- B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4 inches. Remove stones larger than 1-1/2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
 1. Spread planting soil to a depth of 4 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
- C. Unchanged Subgrades: If turf and plants are to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:
 1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.

2. Loosen surface soil to a depth of at least 6 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture.
 3. Remove stones larger than 1-1/2 inches in any dimension and sticks, roots, trash, and other extraneous matter.
 4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.
- D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.
- E. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- F. Before planting, obtain Owner's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.
- 3.02 HYDROSEEDING
- A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
1. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.
- 3.03 SODDING
- A. Lay sod within 48 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

1. Lay sod across angle of slopes exceeding 1:3.

C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.04 TREE AND SHRUB PLANTING

A. Planting Pits and Trenches: Excavate circular planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.

1. Excavate approximately three times as wide as ball diameter.

2. Excavate at least 12 inches wider than root spread and deep enough to accommodate vertical roots for bare-root stock.

B. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1.

C. Set stock plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.

1. Use planting soil for backfill.

2. Balled and Burlapped: After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from

- under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
3. Balled and Potted or Container-Grown: Carefully remove root ball from container without damaging root ball or plant.
 4. Fabric Bag-Grown Stock: Carefully remove root ball from fabric bag without damaging root ball or plant. Do not use planting stock if root ball is cracked or broken before or during planting operation.
 5. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
 6. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
 7. Continue backfilling process. Water again after placing and tamping final layer of soil.
- D. Bare-Root Stock: Set and support bare-root stock in center of planting pit or trench with root flare 1 inch above adjacent finish grade.
1. Use planting soil for backfill.
 2. Spread roots without tangling or turning toward surface, and carefully work backfill around roots by hand. Puddle with water until backfill layers are completely saturated. Plumb before backfilling, and maintain plumb while working backfill around roots and placing layers above roots.
 3. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside soil-covered roots about 1 inch from root tips; do not place tablets in bottom of the hole or touching the roots.
 4. Continue backfilling process. Water again after placing and tamping final layer of soil.

3.05 PLANTING AREA MULCHING

- A. Prior to mulching, treat planting areas with pre-emergent weed killer, applied according to the manufacturer's directions.
- B. Apply 3-inch average thickness of mulch over whole surface of planting area, and finish level with adjacent finish grades.

3.06 MAINTENANCE

- A. Maintain and establish turf and plants by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf and plants.
 - 1. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
 - 2. Spray or treat as required to keep trees and shrubs free of insects and disease.
- B. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain height appropriate for species without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings.

3.07 SATISFACTORY TURF

- A. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
- B. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.

FARMINGTON PUBLIC SCHOOLS
2017 RENOVATIONS-BID PACK #5
ELEMENTARY SCHOOLS

161664B

NOVEMBER 30, 2016

- C. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

END OF SECTION 02900

SECTION 02925 - CLEANUP AND RESTORATION

PART 1 - GENERAL

The Contractor shall restore areas disturbed by construction activities to a condition reasonably close to their condition before the project, unless shown otherwise on the plans. Restoration work should be performed as soon as possible after construction work is completed in a particular area.

Upon the completion of work in an area, all excess materials, debris, equipment, and similar items shall be removed from the project area by the Contractor, and disposed of properly.

PART 2 - MATERIALS

Not Applicable.

PART 3 - EXECUTION

3.01 Restoration

Unless otherwise provided; aggregate surfaces, bituminous pavements, and concrete pavements shall be restored by construction of similar replacement surfaces. Aggregate surfaces shall be replaced with the materials and thicknesses described in the specification for aggregate surfaces. Bituminous pavement shall be replaced with the cross sections(s) shown on the plans and in accordance with the specification for bituminous paving. Concrete pavement shall be replaced with pavement in accordance with the specification for Concrete Driveways and Miscellaneous Pavement.

Turf areas shall be restored by re-establishing the turf as described in the specification for turf establishment. All

areas disturbed by construction that are not to be surfaced with aggregate or pavement shall be restored with turf, unless otherwise directed.

Mailboxes, fences, signs, ornaments, and similar items shall be replaced at the completion of construction. Posts shall be installed plumb. Items that are lost or stolen shall be repaired or replaced at the Contractor's expense. Repairs or replacements shall meet the Owner's approval.

3.02 Temporary Restoration of Driving Surfaces

Where a pavement or gravel surface is removed as a result of construction activities, a temporary surface shall be provided and maintained by the Contractor until the permanent surface is provided. Unless otherwise directed, the temporary surface shall be twelve inches of aggregate compacted to at least 95 percent of its maximum density (ASTM D1557) and graded to meet the adjacent, remaining surfaces. Aggregate shall meet the requirements of Series 23A as described in the 1990 Michigan Department of Transportation Specifications.

The Contractor shall regrade the temporary surface and add additional aggregate at intervals necessary to maintain them in a relatively smooth condition.

END OF SECTION

SECTION 02951 LANDSCAPE RESTORATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Soil Materials and Preparation
- B. Restoration of Lawns (Hydroseeding)

1.2 REFERENCES

- A. FS O-F-241 - Fertilizers, Mixed, Commercial
- B. American Standard for Nursery Stock ANSI 260.1-2004

1.3 QUALITY ASSURANCE

- A. Provide seed mixture in containers showing percentage of seed mix, year of production, net weight. Date of packaging and location of packaging.
- B. Such approval shall not impair the right of inspection and rejection upon delivery at the site or during the progress of the Work.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver landscape materials in original, unopened and undamaged containers showing weight, analysis and name of manufacturer. Store in manner to prevent wetting and deterioration.

1.5 COORDINATION

- A. All disturbed areas shall be restored to a condition equal to or greater than the area's condition before the project began (i.e. lawns, trees, plants, shrubs).
- B. Protect existing utilities, paving and other facilities from damage caused by landscaping operations.
- C. Perform restoration work only after sitework has been completed and ground surface will not be affected.
- D. Locate, protect and maintain the existing irrigation system (if any) during planting, utility trenching and new building construction. Repair irrigation system components and/or piping, damaged during utility

trenching, planting and building construction as part of this contract.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Topsoil: Topsoil shall be free from roots, sticks, weeds, brush or stones larger than 1-in. in diameter or other litter or waste products. It shall be a loamy mixture having at least 90 percent passing a No. 10 sieve. A sample, free from extraneous materials, shall comply to the following requirements:

1. Organic Matter: Topsoil shall contain not less than 10 percent organic matter as determined by the test for organic matter, AASHTO T 194.
2. Clay: The topsoil shall contain not less than 12 percent clay or more than 50 percent as determined in accordance with AASHTO T 88.
3. Sand: The sand content shall not exceed 55 percent as determined in accordance with AASHTO T 88.
4. pH: The pH of the sample shall not be less than 5.0 nor higher than 8.0. The pH shall be determined with an acceptable pH meter, on that portion of the sample passing a No. 10 sieve, in accordance with ASTM D-4972, pH of soils.

B. Supplied or stockpiled topsoil shall be fertile, friable and representative of local productive soil, capable of sustaining vigorous plant growth and screened free of clay lumps, subsoil, noxious weeds or other foreign matter such as stones greater than 1" in diameter in any dimension, roots, sticks and other extraneous materials not frozen or muddy. pH of existing or supplied soil to range between 5.0 and 7.5. Adjusted to not more than 7.0 by additives as required by soil test. Topsoil shall contain not less than 3% and not greater than 10% organic matter. Clay content as determined by Bouyoucous Hydrometer Test shall range between 5 and 15 percent. Mechanical analysis as follows:

PASSING	RETAINED ON	PERCENTAGE
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1" Screen		100%
1" Screen	¼" screen (gravel)	Not more than 3%
¼" Screen	No. 140 USS Mesh Sieve	40-60%
No. 140 USS	Percentage based on dry Weight of the samples	30-35%(Very fine sand, silt and clay)

C. If sufficient topsoil is not available at the Site or the Landscape Contractor elects the option to secure topsoil elsewhere, the Landscape Contractor must receive the Owner's approval of material in writing prior to securing topsoil. All topsoil secured off Site must meet other requirements of this Section.

2.2 SEED MIXTURES

A. Lawn Seed: Fresh, clean and new crop proportioned by weight as follows:

	MIX	MIN. GERMINATION	MIN. PURITY
Perennial Ryegrass	30%	90%	95%
Kentucky Bluegrass	40%	75%	90%
Creeping Red Fescue	30%	80%	95%

2.3 ACCESSORIES

A. Lawn

1. Wood fiber mulch slurry, 1200 lbs fiber per acre.
2. Fertilizer: Water soluble 20-20-20 composition.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine finish surface and grades. Do not start landscape restoration work until all unsatisfactory conditions are corrected.

3.2 PREPARATION OF SUBSOIL

A. Prepare sub-soil to eliminate uneven areas and low spots. Maintain lines, levels, profiles and contours. Make changes in grade gradual. Blend slopes into level areas.

- B. Remove foreign materials, weeds and undesirable plants and their roots. Remove contaminated sub-soil.

3.3 PLACING TOPSOIL

- A. For Seeding Lawns: Spread topsoil to a depth of 2 inches over area to be seeded. Rake smooth and free of debris.

3.4 HYDROSEEDING

- A. Seeding operations shall take place between March 15 and June 15 under favorable climatic conditions or August 15-September 15.
- B. Treat all grassy or weedy areas with "Round-up" to eliminate existing vegetation. Wait 7-10 days, then apply a second application of "Round-up" and wait another 7 days until planting.
- C. Scarify ground with rake as necessary immediately before sowing seed to provide smooth, even grade and friable seed bed.
- D. Use a hydromulcher (sprayer) and apply mixture(s) at the following rate. Mix in accordance with manufacturer's recommendations.
- E. Apply hydroseed slurry to indicated areas. Use tackifier only on erosion prone areas. Apply fertilizer with hydro mix.

Seed: At specified seeding rates (300 pounds per acre)
Fertilizer: 400 pounds per acre
Tackifier: 60 gallons per acre
Wood Cellulose Fiber Mulch: 2000 pounds per acre

- F. Use care so as not to get hydroseed materials on buildings, walks, roadways, plant beds, etc.

3.5 ACCEPTANCE

- A. Architect shall inspect work upon written request of the Landscape Contractor after completion of 60-day establishment maintenance period.
- B. Acceptance of plant material shall be for conformance to specified size, character, and quality and shall not relieve the Landscape Contractor of responsibility for full conformance to Contract Documents including correct species.

- C. Acceptance in part: Portions of lawns and/or transplantings may be accepted in part upon Architect's approval.
- D. Landscape Contractor is responsible for watering of hydroseed and sod until lawn is established to the satisfaction of the Architect/Owner.
- E. Establish dense lawn of permanent grasses, free from lumps and depressions. Any area failing to show uniform germination to be reseeded; continue until dense lawn established. Damage to seeded area resulting from erosion to be repaired by the Landscape Contractor. Scattered bare spots less than 5 percent of the total area is acceptable.
- F. In event the Landscape Contractor does not establish dense lawn during germination period, return to project to refertilize and reseed to establish dense lawn.
- G. Should the seeded lawn become largely weeds after germination, the Landscape Contractor is responsible to kill the weeds and reseed the proposed lawn areas to produce a dense turf, as specified.

3.6 CLEANUP

- A. Perform cleaning during installation of the work and upon completion of the work to the approval of the Architect. Remove from site all excess materials, debris and equipment. Repair damage resulting from seeding operations. Clean all areas where overspray has occurred from hydroseeding operations.

END OF SECTION 02951

SECTION 03001 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.
- B. Related Sections:
 - 1. Section 312000 "Earth Moving" for drainage fill under slabs-on-grade.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete mixture (refer to Structural Drawings for additional information).
- C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement.

1.03 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Material certificates.
- C. Material test reports.
- D. Floor surface flatness and levelness measurements.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- B. Testing Agency Qualifications: An independent agency (Special Inspector), acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."
- D. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 1. ACI 301, "Specifications for Structural Concrete," Sections 1 through 5.
 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
- E. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
- F. Preinstallation Conference: Conduct conference at Project site.

PART 2 - PRODUCTS

2.01 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

2.02 STEEL REINFORCEMENT

- C. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- D. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- E. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from as-drawn steel wire into flat sheets.
- F. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice.

2.03 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
 - 1. Portland Cement: ASTM C 150, Type I, gray. Supplement with the following:
 - a. Fly Ash: ASTM C 618, Class F or C.
 - b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
- B. Normal-Weight Aggregates: ASTM C 33, graded.
 - 1. Maximum Coarse-Aggregate Size: 1 inch (25 mm) nominal.
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Water: ASTM C 94/C 94M and potable.

2.04 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.

- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
 - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.05 WATERSTOPS

- A. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch (19 by 25 mm).

2.06 VAPOR RETARDERS

- A. Sheet Vapor Retarder: ASTM E 1745, Class A, with a thickness not less than 10 mils. Include manufacturer's recommended adhesive or pressure-sensitive tape. Retain paragraph below if generic polyethylene, not complying with ASTM E 1745, is permitted.

2.07 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.

- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.
- D. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering].

2.08 RELATED MATERIALS

- A. Expansion-and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

2.09 CONCRETE MIXTURES

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
- B. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent. Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
 - 1. Fly Ash: 25percent.
 - 2. Combined Fly Ash and Pozzolan: 25 percent.
 - 3. Ground Granulated Blast-Furnace Slag: 50 percent.
 - 4. Combined Fly Ash or Pozzolan and Ground Granulated Blast-Furnace Slag: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
 - 5. Silica Fume: 10 percent.

6. Combined Fly Ash, Pozzolans, and Silica Fume: 35 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
 7. Combined Fly Ash or Pozzolans, Ground Granulated Blast-Furnace Slag, and Silica Fume: 50 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
- C. Admixtures: Use admixtures according to manufacturer's written instructions.
1. Use water-reducing, high-range water-reducing, or plasticizing admixture in concrete, as required, for placement and workability.
 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
- D. Foundations (Footings and Concrete Walls): Proportion normal-weight concrete mixture as follows:
1. Minimum Compressive Strength: 3000 psi (20.7 MPa) at 28 days.
 2. Maximum Water-Cementitious Materials Ratio: 0.50 .
 3. Slump Limit: 4 inches (100 mm), 8 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch (25 mm).
 4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) nominal maximum aggregate size.
- E. Slab-on-Grade: Proportion structural normal-weight concrete mixture as follows:
1. Minimum Compressive Strength: 3000 psi (20.7 MPa) at 28 days.

2. Slump Limit: 5 inches (125 mm), plus or minus 1 inch (25 mm).
3. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

F. Supported Slabs on Metal Deck: Proportion structural normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 3500 psi (20.7 MPa) at 28 days.
2. Slump Limit: 5 inches (125 mm), plus or minus 1 inch (25 mm).
3. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

G. Exterior Concrete: Proportion structural normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 4000 psi (20.7 MPa) at 28 days.
2. Slump Limit: 5 inches (125 mm), plus or minus 1 inch (25 mm).
3. Air Content: 6 percent, plus or minimum 1.5 percent at point of delivery for 1-inch nominal maximum aggregate size.

2.10 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.11 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.01 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Chamfer exterior corners and edges of permanently exposed concrete.

3.02 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.03 VAPOR RETARDERS

- A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.
 - 1. Lap joints 6 inches (150 mm) and seal with manufacturer's recommended tape.

3.04 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
 - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

3.05 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
 - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch (3.2 mm). Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 - 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3.2-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
- E. Waterstops: Install in construction joints and at other joints indicated according to manufacturer's written instructions.

3.06 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

- B. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
 - 1. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
- C. Cold-Weather Placement: Comply with ACI 306.1.
- D. Hot-Weather Placement: Comply with ACI 301.

3.07 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces not exposed to public view.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish, to be covered with a coating or covering material applied directly to concrete.
- C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:
 - 1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
 - 2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces

and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.

3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

- D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.08 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch (6 mm) in one direction.
 1. Apply scratch finish to surfaces to receive mortar setting beds for bonded cementitious floor finishes.
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes

and restraightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.
- D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
1. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
 2. Finish surfaces to the following tolerances, according to ASTM E 1155, for a randomly trafficked floor surface:
 - a. Slab-on-Grade: Specified overall values of flatness, F(F) 25; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and of levelness, F(L) 15.
 - b. Supported Slab on Metal Deck: Finish surfaces to the following tolerances, according to ASTM E 1155: F(L) Specified overall values of 25; provide floor levelness such that 80 percent of the elevation points fall within a $\frac{3}{4}$ inch envelope centered on the mean data collected per ADSTM E1155. Mean elevation tolerance: $\frac{3}{8}$ inch of design elevation.
- E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. While concrete is still plastic, slightly scarify surface with a fine broom.

1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.

3.09 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces

by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.10 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

3.11 FIELD QUALITY CONTROL

- B. Testing and Inspecting: Owner will engage a qualified testing and inspecting agency (Special Inspector) to perform field tests and inspections and prepare test reports (refer to Structural Drawings for additional information).

END OF SECTION 03001

SECTION 04100 - MORTAR & GROUT

PART 1. GENERAL

1.01 RELATED DOCUMENTS

- A. Attention is directed to Division 0, Bidding and Contract Requirements, and to Division 1, General Requirements, which are hereby made a part of this specification. Refer to Structural Drawings for additional information.

1.02 SECTION INCLUDES

- A. Work included in this section consists of furnishing all labor, materials, equipment, and incidentals required for complete installation of mortar and grout for masonry.
- B. Related work specified elsewhere:
 - 1. Section 05120 Structural Steel (Non-shrink grout).

1.03 ENVIRONMENTAL REQUIREMENTS

- A. Recommended Practices for Hot and Cold Weather Masonry Construction as published by the Masonry Industry Council.

PART 2. PRODUCTS

2.01 MATERIALS

- A. Portland Cement: ASTM C150, Type 1 provide natural color or white cement as required to provide mortar color indicated.
- B. Mortar Aggregate: ASTM C144, standard masonry type.
- C. Hydrated Lime: ASTM C207, Type 'S', or 'N'.
- D. Masonry Cement: ASTM C91.
- E. Premix Mortar: ASTM C387.
- F. Grout Aggregate: ASTM C404.
- G. Grout Fine Aggregate: ASTM C144, 100% passing #8 sieve, maximum 5-30% passing #50 sieve.
- H. Water: Clean and potable.
- I. Integral water repellent additive meeting ASTM E-514.

J. Plasticizer:

1. SIKA Chemical Corporation "Intraplast Z".
2. Euclid Chemical Co. "Eucon BK-S".

K. Storage of all material shall prevent the intrusion of foreign matter. Store all masonry units on the ground, protected against damage and intrusion of excess moisture. No damaged or deteriorated materials shall be used.

2.02 MORTAR MIXES

- A. Mortar for exterior load bearing walls and all exterior masonry work below grade; ASTM C270, Type 'M' or 'S', using the property method unless noted otherwise on structural drawings. Use ASTM C270 Type 'N' above grade at exterior veneers.
- B. Mortar for interior non-load bearing walls and partitions: ASTM C270, Type 'M' or 'S', using the property method.
- C. Mortar for reinforced masonry ASTM C270, Type 'S', using the property method.
- D. Pointing mortar for masonry veneers ASTM C270, Type 'N', using the property method.
- E. Mortar Pigments: Natural and synthetic milled, blended iron oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortars.
 1. Provide colored mortar pigments: Color shall be as selected by Architect from SGS concentrated A, H and X Series mortar colors as manufactured by Solomon Colors, Springfield, IL 800-624-0261.
 - a. Carbon added for darker colors shall not exceed 4%.
 - b. Mix shall product uniform and consistent color.
 - c. Inert, stable to atmospheric conditions, sun fast, weather resistant, alkali resistant, water insoluble, lime proof and non bleeding.
 - d. Free of deleterious fillers and extenders.
 - e. Practice size: 95 to 99% minus 325 mesh.
 - f. pH: 6.5 to 9.0.
 - g. Shall be tested per ASTM C91 and ASTM C270. Exceed 1800 psi at 28 days strength requirement.

- F. Ready-Mixed Mortar: Cementitious materials, water, and aggregate complying with requirements specified in this Article; combined with set-controlling admixtures to produce a ready-mixed mortar complying with ASTM C 1142.
- G. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494, Type C, and recommended by the manufacturer for use in masonry mortar of composition indicated.

2.03 MORTAR MIXING

- A. Thoroughly mix mortar ingredients in approved type mixing machine in quantities needed for immediate use in accordance with ASTM C270 or C780. Discharge mixer completely before recharging.
- B. All exterior above grade mortar exposed to moisture shall be fabricated with integral water repellent additive.
- C. Blend admixtures in accordance with manufacturer's instructions.
- D. Do not use anti-freeze compounds to lower the freezing point of mortar.

2.04 GROUT MIXES

- A. Bond beams, lintels, engineered masonry, reinforced masonry walls: min. 3000 psi strength at 28 days unless noted otherwise; 8-10 inches slump; pre-mixed grout in accordance with ASTM C94, or batch mixed in accordance with ASTM C476 for fine or course grout.

PART 3. EXECUTION

3.01 EXAMINATION AND PREPARATION

- A. Apply bonding agent to existing concrete surfaces.

3.02 INSTALLATION

- A. Install pre-mix mortar and grout in accordance with manufacturer's instructions.
- B. Work grout into masonry cores and cavities to eliminate voids. Do not displace reinforcement. Reinforcing shall be

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2017 RENOVATIONS-BID PACK #5
ELEMENTARY SCHOOLS

161664B

NOVEMBER 30, 2016

mechanically anchored in masonry cores to prevent
displacement during grouting.

END OF SECTION 04100

SECTION 04300 - UNIT MASONRY

PART 1. GENERAL

1.01 RELATED DOCUMENTS

- A. Attention is directed to Division 0, Bidding and Contract Requirements, and to Division 1, General Requirements, which are hereby made a part of this specification.

1.02 SECTION INCLUDES

- A. Work included in this section consists of furnishing all labor, materials, equipment and incidentals required for complete installation of concrete masonry and brick units including installation of reinforcement, anchorage and accessories.

- B. Related work specified elsewhere:

- 1. Section 04100 - Mortar & grout
- 2. Section 04720 - Cast Stone

1.03 PERFORMANCE REQUIREMENTS

- A. Provide unit masonry that develops the following installed compressive strengths (f'm) at 28 days.

- 1. For concrete Unit Masonry: As follows, based on net area:
 - a. For 8" CMU: f'm = 1500 psi
 - b. For 12 inch CMU: f'm = 2000 psi
- 2. For Brick Unit Masonry: As follows, based on gross area:
 - a. f'm - 1500 psi (10.3 MPa).

1.04 SUBMITTALS

- A. Provide data on concrete masonry units including proposed reinforcing.
- B. Shop Drawing for stone trim including cutting and setting diagrams.
- C. Reinforcing steel shop drawings (refer to structural drawings for additional information)

- D. If specifically requested by the Architect/Engineer, provide samples for verification as follows:
1. Full-size units for each different exposed masonry unit required showing the full range of exposed colors, textures, and dimensions to be expected in the completed construction.
 2. Weep vents in color to match mortar color.
 3. Accessories embedded in the masonry.

1.05 QUALITY ASSURANCE

- A. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire resistance ratings determined per ASTM E 119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by another means, as acceptable to authorities having jurisdiction.
- B. Single-Source Responsibility for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from one source and by a single manufacturer for each different product required.
- C. Single-Source Responsibility for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from one manufacturer for each cementitious component and from one source or producer for each aggregate.

1.06 ENVIRONMENTAL REQUIREMENTS

- A. Hot and Cold weather requirements: Recommended Practices for Hot or Cold Weather Masonry Construction as published by the Masonry Industry Council.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms, under cover, and in a dry location to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion, and other causes. If units become wet, do not install until they are in an air-dried condition.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location.

- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

PART 2. PRODUCTS

2.01 CONCRETE MASONRY UNITS

- A. Concrete block (CMU): ASTM C90, medium weight (105-125 pcf). Use for above and below grade, exterior or interior wall applications. Provide units made with "dry block" as manufactured by W.R. Grace & Company (or approved) for exterior wall applications. This includes exterior walls with veneers.
- B. Burnished Concrete Masonry Units:
 - 1. Units shall be normal or light weight block. Units shall meet or exceed requirements of ASTM C-90, Grade N, Type 1.
 - 2. Units shall be integrally colored with colors and aggregate as selected by Architect from manufacturer's standard available colors including white aggregate. All pre-colored block shall be in accordance with the Standards of the Concrete Masonry Association.
 - 3. All exterior above grade units exposed to moisture shall be fabricated with integral water repellent additive meeting ASTM E-514.
 - 4. Burnished masonry units shall be manufactured by Grand Blanc Cement Products, Grand Blanc Michigan, 1-800-875-7500. Color and aggregate as selected by Architect. Note: Multiple colors will be used. Cost of burnished block units to be based on "L'Anse Creuse White".
 - 5. All burnished units are to receive one coat of sealant at the factory and a second coat shall be applied after erection.
 - 6. Provide 24" dia. Column block units and other special shapes as indicated on the drawings.
 - 7. Provide filled units at all exterior applications.
 - 8. Construct a sample panel at the jobsite, for approval by the Architect and Owner, of the color and aggregate prior to ordering and erection of the units.

2.02 BRICK UNITS

- A. Face Brick: ASTM C216, Type FBS, Grade SW.
- B. Brick Masonry Units: Modular size of 2-1/4" x 3-5/8" x 7-5/8". Provide special units of shape and size including solids as noted or required on the drawings.
- C. Provide brick as follows (submit sample for verification prior to ordering):
 - 1. Longacre Elementary:
GGBC-Marian/W21/W22 Cider Brown base as manufactured by Brick Tech (248) 548-0777. Mortar color: Grey (match existing).
 - 2. Woodcreek Elementary:
GGBC-Birmingham as manufactured by Brick Tech (248) 548-0777. Mortar color: Grey (match existing).
 - 3. Hillside Elementary:
GGBC-W32/W12 as manufactured by Brick Tech (248) 548-0777. Mortar color: Grey (match existing).

2.03 REINFORCEMENT AND ANCHORAGE

- A. All single wythe joint reinforcement shall be ladder type wire reinforcing consisting of No. 9 gauge deformed side rods, with No. 9 gauge standard ladder type cross rods. All rods shall be mill galvanized using ASTM A153, Class B-2 standards. Out to out spacing of side rods shall be approximately 2" less than the nominal wall thickness. Provide pre-fabricated corners and tee units as required.
- B. All multiple wythe/cavity wall joint reinforcement shall be adjustable ladder type mill galvanized in accordance with ASTM A153, Class B-2 standards. Separate adjustable ties extend to engage outer wythe by at least 2" and spaced not more than 16" o.c.
 - 1. Use where horizontal joints of facing wythe do not align with those of back-up and where indicated.
 - 2. Use where facing wythe is of different material than back-up wythe.

- C. For anchorage to steel framing, provide manufacturer's standard anchors with crimped 1/4 inch (6.4 mm) diameter wire anchor section for welding to steel and triangular-shaped wire tie section sized to extend within 1 inch (25 mm) of masonry face and wire diameter of 0.25". Provide one tie on each side of framing where masonry abuts. Ties to be spaced at 16" o.c. vertical.
- D. Adjustable Steel Wire Wall Ties (For Veneer w/CMU Backup): Formed wire 3/16" diameter high tensile, cold drawn steel wire conforming to ASTM A82, galvanized zinc coated finish, installed at 16" o.c. vertical opposite ladder reinforcing. Provide one tie per 2.66 square feet of wall area minimum.
- E. Manufacturers:
 - 1. AA Wire Products Co.
 - 2. Dur-O-Wal.
 - 3. National Wire.
 - 4. Hohmann and Barnard, Inc.
 - 5. Wire Bond.
 - 6. Other Architect Approved.
- F. Reinforcing Steel: ASTM A615, 60-ksi-yield grade deformed steel bars unprotected finish.

2.04 FLASHINGS

- A. Through-wall Flashing: Rubberized asphalt sheet membrane dampproof coursing. Wall flashing material, 40 mil thick as manufactured by W.R. Grace & Company "Perm-A-Barrier", including bituthene mastic for sealing joints, terminations and penetrations.

2.05 ACCESSORIES

- A. Building Paper: 15# asphalt saturated felt.
- B. Column Wrap: Waxed corrugated cardboard of 15# asphalt saturated felt.
- C. Cavity Wall Insulation: Polystyrene Insulation. Refer to Section 07200 "Insulation".
- D. Foamed-in place insulation, refer to Section 07200 "Insulation".

E. Weep Vents:

1. Plastic Weep Vent: One-piece, flexible extrusion manufactured from ultraviolet-resistant polypropylene copolymer, designed to weep moisture in masonry cavity to exterior, sized to fill head joints with outside face held back 1/8 inch from exterior face of masonry, in color selected from manufacturer's standard.

F. Cavity Drainage Material: 1-inch (25mm) thick, reticulated, nonabsorbent mesh, made from polyethylene strands and shaped to maintain drainage at weep holes without being clogged by mortar droppings.

1. Product: Subject to compliance with requirements, provide "Mortar Net" by Mortar Net USA, Ltd or Architect approved.

2.06 LINTELS

- A. Lintels shall be steel, precast or cast-in-place in accordance with details as shown or scheduled on the drawings.

PART 3. EXECUTION

3.01 EXAMINATION AND PREPARATION

- A. Verify that field conditions are acceptable and ready to receive work. Examine rough-in and built-in construction to verify locations prior to installation.
- B. Coordinate placement of anchors supplied to other sections.
- C. Employ skilled mechanics, experienced supervision. Lay masonry plumb, true to line, with level, accurately spaced courses. Break vertical joints unless otherwise indicated. Keep bond plumb. Rack courses, where necessary, without toothing. Lay out facing before setting, minimize cutting closures, jumping bond.
- D. Do not wet concrete masonry. Lay masonry with complete bearing in full beds of mortar. Butter sides for full vertical joints. Shove units into place. Anchor walls not otherwise bonded with ties every 8", every four (4) courses.

- E. Cover top of masonry work at end of day's work with reinforced waterproof non-staining membrane. When air temperature is below 40°F, heat masonry materials, provide cold weather protection necessary to maintain temperature form 40°F. for 48 hours, both side of masonry.
- F. Mix units for exposed concrete unit masonry from several pallets as they are placed to provide a uniform blend of colors and textures.

3.02 COURSING

- A. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness. Lay out walls in advance for accurate spacing of openings, movement type joints, returns, etc. Avoid units of less than half size at corners and jambs.
- B. Block unit shall be laid in stack or running bond, as indicated on drawings with vertical joints aligned plumb, horizontal joints level. Joints in back-up work shall be worked out to provide bonding with facing masonry. Joints shall be uniform in width, thickness not to exceed 1/3". Exposed joints in finish work shall be tooled slightly concave, others shall be cut flush.
- C. Brick Units: Lay in running, stacked, rowlock and soldier bonds where noted on drawings. Course as detailed on drawings. Form concave mortar joints as detailed.
- D. Initial block course (first course above foundation) in walls (interior or exterior) shall be laid in full mortar beds on shells and cross webs; in other locations, units shall be laid in full mortar beds on shells only. Solid block units shall be laid same as brick. Vertical joints between units shall be filled with mortar between shell ends.
- E. All non-bearing walls and partitions shall terminate against beam soffits, roof, or structural ceilings, unless otherwise shown on drawings, or as stated below. Build wall to within 3/8" of overhead structure on roof, fill top joint and all voids with non-combustible insulation board which has width of 1" less than wall, then caulk joints.

- F. Both bearing and non-bearing masonry walls which enclose corridors, storage or mechanical rooms, shops and other rooms requiring a rated separation from adjacent areas, must have the top joint as well as all voids at roof deck and elsewhere in or over these walls, filled with cement grout, mortar, or plaster bed of at least 2" in width. Where no ceilings occur in the room, said fill shall be troweled flush with the wall surface or surfaces on the exposed side of the wall.
- G. All interior and exterior block walls shall have control joints 20'-0" o.c. maximum for exterior and 25'-0" to 30'-0" at interior walls. Line up control joints with joints in foundation wall and joints in face brick. Leave exposed faces on joints ready for caulking. Provide vertical reinforcing in grouted core on each side of exterior masonry control joints. Reinforcing to match vertical wall steel.
- H. Bond each course at corners and break vertical joints at least 2". Tee shaped or cross shaped intersecting walls shall have vertical continuous joint. These joints shall be caulked. Provide for continuity of joint reinforcing by providing pre-fabricated "T" shaped or "L" shaped units.
- I. Provide welded steel masonry reinforcing placed in every second horizontal course in all block walls with at least one layer below a window sill level and one layer above a lintel level. Lay reinforcing on wall and cover with mortar, bed unit as usual. Longitudinal wire shall be lapped not less than 32 diameters at splices. At corners, cut inside rod and bend to proper angle.
- J. Construct bond beams as indicated with concrete grout. Maintain accurate location of reinforcing steel during grout placement.
- K. Grout course solid (or use solid units) immediately below veneer, where masonry serves as support for the veneer (i.e. brick ledges).
- L. Grout course solid (or use solid units) immediately below window and door openings or other locations where masonry serves as a support for a sill.

- M. Stopping and Resuming Work: In each course, rack back 1/2-unit length for one-half running bond or 1/3-unit length for one-third running bond; do not tooth. Clean exposed surfaces of set masonry and remove loose masonry units and mortar prior to laying fresh masonry.

3.03 PLACING AND BONDING

- A. Isolate masonry partitions from vertical structural framing members with a control joint as indicated.
- B. Isolate top joint of masonry partitions from horizontal structural framing members and slabs or decks with fire rated compressible joint filler.

3.04 WEEPS AND VENTS

- A. Install weep holes in veneer at 24 inches on center horizontally or as indicated on drawings above through-wall flashing, above shelf angles, and at bottom of walls. Weeps shall be laid with masonry. Weep holes shall not be drilled, cut or carved into mortar joints.

3.05 CAVITY WALL

- A. Do not permit mortar to drop or accumulate into cavity air space or to plug weep holes. Provide layer of clean mason's sand at base of cavity directly on through wall flashing of sufficient depth to cover weep holes.
- B. Build inner wythe ahead of outer wythe to receive cavity insulation air/vapor barrier adhesive.
- C. Tie exterior wythe to back-up with continuous horizontal joint reinforcing.

3.06 REINFORCEMENT & ANCHORAGES - SINGLE WYTHE MASONRY

- A. Walls laid up with concrete block, including where used as back-up shall be reinforced with horizontal steel wall reinforcing as specified. Reinforcing shall be of proper width for block wythe, to have side wires over block shells. Place joint reinforcement at 16" o.c. vertical and continuous in first and second joint below top of walls.
- B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum of 3'-0" beyond each side of opening.

- C. Reinforcing in foundation walls (below floor slab) shall be placed every other course, continuous.
- D. Terminate reinforcing each side of control joints; lap end joints 12", form corners by cutting and lapping inside wire, bending outside wire; form intersections by cutting and lapping reinforcing from one wall with other wall. Bed side wires completely in mortar.

3.07 REINFORCEMENT & ANCHORAGES - CAVITY WALL MASONRY

- A. Install horizontal joint reinforcement 16 inches o.c. vertically. Place joint reinforcement continuous in first joint below top of walls.
- B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches each side of opening.

3.08 MASONRY FLASHINGS

- A. Extend flashings under, over and through veneer. Turn up minimum 8 inches and bed into mortar joint of backup masonry.
- B. Lap end joints and seal watertight.
- C. All discontinuous flashing shall be turned up one head joint past the opening jamb to form an end dam.
- D. Use flashing manufacturer's recommended adhesive and sealer.

3.09 LINTELS

- A. Install loose steel lintels over window openings, door openings and other miscellaneous openings as indicated on the structural plans.
- B. Construct concrete block lintels over window openings, door openings and other openings as indicated on the structural plans or otherwise required.
- C. Maintain minimum bearing each side of opening of 8" or as specified on structural drawings. Align end of lintel with vertical block joints.

3.10 GROUTED COMPONENTS

- A. Reinforce bond beams and pilasters as detailed.
- B. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch of dimensioned position.
- C. Place and consolidate grout fill without displacing reinforcing.
- D. At beam bearing locations, fill masonry cores with grout for a minimum 12 inches either side of member and three courses vertical, unless otherwise noted.

3.11 GROUTED COMPONENTS

- A. Reinforce bond beams as detailed.
- B. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch of dimensioned position.
- C. Place and consolidate grout fill without displacing reinforcing.
- D. At beam bearing locations, fill masonry cores with grout for a minimum 12 inches either side of member and three courses vertical, unless otherwise noted.

3.12 ENGINEERED MASONRY

- A. Lay masonry units with core cells vertically aligned and cavities between wythes clear of mortar and unobstructed.
- B. Reinforce masonry unit cores and cavities with reinforcement bars and grout as indicated. Provide vertical bars in corners. Provide vertical bars at each side of all masonry openings. Vertical bars to continue at noted spacing above openings.
- C. Secure vertical reinforcement in position at top and bottom of cells and at intervals not exceeding 192 bar diameters. Splice reinforcement 48 bar diameters, minimum 12".
- D. Place mortar in masonry unit bed joints back 1/4 inch from edge of unit grout spaces; bevel back and upward. Permit mortar to cure 3 days before placing grout.
- E. Grout spaces less than 2 inches in width with fine grout using low lift grouting techniques. Grout spaces 2 inches

or greater in width with coarse grout using high or low lift grouting techniques.

- F. When grouting is stopped for more than one hour, terminate grout 1-1/2 inch below top of upper masonry unit to form a positive key for subsequent grout placement.
- G. Low Lift Grouting: Place first lift of grout to a height of 60 inches maximum and consolidate by mechanical vibration. Place subsequent lifts in maximum 60 inch increments and vibrate grout for consolidation. Ensure mortar has gained sufficient strength to withstand pressure prior to grouting. "Puddling" may be used in lieu of mechanical vibration if grout lifts are limited to 12 inches maximum.
- H. High Lift Grouting:
 - 1. Provide cleanout opening no less than 4 inches high at the bottom of each cell to be grouted by cutting one face shell of masonry unit.
 - 2. Clean out masonry cells and cavities with high-pressure water spray. Permit complete water drainage. Cells and cavities may be "cleaned" by using steel rod to remove excess mortar protrusions.
 - 3. Request that Architect/Engineer inspect the cells. Allow three days advance notice.
 - 4. After cleaning and cell inspection, seal openings with masonry units.
 - 5. Pump grout into spaces. Maintain water content in grout to intended slump without aggregate segregation.
 - 6. Limit grout lift to 60 inches and mechanically vibrate for grout consolidation. Wait 30 to 60 minutes before placing next lift.

3.13 CONTROL AND EXPANSION JOINTS

- A. Do not extend horizontal joint reinforcement through control and expansion joints.
- B. Form control joint with a sheet building paper bond breaker fitted to one side of the hollow contour end of the masonry unit. Fill the resultant elliptical core with grout fill. Rake joint at exposed unit faces for placement of backer rod and sealant.
- C. Form expansion joints as detailed.

3.14 BUILT-IN WORK

- A. As work progresses, build in metal door and glazed frames, fabricated metal frames, window frames, wood nailing strips, anchor bolts, plates, and other items to be built in the Work furnished by other Sections.
- B. Bed anchors of metal door and glazed frames in adjacent mortar joints. Fill frame voids solid with grout. Fill adjacent masonry cores with grout minimum 12 inches from framed openings.

3.15 POINTING AND CLEANING

- A. Point up all exposed existing brick where required, fill all holes and joints; remove loose mortar, cut out defective joints, and repoint where necessary.

3.16 TOLERANCES

- A. Maximum Variation from Plumb: 1/4 inch per story, non-cumulative.
- B. Maximum Variation from Level Coursing: 1/8 inch in 3 ft. and 1/4 inch in 10 ft.; 1/2 inch in 30 ft.

3.17 CUTTING AND FITTING

- A. Cut and fit for chases, pipes, conduit, sleeves, grounds, and other items. Coordinate with other Sections of Work to provide correct size, shape, and location.
- B. Form slots, grooves, chases, recesses, other items required for other trades. Build in all required structural steel, miscellaneous metal, sash anchors, precast concrete anchors, and other items. Bed in mortar to line and level. Build in counter flashing furnished by Roofing Contractor. Check all requirements in advance to eliminate cutting.
- C. Do necessary cutting of masonry for installation of items not otherwise provided for. Patch walls, maintain structural stability, appearance, weather resistance.
- D. Cut masonry units with motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide continuous pattern and to fit adjoining construction. Use full-size units without cutting, where possible. Allow

units cut with water-cooled saws to dry before placing, unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

3.18 REPAIRING, POINTING AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or if units do not match adjoining units. Install new units to match adjoining units; install in fresh mortar or grout, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point-up joints, including corners, opening, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for application of sealants.
- C. Remove excess mortar and mortar smears.
- D. Clean soiled surfaces with cleaning solution.
- E. On completion of pointing and re-pointing of all face brick and block work, interior and exterior, clean thoroughly with "Sure Klean 600", "Craft Klean" or similar prepared detergent, acceptable to brick and/or block manufacturer, applied strictly according to the manufacturer's instructions with stiff fiber brushes. Drench with clean water immediately after cleaning. Do not use job mixed acid on this project. All cleaning shall be done prior to installation of any finished floor, wall mounted light fixtures, aluminum frames or items subject to damage. Protect aluminum and hollow metal frames, other built-in items.
- F. For cleaning pre-faced units, use masonry detergent cleaners in accordance with manufacturer's directions. Do not use hydrochloric acids or other unbuffered acids. Do not use steel wool or other abrasives.

3.19 MASONRY WASTE DISPOSAL

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2017 RENOVATIONS-BID PACK #5
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NOVEMBER 30, 2016

- A. Recycling: Undamaged, excess masonry materials are Contractor's property and shall be removed from the Project site for his use.

END OF SECTION 04300

SECTION 04720 - CAST STONE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Attention is directed to Bidding and Contract Requirements, and to General and Supplemental Conditions, hereby made a part of this Section.

- 1. Section includes:

- a. Custom cast stone

1.02 RELATED SECTIONS:

- A. Section 04100 - Mortar & Grout
- B. Section 04270 - Glass Unit Masonry
- C. Section 04300 - Unit Masonry
- D. Section 07910 - Joint Fillers and Gaskets
- E. Section 07920 - Sealants and Caulking

1.03 REFERENCES:

- A. ASTM A 615/A 615 M - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
- B. ASTM A 767/A767M - Zinc-Coated (galvanized) Steel Bars for Concrete Reinforcement.
- C. ASTM C 33 - Concrete aggregates.
- D. ASTM C 39 - Compressive strength of concrete cylinders.
- F. ASTM C 90 - Loadbearing Concrete Masonry Units
- G. ASTM C 140 - Sampling and Testing Concrete Masonry Units and Related Units
- H. ASTM C 150 - Portland Cement
- I. ASTM C 270 - Mortar for Unit Masonry
- J. ASTM C 426 - Linear Drying Shrinkage of Concrete Masonry Units
- K. ASTM C 494 - Chemical Admixtures for Concrete

- L. ASTM C 666 - Resistance of Concrete to Rapid Freezing and Thawing
- M. ASTM C 979 - Pigments for Integrally Colored Concrete
- N. ASTM C 1194 - Compressive Strength of Architectural Cast Stone
- O. ASTM C 1195 - Absorption of Architectural Cast Stone
- P. ASTM C 1364 - Architectural Cast Stone
- Q. Cast Stone Institute Technical Manual (current ed.)

1.04 DEFINITIONS:

- A. Cast Stone: An architectural masonry unit manufactured to copy fine grain texture and color of natural cut stone.
- B. Dry Cast Concrete Products: Manufactured from zero-slump concrete.
- C. Machine Casting Method: Vibratory compaction by machine of earth-moist, zero-slump concrete against rigid mold until it is densely compacted.
- D. Vibrant Dry Hand Tamp Casting Method: Vibratory compaction by hand tamp of earth-moist, zero-slump concrete against rigid mold until it is densely compacted.

1.05 SUBMITTALS:

- A. Comply with Division 1 - Section 01330 Submittals for Shop Drawings, Product Data and Samples.
- B. Product Data: Submit manufacturer's Product Data
- C. Shop Drawings: Submit manufacturer's shop drawings, including profiles, cross sections, modular unit lengths, reinforcement if required, exposed faces, anchors and anchoring method recommendations if required and annotation of cast stone types and location.
- D. Samples: Submit pieces of manufacturer's cast stone units that represent general range of texture and color proposed to be furnished for project.

E. Test Results:

1. Submit manufacturer's test results from cast stone units previously made by manufacturer using materials from same sources proposed for use in project.
2. Submit manufacturer's test results from plant production testing.

F. Warranty: Submit manufacturer's standard warranty.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Sufficient plant facilities to provide quality, shapes, quantities, and sizes of cast stone units required without delaying progress of the work.
2. Minimum of 10 years experience in producing masonry units or cast stone.

1.07 DELIVERY, STORAGE AND HANDLING

A. Delivery:

1. Deliver cast stone units secured to shipping pallets and protected from damage and discoloration.
2. Provide itemized shipping list.
3. Number each piece individually, as required, to match shop drawings and schedules.

B. Storage

1. Store cast stone units and installation materials in accordance with manufacturer's instructions.
2. Store cast stone units on pallets with non-staining, waterproof covers.
3. Do not double stack pallets.
4. Ventilate units under covers to prevent condensation.
5. Prevent contact with dirt and splashing.

C. Handling:

1. Protect cast stone units, including corners and edges, during storage, handling, and installation to prevent chipping, cracking, staining, or other damage.
2. Handle long units at center and both ends simultaneously to prevent cracking.

1.08 SCHEDULING

- A. Schedule and coordinate production and delivery of cast stone units with unit masonry work.

PART 2 - PRODUCTS

2.01 MANUFACTURER:

- A. RockCast, Division of Reading Rock Inc., 4600 Devitt Drive, Cincinnati, OH 45246. Toll Free (800)482-6466. Phone (513)874-2345. Fax (513)874-2520. Web Site: www.rockcast.com. E-mail: info@rockcast.com
- B. Custom Cast Stone Inc., 734 E. 169th Street, Westfield, Indiana 46074, toll free (888)776-9960 phone (317)896-1700 Fax (317)896-1701
- C. Custom Stone Works, 32910 Plymouth Road, Livonia, MI 48150 Phone:(734) 427-8158 Fax:(734) 427-8178 Toll free:(877)40-GRANITE.
- D. Or Equal as approved by Architect/Owner.

2.02 CUSTOM CAST STONE UNITS

- A. Custom Cast Stone Units; RockCast Custom Cast Stone Series or Custom stone units.
- B. Compliance: ASTM C 1364.
- C. Casting Method: Vibrant dry hand tamp.
- D. Texture: Smooth.
- E. Color: As selected by Architect/Owner from manufacturer's full selection of colors.
- F. Units: As indicated on drawings.
- G. Profiles: As indicated on drawings.
- H. Test Results:
 - 1. Compressive Strength, ASTM C 1194: Greater than 6,500 psi at 28 days.
 - 2. Absorption: ASTM C 1195: 6.0 percent max at 28 days.
 - 3. Linear Shrinkage, ASTM C 426: Less than 0.065 percent.
 - 4. Density, ASTM C 140: Greater than 120 pounds per cubic foot.
 - 5. Freeze-Thaw, ASTM C 666: Less than 4.0 percent.

- I. Curing: Cure in enclosed chamber at 95 percent relative humidity for 24 hours or yard cure for 350° days (i.e. 7 days @ 50°F or 5 days @ 70°F) prior to shipping.
- J. Cast Stone type units, as indicated on drawings.

2.03 CAST STONE MATERIALS

- A. Portland Cement: ASTM C 150, Type I or II. White and/or gray as required to match specified color.
- B. Coarse Aggregate: ASTM C 33, except for gradation. Granite, quartz, or limestone.
- C. Fine Aggregates: ASTM C 33, except for gradation. Manufactured or natural sands.
- D. Pigments: ASTM C 979, except do not use carbon black pigments. Inorganic iron oxide pigments.
- E. Water reducing, retarding, and accelerating admixtures: ASTM C 494.
- F. Water: Potable.
- G. Reinforcing Bars: ASTM A 615, deformed steel bars. Galvanized when covered with less than 1 ½ inches of material.
 - 1. Galvanized Coating: ASTM A 767

2.04 TEXTURE AND COLOR

- A. General: Match texture and color of full-size sample on file with Architect.
- B. Texture of surfaces exposed to view:
 - 1. Fine-grained texture similar to natural stone.
 - 2. Approximately equal to approved sample when viewed in direct daylight at 20 feet.
- C. Surface Voids:
 - 1. Size: Maximum 1/32 inch.
 - 2. Density: Less than 3 occurrences per any 1 square inch.
 - 3. Viewing Conditions: Not obvious under direct daylight at 20 feet.
- D. Minor Chipping:

1. Minor chipping resulting from shipping and delivery shall not be grounds for rejection of cast stone units.
2. Minor chips shall not be obvious under direct daylight at 20 feet, as determined by Architect.

E. Color Variation

1. Viewing Conditions: Compare in direct daylight at 20 feet, between cast stone units of similar age, subjected to similar weathering conditions.

2.05 MORTAR

- A. Mortar: ASTM C 270, Type N, as specified in Section 04100 Mortar & Grout.

2.06 ACCESSORIES

- A. Anchors: Type 304 stainless steel.
- B. Sealant: As specified in Section 07920.
- C. Cleaner: Prosoco Sure Klean 600 Detergent, or Prosoco Sure Klean Vana Trol as required per brick type.

2.07 FABRICATIONS

- A. Shapes: Unless otherwise indicated on drawings, provide:
 1. Suitable wash on exterior sills, copings, projecting courses and units with exposed top surfaces.
 2. Drips on projecting units, wherever possible.
- B. Reinforcement: As required to withstand handling stresses.

2.08 TOLERANCES

- A. General: Manufacture cast stone units within tolerances in accordance with Cast Stone Institute Technical Manual, unless otherwise specified.
- B. Cross Section Dimensions: Do not deviate by more than plus or minus 1/8 inch from approved dimensions.
- C. Length of Units: Do not deviate by more than length/360 or plus or minus 1/8 inch, whichever is greater, not to exceed plus or minus 1/4 inch.
- D. Warp, Bow or Twist: Do not exceed length/360 or plus or

minus 1/8 inch, whichever is greater.

2.09 PRODUCTION QUALITY CONTROL

- A. Mix Designs: Test new and existing mix designs for compressive strength and absorption before manufacturing cast stone units.
- B. Plant Production Testing: Test compressive strength and absorption from specimens selected at random from plant production. Obtain samples every 500 cubic feet of product produced.
 - 1. Custom Cast Stone Units: Test in accordance with ASTM C 1194 and C 1195.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine construction to receive cast stone units. Notify Architect and Construction Manager if construction is not acceptable. Do not begin installation until unacceptable conditions have been corrected.
- B. Examine cast stone units before installation. Do not install unacceptable units.

3.02 INSTALLATION

- A. Install cast stone units in conjunction with masonry, as specified in Section 04300.
- B. Pull units from multiple cubes during installation to minimize variation in color.
- C. Cut units using motor-driven masonry saws.
- D. Do not use pry bars or other equipment in a manner that could damage cast stone units.
- E. Fill dowel holes and anchor slots completely with mortar or non-shrink grout.
- F. Set cast stone units in full bed of mortar, unless otherwise indicated on the drawings.
- G. Fill vertical joints with mortar.
- H. Make joints 3/8 inch, unless otherwise indicated on the

drawings.

- I. Leave head joints in copings and similar units upon for sealant.
- J. Rake mortar joints 3/4 inch for pointing.
- K. Tuck point mortar joints to slight concave profile.
- L. Remove excess mortar immediately.
- M. Remove mortar fins and smears before tooling joints.
- N. Sealant Joints:
 - 1. As specified in Sections 07910 and 07920.
 - 2. Prime ends of cast stone units, insert properly sized backing rod, and install sealant.
 - 3. Provide sealant joints at following locations:
 - a. Cast stone units with exposed tops.
 - b. Joints at relieving angles.
 - c. Control and expansion joints.
 - d. As indicated on the drawings.

3.03 TOLERANCES

- A. Installation Tolerances: Comply with Cast Stone Institute Technical Manual.
 - 1. Variation from Plumb: Do not exceed 1/8 inch in 5 feet or 1/4 inch in 20 feet or more.
 - 2. Variation from Level: Do not exceed 1/8 inch in 5 feet, 1/4 inch in 20 feet, or 3/8 inch maximum.
 - 3. Variation in Joint Width: Do not vary joint thickness more than 1/8 inch or 1/4 of nominal joint width, whichever is greater.
 - 4. Variation in Plane Between Adjacent Surfaces: Do not exceed 1/8-inch difference between planes of adjacent units or adjacent surfaces indicated to be flush with units.

3.04 CLEANING

- A. Clean exposed units after mortar is thoroughly set and cured.
- B. Wet surfaces before applying cleaner.
- C. Apply cleaner to cast stone units in accordance with cleaner manufacturer's instructions.
- D. Perform test of cleaner on small area and receive approval

by Architect before full cleaning.

E. Do **not** use the following to clean cast stone units:

1. Muriatic acid.
2. Power washing.
3. Sandblasting.
4. Harsh cleaning materials or methods that would damage or discolor surfaces.

3.05 REPAIR

- A. Repair chips and other surface damage noticeable when viewed in direct daylight at 20 feet.
- B. Repair with touchup materials provided by manufacturer in accordance with manufacturer's instructions.
- C. Repair methods and results to be approved by Architect.

3.06 INSPECTION AND ACCEPTANCE

- A. Inspect completed installation in accordance with Cast Stone Institute Technical Manual.

3.07 PROTECTION

- A. Protect installed cast stone from splashing, stains, mortar, and other damage.

END OF SECTION 04720

SECTION 05120 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes structural steel and grout

1.02 DEFINITIONS

- A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

1.03 PERFORMANCE REQUIREMENTS

- A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand loads indicated and comply with other information and restrictions indicated.

- 1. Select and complete connections using schematic details indicated and AISC 360.
- 2. Use ASD; data are given at service-load level.

- B. Moment Connections: Type FR, fully restrained.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication of structural-steel components.

- C. For structural-steel connections indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer and fabricator.
- B. Welding certificates.
- C. Mill test reports for structural steel, including chemical and physical properties.
- D. Source quality-control reports.

1.06 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD, or have an equivalent quality assurance program as certified by a qualified independent testing agency.
- B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE, or have an equivalent quality assurance program as certified by a qualified independent testing agency.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Comply with applicable provisions of the following specifications and documents:
 - 1. AISC 303.
 - 2. AISC 360.
 - 3. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

- E. Preinstallation Conference: Conduct conference at Project site.

PART 2 - PRODUCTS

2.01 STRUCTURAL-STEEL MATERIALS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. W-Shapes: ASTM A 992/A 992M.
- C. Channels, Angles, Shapes: ASTM A 36/A 36M.
- D. Plate and Bar: ASTM A 36/A 36M.
- E. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, structural tubing.
- F. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.
- G. Welding Electrodes: Comply with AWS requirements.

2.02 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, (ASTM A 563M, Class 8S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers; all with plain finish.
 - 1. Direct-Tension Indicators: ASTM F 959, Type 325 (ASTM F 959M, Type 8.8), compressible-washer type with plain finish.
- B. High-Strength Bolts, Nuts, and Washers: ASTM A 490 (ASTM A 490M), Type 1, heavy-hex steel structural bolts[or tension-control, bolt-nut-washer assemblies with splined ends]; ASTM A 563, Grade DH, (ASTM A 563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F 436

(ASTM F 436M), Type 1, hardened carbon-steel washers with plain finish.

1. Direct-Tension Indicators: ASTM F 959, Type 490 (ASTM F 959M, Type 10.9), compressible-washer type with plain finish.

C. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH (ASTM A 563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers.

1. Finish: Hot-dip zinc coating] [Mechanically deposited zinc coating] [Hot-dip or mechanically deposited zinc coating].
2. Direct-Tension Indicators: ASTM F 959, Type 325 (ASTM F 959M, Type 8.8), compressible-washer type with [mechanically deposited zinc coating] [mechanically deposited zinc coating, baked epoxy-coated] finish.

D. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, [heavy-hex] [round] head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.

1. Finish: [Plain] [Mechanically deposited zinc coating].

E. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

F. Unheaded Anchor Rods: ASTM F 1554, Grade 36, or ASTM F 1554, Grade 55, weldable (refer to Structural Steel Notes on drawings for additional information).

1. Configuration: Straight.
2. Finish: Plain.

G. Headed Anchor Rods: ASTM F 1554, Grade 36 or ASTM F 1554, Grade 55, weldable, straight (refer to Structural Steel Notes on drawings for additional information).

1. Finish: Plain.

H. Threaded Rods: ASTM A 36/A 36M.

1. Finish: Plain, or hot-dip zinc coating
ASTM A 153/A 153M, Class C, if exposed to weather.

2.03 PRIMER

A. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Primer: Comply with [Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."] [Section 099600 "High-Performance Coatings."] [Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."]

C. Primer: SSPC-Paint 25, [Type I] [Type II], zinc oxide, alkyd, linseed oil primer.

D. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

2.04 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.05 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's

"Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.

- B. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

2.06 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

- 1. Joint Type: Snug tightened, unless noted otherwise.

- B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

2.07 SHOP PRIMING

- A. Shop prime steel surfaces except the following:

- 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
 - 2. Surfaces to be field welded.
 - 3. Surfaces to be high-strength bolted with slip-critical connections.
 - 4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
 - 5. Galvanized surfaces.

- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:

- 1. SSPC-SP 3, "Power Tool Cleaning."
 - 2. SSPC-SP6, "Commercial Blast Cleaning" for galvanized surfaces.

- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

2.08 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123.
- B. Galvanize above the roof and outside the building envelope (exposed to weather).

2.09 SOURCE QUALITY CONTROL

- A. Testing Agency: Owner will engage an independent testing and inspecting agency (Special Inspector, refer to Structural drawings for additional information) to perform shop tests and inspections and prepare test reports.
 - 1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
- B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.
- C. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- D. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
 - 1. Liquid Penetrant Inspection: ASTM E 165.
 - 2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.

3. Ultrasonic Inspection: ASTM E 164.
4. Radiographic Inspection: ASTM E 94.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
- B. Base, Bearing, and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
 1. Set plates for structural members on wedges, shims, or setting nuts as required.
 2. Weld plate washers to top of baseplate.
 3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
 4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

- C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

3.03 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

- 1. Joint Type: Snug tightened, unless noted otherwise.

- B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

- 1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.

3.04 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency (Special Inspector, refer to Structural drawings for additional information) to inspect field welds, and, high-strength bolted connections.

- B. Bolted Connections: Bolted connections will be[tested and] inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

- C. Welded Connections: Field welds will be visually inspected according to AWS D1.1/D1.1M.

- 1. In addition to visual inspection, field welds will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

- a. Liquid Penetrant Inspection: ASTM E 165.

- b. Magnetic Particle Inspection: ASTM E 709;
performed on root pass and on finished weld.
Cracks or zones of incomplete fusion or
penetration will not be accepted.
 - c. Ultrasonic Inspection: ASTM E 164.
 - d. Radiographic Inspection: ASTM E 94.
- D. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

END OF SECTION 05120

SECTION 05210 - STEEL JOIST FRAMING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. K-series steel joists.
2. LH- and DLH-series long-span steel joists.
3. Joist accessories.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of joist, accessory, and product.

B. Shop Drawings:

1. Include layout, designation, number, type, location, and spacing of joists.
2. Include joining and anchorage details, bracing, bridging, and joist accessories; splice and connection locations and details; and attachments to other construction.
3. Submit signed and sealed calculations for special joists. Refer to Structural Drawings for additional information.

1.03 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Manufacturer certificates.

C. Mill Certificates: For each type of bolt.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables in SJI's "Specifications."

1. Manufacturer's responsibilities include providing professional engineering services for designing special joists to comply with performance requirements.

B. Welding Qualifications: Qualify field-welding procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle joists as recommended in SJI's "Standard Specifications, 43rd Edition".

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Structural Performance: Provide special joists and connections capable of withstanding design loads indicated.

1. Use ASD; data are given at service-load level.
2. Design special joists to withstand design loads with live-load deflections no greater than the following:
 - a. Roof Joists: Vertical deflection of 1/360 of the span.
3. Design joists for net wind uplift of 10 psf.

2.02 K-SERIES STEEL JOISTS

- A. Manufacture steel joists of type indicated according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members, underslung ends, and parallel top chord.
- B. Steel Joist Substitutes: Manufacture according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle or -channel members.

2.03 LONG-SPAN STEEL JOISTS

- A. Manufacture steel joists according to "Standard Specifications for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLH-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members; of joist type and end and top-chord arrangements as indicated.

2.04 PRIMERS

- A. Primer: SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.

2.05 JOIST ACCESSORIES

- A. Bridging: Provide bridging anchors and number of rows of horizontal or diagonal bridging of material, size, and type required by SJI's "Standard Specifications, 43rd Edition" for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.
- B. Bridging: Schematically indicated. Detail and fabricate according to SJI's "Standard Specifications, 43rd Edition". Furnish additional erection bridging if required for stability.

C. Carbon-Steel Bolts and Threaded Fasteners: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), carbon-steel, hex-head bolts and threaded fasteners; carbon-steel nuts; and flat, unhardened steel washers.

1. Finish: Plain, uncoated.

D. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy hex steel structural bolts; ASTM A 563 (ASTM A 563M) heavy hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M) hardened carbon-steel washers.

1. Finish: Plain.

E. Furnish miscellaneous accessories including splice plates and bolts required by joist manufacturer to complete joist assembly.

2.06 CLEANING AND SHOP PAINTING

A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories.

B. Apply one coat of shop primer.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Do not install joists until supporting construction is in place and secured.

B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications," joist manufacturer's written recommendations, and requirements in this Section.

1. Before installation, splice joists delivered to Project site in more than one piece.

2. Space, adjust, and align joists accurately in location before permanently fastening.

3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
- C. Field weld joists to supporting steel bearing plates and framework. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
- D. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

3.02 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency (Special Inspector) to inspect field welds and bolted connections and to perform field tests and inspections and prepare test and inspection reports.

END OF SECTION 05210

SECTION 05310 - STEEL DECKING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

- 1. Roof deck.
- 2. Acoustical roof deck.

B. Related Requirements:

- 1. Section 05500 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.
- 2. Section 09900 "Painting" for repair painting of primed deck and finish painting of deck.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of deck, accessory, and product indicated.

B. Shop Drawings:

- 1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Product Certificates: For each type of steel deck.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that each of the following complies with requirements:
 - 1. Power-actuated mechanical fasteners.
 - 2. Acoustical roof deck.
- D. Evaluation Reports: For steel deck.
- E. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.
 - 1. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."
- B. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.
- C. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- D. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.2 ROOF DECK

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Canam United States; Canam Group Inc.
 - 2. Consolidated Systems, Inc.; Metal Dek Group.
 - 3. Marlyn Steel Decks, Inc.
 - 4. New Millennium Building Systems, LLC.
 - 5. Nucor Corp.; Vulcraft Group.
 - 6. Roof Deck, Inc.
 - 7. Verco Manufacturing Co.
 - 8. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.

B. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:

1. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 G90 zinc coating.
2. Profile Depth: 1-1/2 inches.
3. Design Uncoated-Steel Thickness: 0.0358 inch.
4. Span Condition: Triple span or more.
5. Side Laps: Overlapped.

2.3 ACOUSTICAL ROOF DECK (FOREST ELEMENTARY GYMNASIUM)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Canam United States; Canam Group Inc.
2. Consolidated Systems, Inc.; Metal Dek Group.
3. Marlyn Steel Decks, Inc.
4. New Millennium Building Systems, LLC.
5. Nucor Corp.; Vulcraft Group.
6. Roof Deck, Inc.
7. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.

C. Acoustical Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:

1. Galvanized and Shop-Primed Steel Sheet:
ASTM A 653/A 653M, Structural Steel (SS), Grade 33, G90 zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.
 - a. Color: Manufacturer's standard.
2. Deck Profile: Type 3DR, deep rib and Type BA (refer to Structural Drawings).

3. Profile Depth: 3 inches (Type NA) and 1-1/2 inches (Type BA).
4. Design Uncoated-Steel Thickness: 0.0358 inch.
5. Span Condition: Triple span or more.
6. Side Laps: Overlapped.
7. Acoustical Perforations: Deck units with manufacturer's standard perforated vertical webs.
8. Sound-Absorbing Insulation: Manufacturer's standard premolded roll or strip of glass or mineral fiber.
 - a. Factory install sound-absorbing insulation into cells of cellular deck.
 - b. Installation of sound-absorbing insulation is specified in Section 07500 "Membrane Roofing".
9. Acoustical Performance: NRC 0.65, tested according to ASTM C 423.

2.4 ACCESSORIES

- A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
- B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
- C. Side-Lap Fasteners (at 1-1/2 wide rib deck only): Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.
- D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
- E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

- F. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.
- G. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0598 inch thick, with factory-punched hole of 3/8-inch minimum diameter.
- H. Flat Sump Plates: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck. For drains, cut holes in the field.
- I. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck, with 3-inch-wide flanges and sloped recessed pans of 1-1/2-inch minimum depth. For drains, cut holes in the field.
- J. Galvanizing Repair Paint: SSPC-Paint 20 or MIL-P-21035B, with dry film containing a minimum of 94 percent zinc dust by weight.
- K. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.

- B. Install temporary shoring before placing deck panels if required to meet deflection limitations.
- C. Locate deck bundles to prevent overloading of supporting members.
- D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
 - 1. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.
- E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
- F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
- G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
- H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
- I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

3.3 ROOF-DECK INSTALLATION

- A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches (38 mm) long, and as follows:
 - 1. Weld Diameter: 3/4 inch, nominal.
 - 2. Weld Spacing for 1 1/2 in. roof deck (including acoustical deck): Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at

- each support. Space welds 12 inches apart in the field of roof and 6 inches apart in roof corners and perimeter, based on roof-area definitions in FMG Loss Prevention Data Sheet 1-28.
3. Weld spacing for 3 inch acoustical deck: as indicated on drawings.
 4. Weld Washers: Install weld washers at each weld location.
- B. Side-Lap and Perimeter Edge Fastening for 1-1/2 inch deck only: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/2 of the span or 36 inches, and as follows:
1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.
 2. Mechanically clinch or button punch.
 3. Fasten with a minimum of 1-1/2-inch- long welds.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:
1. End Joints: Lapped 2 inches minimum or butted at Contractor's option.
- D. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and weld flanges to top of deck. Space welds not more than 12 inches apart with at least one weld at each corner.
1. Install reinforcing channels or zees in ribs to span between supports and weld.
- E. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld to substrate to provide a complete deck installation.
1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.

- F. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.
- G. Sound-Absorbing Insulation: Installation into topside ribs of deck as specified in Section 07500 "Membrane Roofing".

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency (Special Inspector) to perform tests and inspections.
- B. Field welds will be subject to inspection.
- C. Testing agency will report inspection results promptly and in writing to Installer, Construction Manager and Architect.
- D. Remove and replace work that does not comply with specified requirements.
- E. Additional inspecting, at Installer's expense, will be performed to determine compliance of corrected work with specified requirements.

3.5 PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.
 - 1. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.

2. Wire brushing, cleaning, and repair painting of bottom deck surfaces are included in Section 09900 "Painting".
- C. Repair Painting: Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Section 09900 "Painting".
- D. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05310

SECTION 05400 - COLD-FORMED METAL FRAMING

PART 1. GENERAL

1.01 RELATED DOCUMENTS

- A. Attention is directed to Division 0, Bidding and Contract Requirements, and to Division 1, General Requirements, which are hereby made a part of this specification.

1.02 SECTION INCLUDES

- A. Work included in this Section consists of furnishing all labor, materials, equipment and incidentals required for complete installation of all load and non-load bearing exterior structural steel studs and joist framing, fasteners and accessories. Refer to Section 09250 for lightweight metal framing and furring.
- B. Related work specified elsewhere:
 - 1. Section 06100 - Rough Carpentry
 - 2. Section 09250 - Gypsum Drywall

1.03 SYSTEM DESCRIPTION

- A. Size components to withstand design live, dead and wind loads per design drawings or as follows:
 - 1. Vertical Assembly: Exterior, 25 PSF positive or negative; Interior 5 PSF positive or negative.
 - 2. Horizontal Assembly: 40 PSF live load.
- B. Maximum allowable deflection: Per design drawings or 1/360 of span for all materials other than masonry veneer. 1/720 of span for stud back-up to masonry veneer.
- C. Design wall system to provide for movement of components without damage. Contribution from sheathing shall not be considered for lateral deflection.

- D. Design system to accommodate construction tolerances, deflection of building structural members, including metal deck and clearances of intended openings.
- E. Refer to structural drawings for additional information.

1.04 SUBMITTALS

- A. Shop Drawings: Indicate component details, framed openings, bearing required, loading, welds, type and location of fasteners and describe framing connections.
- B. Provide stud and joist layout. Submit signed and sealed calculations by the responsible professional engineer for loading, deflection, and stresses of framing, for review and approval.
- C. Product Data: Describe materials and finish, product criteria, and limitations.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer who has completed cold-formed metal framing similar in material, design, and extent to that indicated for this project and with a record of successful in-service performance, and who is a current member in good standing of the Steel Stud Manufacturer's Association (SSMA).
- B. AISI - American Iron and Steel Institute, Cold-Formed Steel Design Manual.
- C. ASTM A446 - Steel Sheet, Zinc Coated (Galvanized) by Hot-Dip Process, Physical (Structural) Quality.
- D. ASTM A525 - Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process.
- E. ASTM A570 - Hot-Rolled Carbon Steel Sheet and Strip Structural Quality.
- F. ASTM A611 - Steel, Cold-Rolled Sheet, Carbon, Structural.

- G. ASTM C955 - Load Bearing (Transverse and Axial) Steel Studs, Runners (Track) and Bracing or Bridging, for Screw Application of Gypsum Board and Metal Plaster Bases.
- H. AWCI (Association of Wall & Ceiling Industries) - Specification Guide for Cold-Formed Structural Members.
- I. AWS D1.1 - Structural Welding Code - steel.
- J. AWS D1.3 - Structural welding code - Sheet Steel.
- K. SSPC (Steel Structures Painting Council) - Steel Structures Painting Manual.
- L. MFMA (Metal Framing Manufacturers Association) - Guidelines for the Use of Metal Framing.

PART 2. PRODUCTS

2.01 FRAMING MATERIALS

- A. Manufacturers
 - 1. Clark Steel Framing
 - 2. Dietrich Industries, Inc.
 - 3. Marino/Ware
 - 4. Other Architect approved current member in good standing of the SSMA.
- B. Studs: ASTM A446, sheet steel 'C' channel shape, solid web, minimum 18-gage, size as noted on drawings, galvanized to G-90 coating class, complying with ASTM C955. Yield strength of 33,000 psi minimum. 25-gage studs are acceptable for interior applications unless noted otherwise.
- C. Joists: ASTM A446, Grade 33, sheet steel 'C' channel shape, solid web, 18-gage or size as noted on drawings, galvanized to G-90 coating class, complying with ASTM C955.

- D. Stud Track: Formed steel, channel shaped; same width and gage as stud, solid web, galvanized to G-90 coating class, complying with ASTM C955.

2.02 ACCESSORIES

- A. Bracing, Furring, Bridging, Plates, Gussets, Kickers, Stiffeners, Clips: Formed steel, thickness, same as stud or determined for conditions encountered; same finish as framing members.
- B. Screws: ASTM A123, hot dip galvanized to 1.25-oz./sq. ft., self-drilling, self-tapping, No.10 (minimum).
- C. Anchorage Devices: Power driven, power actuated or drilled expansion joint as required relative to substrate.
- D. Welding: In accordance with AWS D1.1 or D1.3.
- E. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20 with dry film containing minimum of 94 percent zinc dust by weight.

2.03 FABRICATION

- A. Fabricate assemblies of sizes and profiles required; with framing members fitted, reinforced and braced.
- B. Fit and assemble in largest practical sections for delivery to site, ready for installation.
- C. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or distortion.

PART 3. EXECUTION

3.01 EXAMINATION AND PREPARATION

- A. Verify that substrate surfaces and building framing components are ready to receive work.

- B. Beginning of installation means acceptance of existing conditions and substrate.

3.02 ERECTION OF STUDDING

- A. Install components in accordance with manufacturer's instructions.
- B. Align top and bottom tracks; locate to wall layout. Secure with fasteners at maximum 24-inches o.c.
- C. Place studs at 16-inches o.c. unless noted otherwise on drawings; not more than 2-inches from abutting walls and at each side of openings. Connect studs to tracks using fastener method. Wire tying of framing members is not permitted.
- D. Construct corners using minimum three studs. Double stud each wall opening, door, and window jamb. Install intermediate studs above and below openings to match wall stud spacing.
- E. Erect load bearing studs one-piece full length. Splicing of studs is not permitted.
- F. Allow for deflection, directly below horizontal building framing, metal decking, etc., for non-load bearing framing.
- G. Attach cross studs and furring channels to studs for attachment of fixtures anchored to walls and for attachment of mechanical and electrical items within walls.
- H. Touch-up field welds and damaged prefinished surfaces with primer.
- I. Coordinate placement of insulation in multiple stud spaces made inaccessible after erection.
- J. Coordinate installation of all wood blocking for installation of items supplied by other trades.
- K. Coordinate installation of all framing to accommodate openings required by architectural, mechanical and electrical trades.

3.03 ERECTION OF JOISTS

- A. Install components in accordance with manufacturer's instructions.
- B. Make provisions for erection stresses. Provide temporary alignment and bracing.
- C. Place joists at 16-inches o.c. unless noted otherwise on drawings; position not more than 2-inches from abutting walls. Connect joists to supports using fastener method. Fasten joists to both flanges of joist track.
- D. Set joists parallel with lateral bracing and bridging.
- E. Locate joist end bearing directly over load bearing studs or provide load-distributing member to top of stud track.
- F. Provide web stiffeners at reaction points.
- G. Touch up field welds and damaged prefinished surfaces with primer.

3.04 TOLERANCES

- A. Maximum variation from true position: 1/4-inch.
- B. Maximum variation of any member from plane: 1/4 inch.

END OF SECTION 05400

SECTION 05500 - METAL FABRICATIONS

PART 1. GENERAL

1.01 RELATED DOCUMENTS

- A. Attention is directed to Division 0, Bidding and Contract Requirements, and to Division 1, General Requirements, which are hereby made a part of this specification.

1.02 SECTION INCLUDES

- A. Work included in this section consists of furnishing all labor, materials, equipment and incidentals required for complete installation of miscellaneous metal work shown on the drawings, as specified herein, and/or as needed for a complete and proper installation whether shown or not.
- B. Related work specified elsewhere:
 - 1. Section 05120 - ``Structural Steel'', including all angles, beams, columns, bolts, etc., shown on the structural drawings or required by the architectural drawings.
 - 2. Section 05210 - ``Steel Joists''
 - 3. Section 05310 - ``Steel Decking''
 - 4. Section 05510 - ``Metal Stairs''

1.03 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this section.
- B. Perform shop and/or field welding required in connection with the work of this Section in strict accordance with pertinent recommendations of the American Welding Society.
- C. Fabricator Qualifications: Firm experienced in producing metal fabrications similar to those indicated for this project with a record of successful in-service performance, and with sufficient production capacity to produce required units without delaying the work.

D. Welding Standards: Comply with applicable provisions of AWS D1.1 ``Structural Welding Code—Steel,’’ AWS D1.2 ``Structural Welding Code—Aluminum,’’ and AWS D1.3 ``Structural Welding Code—Sheet Steel.’’

1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.04 SUBMITTALS

A. Comply with pertinent provisions of Division 1.

B. Product Data: Within 35 calendar days after the contractor has received the Construction Manager's Notice to Proceed, submit:

1. Shop drawings in sufficient detail to show fabrication, installation, anchorage, and interface of the work of this section with the work of adjacent trades. Provide templates for anchors and bolts specified for installation under other sections.
2. Submit signed and sealed calculations for steel pipe railings by the registered professional engineer registered in the State of Michigan responsible for their preparation.

1.05 PROJECT CONDITIONS

A. Field Measurements: Check Actual locations of walls and other construction to which metal fabrications must fit by accurate field measurements before fabrication. Show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the work.

1. Where field measurements cannot be made without delaying the work, guarantee dimensions and proceed with fabricating products without field measurements. Coordinate construction to ensure that actual dimensions correspond to guaranteed dimensions. Allow for trimming and fitting.

PART 2. PRODUCTS

2.01 MATERIALS

A. In fabricating items which will be exposed to view, limit materials to those which are free from surface blemishes, pitting, rolled trade names, and roughness.

B. Comply with following standards as pertinent:

1. Steel plates, shapes and bars: ASTM A36.
2. Steel plates to be bent or cold-formed: ASTM A283, Grade C.
3. Steel tubing: ASTM A501, Grade B.
4. Cold-finished steel bars: ASTM A108.
5. Cold-rolled carbon steel sheets: ASTM A336.
6. Galvanized carbon steel sheets: ASTM A526, with G90 zinc coating in accordance with ASTM A525.
7. Steel pipe: ASTM A53, Grade B, standard weight, black finish unless otherwise noted.
8. For exterior installations and where indicated, provide members with hot-dip galvanizing coat per ASTM A53.
9. Concrete inserts:
 - a. Threaded or wedge type galvanized ferrous castings of malleable iron complying with ASTM A27.
 - b. Provide required bolts, shims, and washers, hot-dip galvanized in accordance with ASTM A153.

2.02 FASTENERS

A. General:

1. For exterior use and where built into exterior walls, provide zinc-coated fasteners.
2. Provide fasteners of type, grade, and class required for the particular use.

B. Comply with following standards as pertinent:

1. Bolts and nuts: Provide hexagon-head regular type complying with ASTM A307, Grade A.
2. Lag bolts: Provide square-head type complying with Fed. Spec. FF-B-561.
3. Machine screws: Provide cadmium plated steel type complying with Fed. Spec. FF-S-111.
4. Washers:
 - a. Plain washers: Comply with Fed. Spec. FF-W-92, round, carbon steel.
 - b. Lock washers: Comply with Fed. Spec. FF-W-84, helical spring type carbon steel.
5. Toggle bolts: Provide type, class and style needed but complying with Fed. Spec. FF-B-588.
6. Anchorage devices: Provide expansion shield complying with Fed. Spec. FF-S-325.

2.03 OTHER MATERIALS

- A. Provide other materials, not specifically described but required for a complete and proper installation, as selected by contractor subject to the approval of the Architect.

2.04 SHOP PAINT

- A. Primer: Use "10-99 Tnemec Primer" or Architect/Engineer equal product by Rustoleum.
- B. For repair of galvanizing, use a high zinc-dust content paint complying with SSPC-paint 20. Dry film containing not less than 94 percent zinc dust by weight.
- C. Bituminous Paint: Cold-applied asphalt mastic complying with SSPC-Paint 12, except containing no asbestos fibers.

2.05 FABRICATION

- A. Except as otherwise shown on the drawings or the approved shop drawings, use materials of size, thickness, and type required to produce reasonable strength and durability in the work of this Section.
- B. Fabricate with accurate angles and surfaces which are true to the required lines and levels, grinding exposed welds smooth and flush, forming exposed connections with hairline joints, and using concealed fasteners wherever possible.
- C. Prior to shop painting or priming, properly clean metal surfaces as required for the applied finish and for the proposed use of the items.
- D. On surfaces inaccessible after assembly or erection, apply two coats of the specified primer. Change color of second coat to distinguish it from the first.
- E. Shear and punch metals cleanly and accurately. Remove burrs.
- F. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- G. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling

limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

2.06 MISCELLANEOUS METAL FABRICATIONS

A. Rough Hardware:

1. Furnish bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels and other miscellaneous steel and iron shapes as required for framing and supporting woodwork and for anchoring or securing woodwork to concrete or other structures. Straight bolts and other stock rough hardware items are specified in Section 06100.
2. Manufacture or fabricate items of sizes, shapes, and dimensions required. Furnish malleable iron washers for heads and nuts which bear on wood structural connections; elsewhere, furnish steel washers.

B. Loose Bearing and Leveling Plates:

1. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction made flat, free from warps or twists, and of required thickness and bearing area. Drill plates to receive anchor bolts and for grouting as required. Galvanize after fabrication.

C. Loose Steel Lintels:

1. Provide loose structural steel lintels for opening and recesses in masonry walls and partitions as shown. Weld adjoining members together to form a single unit where indicated. Provide not less than 8'' bearing at each side of openings, unless otherwise shown.
2. Size lintels as follows, unless otherwise indicated.
 - a. Up to 4'-0'' span: One 3 1/2'' x 4'' x 5/16'' steel angle supporting each 4'' thick module of masonry.
 - b. Spans 4'-0'' to 7'-0'': One 5'' x 3-1/2'' x 5/16'' steel angle supporting each 4'' thick module of masonry.
 - c. Over 7'-0'': Consult Architect if not indicated.
3. Hot dip galvanized loose steel lintels to be installed in exterior walls.

D. Steel Pipe Railings:

1. Provide railings and handrails capable of withstanding the following loads applied as indicated when tested per ASTM E 935.
 - a. Concentrated loads of 200 lbs. Applied at any point in any direction.
 - b. Uniform load of 50 lbs. Per linear ft. applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 - d. Infill of Guards:
Concentrated load of 50 lbs. applied horizontally on an area 1 sq. ft.
Uniform load of 25 lb./ft. applied horizontally.
Infill load and other loads need not be assumed to act concurrently.
 - e. Provide X-Strong pipe (Schedule 80).
 2. Interconnect railing and handrail members by butt-welding or welding with internal connectors, at fabricator's option.
 3. At tee and cross intersections provide coped joints.
 4. At bends interconnect pipe by means of prefabricated elbow fittings or flush radius bends, as applicable.
 5. Form simple and compound curves by bending pipe in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross-section of pipe throughout entire bend without buckling, twisting or otherwise deforming exposed surfaces of pipe.
 6. Provide wall returns at ends of wall-mounted handrails, except where otherwise indicated.
 7. Close exposed ends of pipe by welding 3/16" thick steel plate in place or by use of prefabricated fittings.
 8. Provide wall brackets, end closures, flanges, miscellaneous fittings and anchors for interconnections of pipe and attachment of railings and handrails to other work. Furnish inserts and other anchorage devices for connecting railings and handrails to concrete or masonry work.
- E. Miscellaneous Framing and Supports:
1. Provide miscellaneous steel framing and supports as required to complete work.
 2. Fabricate miscellaneous units to sizes, shapes, and profiles shown or, if not shown, or required dimensions to receive adjacent other work to be retained by framing. Except as otherwise shown, fabricate from structural steel shapes, plates, and steel bars of welded construction using metered joints for field connection. Cut, drill and tap units to receive hardware and similar

items.

3. Hot dip galvanize exterior miscellaneous frames and supports.

PART 3. EXECUTION

3.01 SURFACE CONDITIONS

- A. Examine the areas and conditions under which work of this section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

3.02 COORDINATION

- A. Coordinate as required with other trades to assure proper and adequate provision in the work of those trades for interface with the work of this Section.

3.03 INSTALLATION

A. General:

1. Set work accurately into position, plumb, level, true and free from rack.
2. Anchor firmly into position.
3. Where field welding is required, comply with AWS recommended procedures of manual-shielded metal-arc welding for appearance and quality of weld and for methods to be used in correcting welding work.
4. Grind exposed welds smooth and touch up shop prime coats.
5. Do not cut, weld, or abrade surfaces which have been hot-dip galvanized after fabrication and which are intended for bolted or screwed field connections.

- B. Immediately after erection, clean the field welds, bolted connections and abraded areas of shop priming. Paint the exposed areas with same material used for shop priming.

END OF SECTION 05500

SECTION 05805 - EXPANSION JOINT COVERS

PART I - GENERAL

1.01 RELATED DOCUMENTS:

- A. Attention is directed to Division 0, Bidding and Contract Requirements, and to Division 1, General Requirements, which are hereby made a part of this section.

1.02 DESCRIPTION OF WORK:

- A. The extent of expansion joint covers is shown on the drawings.
- B. The types of expansion joint covers required are wall expansion joint covers.

1.03 QUALITY ASSURANCE:

A. Field Measurements:

- 1. Take field measurements prior to preparation of shop drawings and fabrication, where possible, to ensure proper fitting of the work. However, do not delay job progress; allow for adjustments and fittings wherever the taking of field measurements before fabrication might delay the work.

B. Shop Assembly:

- 1. Preassemble items in the shop to the greatest extent possible, so as to minimize field splicing and assembly of units at the project site. Disassemble units only to the extent necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

C. Insert and Anchorages:

- 1. Furnish insert type anchoring devices which must be set in concrete or built into masonry for the installation of ornamental metal work. Provide setting drawings, templates, instructions and directions for installation of anchorage devices. Coordinate delivery with other work to avoid delay.
- 2. See concrete and masonry divisions of these specifications for installation of insert type anchorage devices.

1.04 SUBMITTALS:

A. Manufacturer's Data:

1. For information only, submit two (2) copies of manufacturer's finisher's specifications and installation instructions for expansion joint cover work, including finishing materials and methods. Indicate by transmittal that copy of any applicable instructions have been distributed to the Installer.

B. Shop Drawings:

1. Submit shop drawings for the fabrication and installation of expansion joint cover work. Include plans, elevations, and detail sections. Show jointing anchorage and accessory items, and specify finishes. Furnish setting diagrams and templates for items set in other work.

C. Samples:

1. Submit three (3) samples, 6" square, of metal finish required. Prepare samples on metal of the same alloy and gauge to be used for the work. Samples will be reviewed by Architect for color and texture only. Compliance with all other requirements is the exclusive responsibility of the Contractor.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Aluminum: ASTM B 221 alloy 6063-T5 for extrusions; ASTM B 209, alloy 6061-T6, sheet and plate.
- B. Accessories: Manufacturer's standard anchors, fasteners, set screws, spacers, flexible seal and filler materials, adhesive and other accessories compatible with material in contact; as shown or required for complete installations.
- C. Manufacturer: Provide expansion joint covers as manufactured by one of the following:
 1. Architectural Art Mfg.
 2. Julius Blum & Co.
 3. Balco, Inc.

4. Construction Specialties, Inc.
 5. MM Systems Corp.
 6. Inpro Corp.
- D. Design/Profile: Provide the equivalent of the following as judged solely by the Architect:
1. Wall: MM Systems - AKL, 1-.5 (corner/wall)
ASK, 1-1 (wall/wall)

2.02 FINISH:

- A. Comply with NAAMM "Metal Finishes Manual"
- B. Anodized Finishes:
 1. Aluminum Contact Surfaces on Concrete: Zinc chromate primer; except where anodic coating required.
 2. Anodized Aluminum Finish: Apply the following to all exposed aluminum metal work.
 - a. Alumilite 215-R1; clear anodize: 0.07 or greater mil thickness anodil coating conforming to AA-M10C22A41.

2.03 FABRICATION:

- A. General:
 1. Furnish the basic profile and operating units for expansion joint covers as shown on the drawings and indicated herein before. Select units comparable to those shown or required for the joint size, and to absorb variations in adjacent surfaces and structural movement. Furnish the longest practicable lengths to minimize the number of end joints. Provide hairline mitered corners where joint changes direction or abuts other material systems.
- B. Joint Cover Assemblies:
 1. Furnish concealed, continuously anchored members fastened to wall, ceiling, or soffit only on one side of the joint. Extend cover to lap each side of joint, with free movement. Attach cover to the anchor member, with the cover in close contact with adjacent contact surfaces.
- C. Fire-rated Systems:

1. For two-hour rated wall locations:
 - a. Pyro-flex 2000W with specified cover for walls.
2. Characteristics:
 - a. Prefabricated fire barrier assemblies shall have ratings not less than the rating of adjacent construction when tested in accord with, UL 263, ANSI A2.1, NFPA 251, ASTM E119-95a and ASTM E1399-91, including hose steam test for walls.
 - b. System shall be capable of anticipated movement with maintaining fire rating.
 - c. Coverless applications shall maintain fire rating without joint cover system.

PART 3 - EXECUTION:

3.01 INSTALLATION:

A. Manufacturer's Instructions:

1. In addition to the requirements of these specifications, comply with manufacturer's instructions and recommendations for all phases of the work, including preparation of substrate, applying materials, and protection of installed units.

B. Cutting, Fitting and placement:

1. Perform all cutting, drilling and fitting required for installation of the items. Set the work accurately in location, alignment and elevation, plumb, level, true, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items which are to be built into concrete, masonry or similar construction.
2. Install joint cover assemblies in true alignment. Locate wall covers in continuous contact with adjacent surfaces. Securely attach in place with all required accessories. Locate anchors approximately 3" from each end, 12" o.c. between ends for set screws and 18" o.c. between ends for other fasteners, unless closer spacing is recommended by the manufacturer.
3. Hold end joints to the minimum; make end joints with strong, rigid, mechanical splice plate in true alignment, with hairline joints.

3.02 CLEANING AND PROTECTION:

- A. Do not remove strippable protective material until finish work in adjacent areas is complete. When protective material is removed, clean exposed metal surfaces in accordance with manufacturer's instructions.

END OF SECTION 05805

SECTION 06100 - CARPENTRY

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Attention is directed to Division 0, Bidding and Contract Requirements, and to Division 1, General Requirements, which are hereby made a part of this Section.

1.02 DESCRIPTION OF WORK:

- A. The extent of the carpentry work is shown on the Drawings.

1.03 QUALITY ASSURANCE:

- A. Lumber Standard: Comply with U.S. Department of Commerce Product Voluntary Standards PS 1-07, "Structural Plywood", PS 2-04 Performance Standard for "Wood based structural use panels" and PS 20-05 American Softwood Lumber Standard, except as otherwise indicated.
- B. Factory mark each piece of lumber and plywood with type, grade, mill, and grading agency: West Coast Lumber Assoc. (WBLC) or Western Wood Products Association (WWPA).

1.04 SUBMITTALS:

- A. Wood Treatment Data:
 - 1. Submit treatment manufacturer's instructions for proper use of each type of treated material.
 - a. Pressure Treatment: For each type specified, include certification by treating plant stating chemicals and process used, net amount of preservative retained, and conformance with applicable standards.
 - b. For water-borne preservatives, include statement that moisture content of treated materials was reduced to a maximum of 15% prior to shipment to project site.
- B. Product Data:
 - 1. Submit manufacturer's specifications and other data for each carpentry anchorage, fastening, and miscellaneous material. Provide material certificates for all lumber and plywood. Transmit a copy of each instruction to the Installer.

1.05 PRODUCT HANDLING:

- A. Delivery and Storage: Keep materials dry during delivery and storage. Protect against exposure to weather and contact with damp or wet surfaces. Stack lumber and plywood and provide air circulation within stacks.

1.06 JOB CONDITIONS:

- A. Coordination: Fit carpentry work to other work, scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds, and similar supports to allow proper attachment of other work.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Lumber - General:

- 1. Nominal sizes are indicated, except as shown by detail dimensions. Provide actual sizes as required by PS 20-05, for the moisture content specified for each use. Use dressed lumber, surfaced four sides (SFS) seasoned with 19% maximum moisture content at time of dressing.

B. Framing Lumber (2" through 4" thick):

- 1. For light framing (less than 6" wide), provide Construction Grade Douglas Fir as graded by the West Coast Lumber Bureau (WCLB) or equivalent species and grade with minimum fiber stress rating (bending) of 1000 psi (Fb), and modulus of elasticity of 1,500,000 psi.
- 2. For structural framing (6" and wider and from 2" to 4" thick) provide dense No. 1 Grade Douglas Fir as graded by the West Coast Lumber Bureau (WCLB) or equivalent species and grade with minimum fiber stress rating (bending) of 1500 psi (Fb), and modulus of elasticity of 1,700,000 psi.

C. Boards (less than 2" thick):

- 1. Produce lumber of 19% maximum moisture content (S-DRY) and of the following species and grade.
 - a. Redwood Construction Common (RIS).
 - b. Southern Pine No. 2 Boards (SPIB).
 - c. Or any species graded construction Boards (WCLB or WWPA).

D. Plywood:

1. Provide only Douglas Fir Plywood in accordance with grading requirements of the APA - The Engineered Wood Association as follows:
 - a. Treated non-combustible AC standard with exterior glue.

E. Anchorage and fastening Materials:

1. Select proper type, size, material, and finish for each application. Comply with the following:
 - a. Nails and Staples: FS FF-N-105.
 - b. Wood Screws: FS FF-S-111.
 - c. Bolts and Studs: FS FF-B-575.
 - d. Nuts: FS FF-N-836.
 - e. Washers: FS FF-W-92.
 - f. Lag Screws or Lag Bolts: FS FF-B-561.
 - g. Masonry Anchoring Devices: For expansion shields, nails, and drive screws, comply with FS FF-S-325.
 - h. Toggle Bolts: FS FF-B-588.
 - i. Bar or Strap Anchors: ASTM A 575 carbon steel bars.

2.02 WOOD TREATMENT:

- A. Preservation Treatment: Where lumber or plywood is indicated as "Treated" or is specified herein to be treated, comply with the applicable requirements of the American Wood Preservers Association (AWPA) AWPA P23-08, ASTM D-1625 and Federal Specification TT-W-50.
- B. Pressure-treat above-ground items with water-borne preservatives complying with AWPA P5-09, ASTM D-1760, and Federal Specification TT-W-571. After treatment, kiln-dry to a maximum moisture content of 19%. Treat indicated items and the following, except where fire retardant treated.
 1. Wood cants, nailers, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers and waterproofing.
 2. Wood sills, sleepers, blocking, furring, stripping, and

similar concealed members in contact with masonry or concrete.

3. Wood framing members less than 12 inches above grade excepting timber.

C. Fire Retardant Treated:

1. Wood blocking and similar items installed within the building shall be pressure impregnation with retardant chemicals to achieve a flame spread rating of not more than 25 when tested in accordance with UL Test 723, ASTM E 84, or NFPA Test 355.

PART 3 - EXECUTION

3.01 INSPECTION:

- A. Installer must examine the substrates and supporting structure and the conditions under which the carpentry work is to be installed and notify the Constructor, in writing, of conditions detrimental to the work. Do not proceed with the installation until unsatisfactory conditions have been corrected in a manner acceptable to the installer.

3.02 INSTALLATION:

A. General:

1. Discard units of material with defects which might impair the quality of the work, and units which are too small to fabricate the work with minimum joints or the optimum joint arrangement.
2. Set carpentry work accurately to required levels and lines, with members plumb and true and accurately cut and fitted.
3. Securely attach carpentry work to substrate by anchoring and fastening as shown and as required. Provide washers under bolt heads and nuts in contact with wood. Nail plywood in accordance with the recommendations of APA-The Engineered Wood Association.
4. Use common wire nails, except as otherwise shown or specified herein. Use finishing nails for exposed work. Do not wax or lubricate fasteners that depend on friction for holding power. Select fasteners of size that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members.

Install fasteners without splitting of wood; pre-drill as required. Do not drive threaded friction type fasteners; turn into place. Tighten bolts and lag screws at installation and retighten as required for tight connections prior to closing in or at completion of work.

B. Wood Grounds, Nailers, Blocking and Sleepers:

1. Provide wherever shown and where required for screening or attachment of other work. Form to shapes as shown and cut as required for true line and level of work to be attached. Coordinate location with other work involved.
2. Attach to substrates as required to support applied loading. Countersink bolts and nuts flush with surfaces, unless otherwise shown. Build into masonry during installation of masonry work. Where possible, anchor to form work before concrete placement.
3. Provide permanent grounds of dressed, pressure preservative treated key-bevelled lumber not less than 1-1/2" wide and of the thickness required to bring face of ground to exact thickness of finished material involved. Remove temporary grounds when no longer required.

C. Wood Furring:

1. Install plumb and level with closure strips at all edges and openings. Shim with wood as required for tolerance of finished work.

D. Wood Framing:

1. Provide framing members of sizes and on spacings shown and frame openings as shown, or if not shown, comply with recommendations of "The Wood Frame Construction Manual" 2001 Ed. of the American Wood Council. Do not splice structural members between supports.
2. Anchor and nail as shown, and comply with the "Recommended Nailing Schedule - Table I of the Manual for Housing Framing: and other recommendations of the N.F.P.A.

E. Installation of Plywood:

FARMINGTON PUBLIC SCHOOLS
2017 RENOVATIONS-BID PACK #5
ELEMENTARY SCHOOLS

161664B

NOVEMBER 30, 2016

1. Comply with recommendations of the Engineered Wood Association (APA) for the installation of plywood.

END OF SECTION 06100

SECTION 06402 - INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Interior standing and running trim.
 - 2. Laminate clad cabinets (plastic-covered casework).
 - 3. Cabinet tops (countertops).
 - 4. Interior miscellaneous ornamental items.
- B. Related Sections: The following sections contain requirements that relate to this section:
 - 1. Division 6 Section 06100 "Carpentry" for furring, blocking, and other carpentry work that is not exposed to view.
 - 2. Division 9 Section 09900 "Painting" for final finishing of installed architectural woodwork.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data for each type of product and process specified in this section and incorporated into items of architectural woodwork during fabrication, finishing and installation.
- C. Fire-retardant treatment data for material impregnated by pressure process to reduce combustibility. Include certification by treating plant that treated materials comply with requirements.

- D. Shop drawings showing location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
1. Plastic laminate.
 2. Factory-applied opaque finishes.
- E. Samples for verification purposes of the following:
1. Lumber with or for transparent finish, 50 square inches, for each species and cut, finished on one side and one edge.
 2. Veneer leaves representative of and selected from flitches to be used for transparent finished woodwork.
 3. Wood veneer faced panel products; with or for transparent finish, 8-1/2 inches by 11 inches, for each species and cut with one half of exposed surface finished, with separate samples of unfaced panel product used for core.
 4. Lumber and panel products with factory-applied opaque finish, 8- 1/2 inches by 11 inches for panels and 50 square inches for lumber, for each finish system and color, with one half of exposed surface finished.
 5. Laminate clad panel products, 8-1/2 inches, by 11 inches for each type, color, pattern, and surface finish, with separate samples of unfaced panel product used for core.
 6. Corner pieces as follows:
 - a. Cabinet front frame joints between stiles and rail as well as exposed end pieces, 18 inches high by 18 inches wide by 6 inches deep.
 - b. Miter joints for standing trim.
 7. Exposed cabinet hardware, one unit of each type and finish.
- F. Product certificates signed by woodwork manufacturer certifying that products comply with specified requirements.

- G. Qualification data for firms and persons specified in "Quality Assurance" article to demonstrate their capabilities and experience. Include list of completed projects with project names, addresses, names of Architects and Owners, and other information specified.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Firm experienced in successfully producing architectural woodwork similar to that indicated for this Project, with sufficient production capacity to produce required units without causing delay in the Work.
- B. Single-Source Responsibility: Arrange for production by a single firm of architectural woodwork with sequence matched wood veneers.
- C. Single-Source Manufacturing and Installation Responsibility: Engage a qualified Manufacturer to assume undivided responsibility for woodwork specified in this section, including fabrication, finishing and installation.
- D. Installer Qualifications: Arrange for installation of architectural woodwork by a firm that can demonstrate successful experience in installing architectural woodwork items similar in type and quality to those required for this project.
- E. AWI Quality Standard: Comply with applicable requirements of "Architectural Woodwork Quality Standards" published by the Architectural Woodwork Institute (AWI) except as otherwise indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect woodwork during transit, delivery, storage, and handling to prevent damage, soilage and deterioration.
- B. Do not deliver woodwork until painting, wet work, grinding, and similar operations that could damage, soil, or deteriorate woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas whose environmental conditions meet requirements specified in "Project Conditions."

1.6 PROJECT CONDITIONS

- A. Environmental Conditions: Obtain and comply with Woodwork Manufacturer's and Installer's coordinated advice for optimum temperature and humidity conditions for woodwork during its storage and installation. Do not install woodwork until these conditions have been attained and stabilized so that woodwork is within plus or minus 1.0 percent of optimum moisture content from date of installation through remainder of construction period.
- B. Field Measurements: Where woodwork is indicated to be fitted to other construction, check actual dimensions of other construction by accurate field measurements before manufacturing woodwork; show recorded measurements on final shop drawings. Coordinate manufacturing schedule with construction progress to avoid delay of Work.
 - 1. Where field measurements cannot be made without delaying the Work, guarantee dimensions and proceed with manufacture of woodwork without field measurements. Coordinate other construction to ensure that actual dimensions correspond to guaranteed dimensions.

PART 2 - PRODUCTS

2.1 HIGH PRESSURE DECORATIVE LAMINATE MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering high pressure decorative laminates which may be incorporated in the work include but are not limited to the following:
- B. Manufacturer: Subject to compliance with requirements, provide high pressure decorative laminates from:
 - 1. Wilsonart International

2.2 MATERIALS

- A. General: Provide materials that comply with requirements of the AWI woodworking standard for each type of woodwork and quality grade indicated and, where the following products are part of woodwork, with requirements of the referenced product standards that apply to product characteristics indicated:
 - 1. Hardboard: ANSI/AHA A135.4

2. High Pressure Laminate: NEMA LD 3-2005.
 - a. Fire rated laminate: ASTM E84 and UL 723 and NEMA LD3-2005.
 3. Medium Density Fiberboard: ANSI A208.2.
 4. Particleboard: ANSI A208.1
 5. Softwood Plywood: PS 1.
 6. Formaldehyde Emission Levels: Comply with formaldehyde emission requirements of each voluntary standard referenced below:
 - a. Particleboard: NPA 8.
 - b. Medium Density Fiberboard: NPA 9.
 - c. Hardwood Plywood: HPM FE.
- B. Fire-Retardant Particleboard: Where indicated on the documents, provide panels complying with the following requirements that have fire-retardant chemicals bonded to softwood particles at time of panel manufacture to achieve products identical to those tested for flame spread of 20 or less and for smoke developed of 25 or less per ASTM E 84 by UL or other testing and inspecting organization acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing and inspecting organization.
1. For 45-lb-density panels and thicknesses of 3/4 inch and less, comply with ANSI A208.1 for Grade 1-M-1 except that minimums for modulus of elasticity and screw-holding capacity on face and edge shall be 300,000 psi, 250 lb, and 225 lb, respectively.
 2. For 44-lb-density panels and thicknesses of 13/16 inch to 1-1/4 inch, comply with ANSI A208.1 for Grade 1-M-1 except that minimums for modulus of rupture, modulus of elasticity, internal bond, linear expansion, and screw-holding capacity on face and edge shall be 1300 psi, 250,000 psi, 60 psi, 0.50 percent, 250 lb, and 175 lb, respectively.
 3. Product: Subject to compliance with requirements, provide "Duraflake FR" by Duraflake Div.; Willamette Industries, Inc.

2.3 FABRICATION, GENERAL

- A. Wood Moisture Content: Comply with requirements of referenced quality standard for moisture content of lumber in relation to relative humidity conditions existing during time of fabrication and in installation areas.
- B. Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:
 - 1. Corners of cabinets and edges of solid wood (lumber) members less than 1 inch in nominal thickness: 1/16 inch.
 - 2. Edges of rails and similar members more than 1 inch in nominal thickness: 1/8 inch.
- C. Complete fabrication, including assembly, finishing, and hardware application, before shipment to project site to maximum extent possible. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
- D. Factory-cut openings, to maximum extent possible, to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Smooth edges of cutouts and, where located in countertops and similar exposures, seal edges of cutouts with a water-resistant coating.

2.4 FIRE-RETARDANT-TREATED LUMBER

- A. Low-Hygroscopic Formulation: Interior Type A per AWPA C20.
- B. Fire Performance Characteristics: Provide materials identical to those tested for the following fire performance characteristics per ASTM test methods indicated by UL or other testing and inspecting organizations acceptable to authorities having jurisdiction. Identify treated lumber with classification marking of inspecting and testing organization in the form of separable paper label or, where required by authorities having jurisdiction, of imprint on lumber surfaces that will be concealed from view after installation.

1. Surface Burning Characteristics: Not exceeding values indicated below, tested per ASTM E 84 for 30 minutes with no evidence of significant combustion.
 - a. Flame Spread: 25.
 - b. Smoke Developed: 50.
 - C. Mill lumber after treatment, within limits set for wood removal that does not affect listed fire performance characteristics, using a woodworking plant certified by testing and inspecting organization.
 - D. Kiln-dry woodwork after treatment to levels required for untreated woodwork. Maintain moisture content required by kiln drying before and after treatment.
 - E. Discard treated lumber that does not comply with requirements of referenced woodworking standard. Do not use twisted, warped, bowed, discolored, or otherwise damaged or defective lumber.
 - F. Available Products: Subject to compliance with requirements, products that may be incorporated in the work include but are not limited to the following:
 1. Koppers Company, Inc.
 2. Osmose Wood Preserving, Inc.
- 2.5 STANDING AND RUNNING TRIM FOR TRANSPARENT FINISH (Chair rails; door casings; guard rails)
- A. Quality Standard: Comply with AWI Section 300.
 - B. Backout or groove backs of flat trim members and kerf backs of other wide flat members, except for members with ends exposed in finished work.
 - C. Assemble casings in plant except where limitations of access to place of installation require field assembly.
 - D. Grade: Premium.
 - E. Lumber Species: Red oak, rift sawn.

F. Lumber Species: Match species and cut indicated for other types of transparent finished architectural woodwork located in same area of building unless otherwise indicated.

1. Provide split species on trim that face areas with different wood species, matching each face of woodwork to species and cut of finish wood surfaces in areas finished.

2.6 STANDING AND RUNNING TRIM FOR OPAQUE FINISH

A. Quality Standard: Comply with AWI Section 300.

B. Grade: Custom.

C. Backout or groove backs of flat trim members and kerf backs of other wide flat members, except for members with ends exposed in finished work.

D. Assemble casings in plant except where limitations of access to place of installation require field assembly.

E. Lumber Species: Red Oak.

2.7 LAMINATE CLAD CABINETS (PLASTIC-COVERED CASEWORK)

A. Quality Standard: Comply with AWI Section 400 and its Division 400B "Laminate Clad Cabinets."

B. Grade: Custom.

C. AWI Type of Cabinet Construction: As indicated.

D. Laminate Cladding: High pressure decorative laminate complying with the following requirements: (provide fire-rated laminate where indicated on the documents).

1. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

a. Provide selections made by Architect from laminate manufacturer's full range of standard colors and finishes in the following categories:

- 1) Solid colors.
- 2) Patterns.

2. Laminate Grade for Exposed Surfaces: Provide laminate cladding complying with the following requirements for type of surface and grade.
 - a. Horizontal Surfaces Other Than Tops: GP-50 (0.050-inch nominal thickness).
 - b. Postformed Surfaces: PF-42 (0.042-inch nominal thickness).
 - c. Vertical Surfaces: GP-50 (0.050-inch nominal thickness).
 - d. Vertical Surfaces: GP-50 (0.050-inch nominal thickness).
 3. Semiexposed Surfaces: Provide surface materials indicated below:
 - a. High pressure laminate, GP-28.
- E. Provide dust panels of 1/4-inch plywood or tempered hardboard above compartments and drawers except where located directly under tops.

2.8 CABINET HARDWARE AND ACCESSORY MATERIALS

- A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets, except for items specified in Division 8 Section "Finish Hardware."
- B. Cabinet Hardware Schedule: Refer to schedule at end of this section for cabinet hardware required for architectural cabinets.
- C. Hardware Standard: Comply with ANSI/BHMA A156.9 "American National Standard for Cabinet Hardware" for items indicated by reference to BHMA numbers or referenced to this standard.
- D. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with ANSI/BHMA A156.18 for BHMA code number indicated.
 1. Satin Stainless Steel, Stainless Steel Base: BHMA 630.
- E. For concealed hardware provide manufacturer's standard finish that complies with product class requirements of ANSI/BHMA A156.9.

- F. Uncoated Clear Tempered Float Glass for Doors: ASTM C 1048, Condition A, Type I, Class 1, Quality q3. Kind FT, manufactured by horizontal (roller hearth) process, with exposed edges seamed before tempering, 1/4-inch thick unless otherwise indicated.
 - 1. Install glass to comply with applicable requirements of Division 8 Section "Glass and Glazing" and of FGMA "Glazing Manual." For glass in wood frames, secure glass with removable stops.
- G. Clear Tempered Float Glass for Shelves: ASTM C 1048, Condition A, style I, type I, quality q3, class 1, seamed at edges before tempering, 1/4-inch thick unless otherwise indicated.

2.9 ARCHITECTURAL CABINET TOPS (COUNTERTOPS)

- A. Quality Standard: Comply with AWI Section 400 and its Division 400C.
- B. Type of Top: High pressure decorative laminate complying with the following: (provide fire-rated laminate where indicated on the documents).
 - 1. Grade: Custom.
 - 2. Laminate Cladding for Horizontal Surface: High pressure decorative laminate as follows:
 - a. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
 - 1) Match Architect's sample.
 - 3. Edge Treatment: 3mm edge.
- C. Fire Performance Characteristics: Provide paneling composed of panels of wood veneer density and fire-retardant particleboard that are identical in construction to units tested for the following surface burning characteristics per ASTM E 84 by UL or other testing and inspecting organization acceptable to authorities having jurisdiction. Identify panels with appropriate markings of applicable testing and inspecting organization on surfaces that will be concealed from view after installation.
 - 1. Flame Spread: 75 or less.
 - 2. Smoke Developed: 40 or less.

- 2.10 INTERIOR MISCELLANEOUS ORNAMENTAL ITEMS FOR TRANSPARENT FINISH
- A. Quality Standard: Comply with AWI Section 700.
 - B. Grade Premium
 - C. Lumber Species: Red Oak, rift sawn.
- 2.11 INTERIOR MISCELLANEOUS ORNAMENTAL ITEMS FOR OPAQUE FINISH
- A. Quality Standard: Comply with AWI Section 700.
 - B. Grade: Custom.
 - C. Lumber Species: Eastern white pine, sugar pine or Idaho white pine.
- 2.12 FASTENERS AND ANCHORS
- A. Screws: Select material, type, size, and finish required for each use. Comply with FS FF-S-111 for applicable requirements.
 - 1. For metal framing supports, provide screws as recommended by metal framing manufacturer.
 - B. Nails: Select material, type, size, and finish required for each use. Comply with FS FF-N-105 for applicable requirements.
 - C. Anchors: Select material, type, size, and finish required by each substrate for secure anchorage. Provide nonferrous metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed steel or lead expansion bolt devices for drilled-in-place anchors. Furnish inserts and anchors, as required, to be set into concrete or masonry work for subsequent woodwork anchorage.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Condition woodwork to average prevailing humidity conditions in installation areas before installing.

- B. Deliver concrete inserts and similar anchoring devices to be built into substrates well in advance of time substrates are to be built.
- C. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including back priming and removal of packing.

3.2 INSTALLATION

- A. Quality Standard: Install woodwork to comply with AWI Section 1700 for same grade specified in Part 2 of this section for type of woodwork involved.
- B. Install woodwork plumb, level, true, and straight with no distortions. Shim as required with concealed shims. Install to a tolerance of 1/8 inch in 8'-0" for plumb and level (including tops) and with no variations in flushness of adjoining surfaces.
- C. Scribe and cut woodwork to fit adjoining work and refinish cut surfaces or repair damaged finish at cuts.
- D. Fire-Retardant-Treated Wood: Handle, store, and install fire-retardant-treated wood to comply with recommendations of chemical treatment manufacturer including those for adhesives where are used to install woodwork.
- E. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure to grounds, stripping and blocking with countersunk, concealed fasteners and blind nailing as required for a complete installation. Except where prefinished matching fastener heads are required, use fine finishing nails for exposed nailing, countersunk and filled flush with woodwork and matching final finish where transparent finish is indicated.
- F. Standing and Running Trim and Rails: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to the greatest extent possible. Stagger joints in adjacent and related members. Cope at returns and miter at corners.
- G. Cabinets: Install without distortion so that doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete the installation of hardware and accessory items as indicated.

Maintain veneer sequence matching (if any) of cabinets with transparent finish.

- H. Tops: Anchor securely to base units and other support systems as indicated.
- I. Complete the finishing work specified in this section to whatever extent not completed at shop or before installation of woodwork.
- J. Refer to the Division 9 sections for final finishing of installed architectural woodwork.

3.3 ADJUSTMENT AND CLEANING

- A. Repair damaged and defective woodwork where possible to eliminate defects functionally and visually; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
- B. Clean, lubricate and adjust hardware.
- C. Clean woodwork on exposed and semiexposed surfaces. Touch up factory-applied finishes to restore damaged or soiled areas.

3.4 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensures that woodwork is being without damage or deterioration at time of Substantial Completion.

3.5 HARDWARE SCHEDULE

- A. Keyboard slide and tray: Knape & Vogt KV SRS with platform (BBP1824).
- B. Grommets: Mockett 3'' o.d. black: MQEDP3BK with fliptop tab.

END OF SECTION 06402

SECTION 07160 - BITUMINOUS DAMPPROOFING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Attention is directed to Division 0, Bidding and Contract Requirements and to Division 1, General Requirements, which are hereby made a part of this Section.

1.02 DESCRIPTION OF WORK:

- A. The extent of surfaces to receive bituminous dampproofing is as noted below and shown on the drawings.
- B. Apply to exterior side of CMU foundations below grade at all perimeter walls of building (unless noted to receive sheet membrane waterproofing).
- C. Related Work Specified Elsewhere:
 - 1. Section 07110 - Sheet Membrane Waterproofing
 - 2. Section 07200 - Perimeter Insulation

1.03 SUBMITTALS

- A. Product Data:
 - 1. Submit 2 copies of manufacturer's specifications, installation instructions and general recommendations for required dampproofing material. Include manufacturer's certification to other data substantiating that the materials comply with the requirements, and are recommended by the manufacturer for the application shown or specified. Indicate by copy of transmittal form that the Installer has received a copy of the instructions and recommendations.

1.04 JOB CONDITIONS:

- A. Do not proceed with dampproofing work until blocking, nailers, piping, conduit and other projections through the substrate have been installed, with substrate properly patched and sealed or flashed to receive the dampproofing.

- B. When ambient temperature is 40 degrees F or less and falling, do not proceed with dampproofing. Do not apply dampproofing materials to frozen substrate or to any substrate in a condition not complying with manufacturer's recommendations.
- C. The Installer must examine the substrates and the conditions under which the dampproofing is to be applied and advise the Construction Manager in writing of unsatisfactory conditions. Do not proceed with the dampproofing work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Asphalt Compound: Manufacturer's standard asphalt and solvent compound recommended for above-grade interior applications, compounded to penetrate substrate and build to a moisture-resistant, vapor-resistant, firm elastic coating.
 - 1. Provide semi-fibrated type semi-mastic compound FS SS-A-694.
- B. Cold-Applied, Asphalt Emulsion Dampproofing: Asphalt-based emulsions recommended by the manufacturers for dampproofing use when applied according to the manufacturer's instructions and as follows:
 - 1. Trowel Grade: Emulsified asphalt mastic, prepared with mineral-colloid emulsified agents and containing fibers other than asbestos, complying with ASTM D 1227, Type III or IV.
- C. Primer: Asphalt primer complying with ASTM D 41, for asphalt based dampproofing.
- D. Rigid protective boards shall be 1/8 inch thick similar to "Protective Course II" material by Sonneborn. Provide protective boards where perimeter insulation is not used.
- E. Odor Elimination For interior and concealed-in-wall uses, provide type of bituminous dampproofing material which is warranted by manufacturer to be substantially odor-free after drying for 24 hours under normal conditions.

PART 3 - EXECUTION

3.01 PREPARATION OF SUBSTRATE

- A. Clean the substrate of dirt, oil, loose materials and other substances which interfere with penetration, bond or performance of dampproofing materials.
- B. Prime substrate, except where specifically recommended by manufacturer of dampproofing compound to omit primer; apply type recommended by manufacturer, at rate recommended for condition of substrate.

3.02 INSTALLATION

- A. Apply coating material in accordance with the manufacturer's printed instructions using sufficient quantity to form a continuous unbroken coating over surfaces to be dampproofed. Retouch surfaces as necessary to provide a continuous coating. Protect adjacent surfaces from damage by the dampproofing. Material applied with trowel shall have at least 1/8 inch thickness.
- B. Apply mastic in one coat directly from the container without thinning. Form a cove at the corner junction of surfaces which are coated. Joints, grooved, slots, or breaks in the surfaces shall be completely and continuously covered. Spread coating into chases, corners, reveals, or other surfaces which occur below grade. Reinforce at corners and angles with one additional thickness of membrane.
- C. Apply vertical dampproofing down walls to top of footing, but do not extend onto surfaces exposed to view when the Project is completed.

3.03 COLD-APPLIED, ASPHALT EMULSION DAMPPROOFING

- A. Trowel Grade: Trowel apply a coat of mastic asphalt emulsion dampproofing onto substrate a minimum rate of 7 gal./100 sq. ft. to produce an average, dry-film thickness of 60 mils, but not less than 30 mils at any point.

3.04 PROTECTION

- A. After the mastic has set and solvents have left the mixture, apply protective board layer over the entire surface of the mastic, holding in place with spots of additional mastic, where wall will not be covered with perimeter insulation.

END OF SECTION 07160

SECTION 07200 - INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Attention is directed to Division 0, Bidding and Contract Requirements, and to Division 1, General Requirements, which are hereby made a part of this Section.

1.02 DESCRIPTION OF WORK:

- A. The extent of thermal insulation work is shown on the drawings.
- B. The applications of thermal insulation specified in this section include the following:
 - 1. Cavity wall.
 - 2. Board-type building insulation.
 - 3. Blanket-type building insulation.
- C. Related Work Specified Elsewhere:
 - 1. Section 07200 - Standing Seam Metal Roof Deck/Insulation
 - 2. Section 07500 - Flat Roof Insulation
 - 2. Section 07840 - Firestopping: For safing insulation
 - 3. Section 09200 - Exterior Plaster System: Rigid Insulation Board
 - 4. Section 09250 - Gypsum Board: Acoustical batt insulation
 - 5. Division 15, Mechanical: Insulation for ducts, heating, air conditioning, ventilating, and plumbing work shall be furnished and installed by the respective Mechanical Contractor.
 - 6. Division 16, Electrical: Insulation for electrical work shall be furnished and installed by Electrical Contractor.

1.03 QUALITY ASSURANCE:

- A. Thermal Conductivity: The thickness shown are for the thermal conductivity (k-value at 75%) specified for each material. Provide adjusted thicknesses as directed for the equivalent use of material having a different thermal conductivity.

- B. Fire Ratings: Comply with the fire-resistance and flammability ratings indicated, and comply with governing regulations as interpreted by authorities including:
 - 1. UL requirements for "Roof Deck Constructions" which are rated "Fire-Acceptable".

1.04 SUBMITTALS:

A. Product Data:

- 1. Submit manufacturer's specifications and installation instructions for each type of insulation required. Include data substantiating that materials comply with specified requirements.

B. Shop Drawings:

- 1. Submit shop drawings for tapered roof area. Show all slopes, thickness, perimeter and roof sump conditions.

1.05 PRODUCT HANDLING:

- A. Protection from Deterioration: Do not allow insulation materials to become wet, soiled, or covered with ice or snow. Comply with manufacturer's recommendations for handling, storage and protection during installation. Protect plastic insulation from exposure to sunlight.
- B. Fire Hazard: Do not deliver plastic insulating materials to the project site ahead of installation time. Protect at all times against ignition. Complete installation and concealment of plastic materials as rapidly as possible in each area of work.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Extruded Polystyrene Plastic Board Insulation:

- 1. Cavity Wall Insulation
 - a. Material Properties
 - 1. Rigid closed-cell, polystyrene thermal board insulation.
 - 2. Comply with ASTM C 578-95, Type x, density 1.35 lb/cu. Fet. Min., compressive strength 15 psi (ASTM D 1621-94).

3. Thermal resistance: 5-year aged R-values of 5.4 and 5.0 min. °F-ft²-h/Btu²/inch at 40°F and 75°F respectively (ASTM C 518-91).
 4. Water absorption: Max. 0.1% by volume (ASTM C 272-91 (96)).
 5. Surface Burning Characteristics:
 - i. Flame Spread: 5
 - ii. Smoke Developed: 165
 - b. Thickness: 2'' (R-10)
 - c. Acceptable manufacturer's product: The Dow Chemical Company ``STYROFOAM® Brand CAVITYMATE®.``
2. Perimeter Edge Insulation
- a. Material Properties:
 1. Rigid closed-cell extruded polystyrene thermal board insulation.
 2. Comply with ASTM C 578-92, Type VI, density 1.8 lb/cu. Ft. min., compressive strength 40 psi (STM D 1621-73).
 3. Thermal resistance: 5-year aged R-values of 5.4 and 5.0 min. °F-ft²-h/Btu²/inch at 40°F and 75°F respectively (ASTM C 518-91).
 4. Water absorption: Max 0.3% by volume (ASTM C 272-91).
 - b. Thickness: 2'' unless otherwise indicated.
 - c. Acceptable manufacturer's product: Dow Chemical Company ``STYROFOAM® Brand High Load (HI-40)`` material.
- B. Glass Fiber Board Insulation:
1. Glass fibers and water-resistant binders formed into rigid, non-combustible boards complying with FS HH-I-558, Form A; thermal conductivity (k-value at 75 degrees F.) of 0.26; manufacturer's standard lengths and widths, unless otherwise shown.
 - a. Provide "CWE Type FRK Faced Board by Owens-Corning Fiberglass Corp."
- C. Mineral/Glass Fiber Blanket/Batt Insulation:
1. Unfaced Mineral Fiber Blanket/Batt Insulation: Thermal insulation produced by combining mineral fibers of type described below with thermosetting resins to comply with ASTM C665 for type described below with thermosetting resins to comply with ASTM C665 for Type 1 (blankets without membrane facing); and as follows:
 - a. Mineral Fiber Type: Fibers manufactured from

- glass.
- b. Surface Burning Characteristics: Maximum flame spread and smoke developed values of 25 and 50, respectively.
2. Batt insulation shall be foil faced when exterior wall or ceiling is not indicated to receive a separate vapor barrier. Locations with vapor barrier shall be unfaced. Provide batt insulation equal to or exceeding the "R" values for the following nominal indicated insulation thicknesses.
 - a. "R" = 11 for 3-1/2 inches thick insulation
 - b. "R" = 19 for 6-1/4 inches thick insulation
 3. Foil-Faced, Glass Fiber Board Insulation: Thermal insulation combining glass fibers with thermosetting resin binders and faced on one side with foil-scrim-kraft or foil-scrim-polyethylene vapor retarder to comply with ASTM C612, Type 1A or Type 1A or 1B, and with other requirements indicated below:
 - a. Nominal density of 2.25 lb./cu. ft., thermal resistivity of 4.3 degrees F. by high by sq. ft./BTU by inch at 75 degrees F.
 4. Miscellaneous Insulation: Shall be inorganic (nonasbestos) mineral wool insulation without facing, for the purpose of filling and stuffing openings in walls around pipes, structural components, windows, conduits, expansion joints to eliminate noise transfer and to insulate. Use to seal top of interior walls, except fire rated walls, between masonry and roof deck, where indicated. Use at expansion joints as detailed. Insulation shall have a flame spread rating of 15 or less, and a smoke development rating of 0; per ASTM E84.
 5. All glass fiber insulation types shall be formaldehyde-free. Insulation shall be Johns Manville and meet minimum environmental specifications 1350 with non-detect pollutants for indoor air quality. Other manufacturers must be approved by Architect for comparison.

2.02 AUXILIARY INSULATING MATERIALS

- A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of thickness indicated, securely in position indicated with self-locking washer in place; and complying with the following requirements:
1. Plate: Perforated galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 2. Spindle: Copper-coated low carbon steel, fully annealed, 0.105 inches in diameter, length to suit depth of insulation indicated.
 3. Insulation-Retaining Washers: Self-locking washers formed from 0.016 inch thick galvanized steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches square or in diameter.
 - a. Where spindles will be exposed to human contact after installation, protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap.
 4. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates.
 5. Products: Subject to compliance with requirements, provide one of the following:
 - a. Adhesively attached, spindle type anchors
 1. TACTOO Insul-Hangers; AGM Industries, Inc. Canton, MA
 2. Spindle Type Gemco Hangers; Gemco, Danville, IL
 - b. Insulation - Retaining Washers
 1. RC150; AGM Industries Inc, Canton, MA
 2. R150; Gemco, Danville, IL
 - c. Adhesive
 1. TACTOO Adhesive; AGM Industries, Inc. Canton, MA
 2. Tuff Bond Hanger Adhesive; Gemco, Danville, IL

3.01 INSPECTION:

- A. The Installer must examine the substrate and conditions under which the insulation work is to be performed, and notify the Construction Manager in writing of unsatisfactory conditions. Do not proceed with the insulation work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 INSULATION:

A. General:

- 1. Comply with manufacturer's instructions for the particular conditions of installation in each case. If printed instructions are not available or do not apply to the project conditions, consult the manufacturer's technical representative for specific recommendations before proceeding with the work.
- 2. Extend insulation full thickness as shown over entire area to be insulated. Cut and fit tightly around obstructions, and fill voids with insulation. Remove projections which interfere with placement.
- 3. Apply a single layer of insulation of the required thickness unless otherwise shown or required to make up the total thickness.

B. Perimeter Insulation:

- 1. On vertical surfaces, set units in adhesives applied in accordance with manufacturer's instructions. Use type adhesive recommended by manufacturer of insulation.

C. General Building Insulation:

- 1. Apply insulation units to the substrate by the method indicated, complying with the manufacturer's recommendations. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage, to provide permanent placement and support of units.

- 2. Set vapor barrier faced units with vapor barrier to

warm side of construction, except as otherwise shown.
Do not obstruct ventilation spaces, except for
firestopping.

- a. Tape joints and ruptures in vapor barriers, using adhesive tape of type recommended by insulation manufacturer, and seal each continuous area of insulation to surrounding construction so as to ensure vapor-tight installation of the units.
3. Stuff loose mineral fiber insulation into miscellaneous voids and cavity spaces as indicated. Compact to approximately 40% of normal maximum volume (to a density of approximately 2.5 lbs. per cu. ft.).

END OF SECTION 07200

SECTION 07500 - MEMBRANE ROOFING

The General Conditions, Supplementary General Conditions and General Requirements (Division 1) are a part of all Divisions and all other documents bound herein.

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Single-ply mechanically fastened membrane roofing system
- B. Roof insulation for membrane roofing

1.02 SCOPE OF WORK

- A. Scope (Refer to drawings for specific areas of work at each location)
 - 1. Vacuum and remove loose gravel.
 - 2. Remove all saturated areas and fill resulting void with insulation to match surrounding level/thickness. Areas shown on drawings are approximate. Contractor to provide their own infra-red scan to verify all wet insulation areas.
 - 3. Install 1.5" of polyisocyanurate insulation to cover entire deck. Fasten in accordance with specifications based upon roof deck condition.
 - 4. Contractor shall furnish and install a 40mil **LITE GREY** single-ply membrane roofing system that is fabricated of a weft inserted low-shrink, anti-wicking polyester fabric and has a thermoplastic coating of PVC material laminated to both sides.
 - 5. At all Schools, 4" metal fascia cover with Kynar-coated steel metal cover, as manufactured by Exceptional Metals, Inc. (or approved equal by roof manufacturer). Color to match existing.
 - 6. Install walk pads around all services units and roof hatches and direct path from hatch to each unit.
 - 7. Dispose of all debris in an approved facility in accordance with all local, state and federal regulations.
 - 8. Finished roofing system to be installed in accordance with membrane manufacturers published specifications in order to receive the standard 15-year warranty.

1.03 QUALITY ASSURANCE

- A. Membrane roofing and associated work for a single building shall be subcontracted to a single firm, hereinafter called the "Installer," so there will be undivided responsibility for the work.
 - 1. Installer shall be franchised or otherwise accepted in writing by the roofing materials manufacturer for installation of fully-guaranteed roof in accordance with the requirements.
 - a. Roofing materials manufacturer for membrane roofing system shall be one publishing complete information on the required system and offering to guarantee or bond the completed roofing installation as required.
 - b. Secondary materials shall be obtained from sources acceptable to the manufacturer of the primary membrane roofing system materials.
 - 2. Refer to Section 01400, "Quality Requirements" for information on Owner's option to obtain services of an Authorized Material Manufacturer's Field Representative to assist in quality assurance services.
- B. Membrane roofing system and associated work shall satisfy "Class A" rating as tested, listed and labeled by Underwriters Laboratories and shall conform to UL classified wind uplift resistance - UL1897 FM requirements FM 4470 Class 1, 1-90 windstorm.

1.04 SUBMITTALS

- A. If the Installer wishes to use a manufacturer's detail differing from these Specifications, the Installer shall submit a written request prior to construction for authorization by the Construction Manager and Architect; no changes will be permitted without such written authorization.
- B. The Installer shall submit two (2) copies of the most current edition of specifications and installation instructions from the manufacturer for each major roofing product or system required.

1. The Installer shall indicate by transmittal form that the Installer has received a copy of the manufacturer's installation instructions and recommendations. Data substantiating compliance with such requirements shall also be provided.
 2. Such manufacturer's specifications and installation instructions shall become a part of these Specifications.
- C. Should the Owner require information on reference projects of the Installer, such projects shall be located within fifty miles of the Owner's office. Each project must be at least three years old and must be available for inspection by the Construction Manager and Architect.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Materials shall be delivered in their original, unopened containers, clearly labeled with the manufacturer's name, brand name, and such identifying numbers as are appropriate.
- B. Materials shall be stored neatly in areas acceptable to the Construction Manager and Architect and dispersed so as to minimize fire hazard.
- C. Loads placed on the roof at any point shall not exceed the safe loading for which the roof is designed.

1.06 JOB CONDITIONS

- A. All substrates to be treated shall be smooth, visually dry, and free of dirt, debris and foreign matter before any treatment is initiated.
 1. Proceed with roofing work only after substrate construction and penetrating work have been completed.
 2. Proceed with roofing work only when weather conditions will permit the work to proceed in accordance with the manufacturer's recommended limitations.

- B. A Pre-roofing Conference will be held at the project site well in advance of the time scheduled for roofing work, to review requirements for the work and conditions which could possibly interfere with successful performance of the work. Attendance will be required for every party concerned with the work or designated to coordinate it or to protect it thereafter.
- C. Equipment shall be located on the ground, at a safe distance from the buildings, in a location acceptable to the Construction Manager.
- D. Competent operators shall be in attendance at all times when equipment is in use. The Installer shall be responsible for exercising all reasonable precautions to avoid fires, and shall provide suitable fire extinguishers, readily accessible.
- E. Installation of the roofing system is not restricted because of cold temperatures. Follow precautions as stated for storage, and expose only enough cement and adhesive to be used within a four (4) hour period.
- F. Exercise precautions in use of cements and bonding adhesives as follows:
 - 1. Such materials contain petroleum distillates; avoid breathing vapors.
 - 2. Such materials are extremely flammable; do not use near fire or flame.
- G. Waste products (petroleum, grease, oil, and solvents - vegetable or mineral oil and animal fat) and direct contact with steam venting should not be allowed to come in contact with the roofing system.

1.07 GUARANTEE/WARRANTY

- A. The single-ply roofing system manufacturer's Warranty shall consist of a standard limited warranty for a fifteen (15) year total system warranty of water-tight integrity of the system. Upon completion of the roofing installation, an inspection shall be made by a representative of the manufacturer to ascertain that the roofing system has been installed according to the manufacturer's specification and details. The Warranty shall be issued upon approval of the installation by the manufacturer.

PART TWO - PRODUCTS

2.01 STANDARD OF MANUFACTURE

A. To establish construction standards and functional and aesthetic requirements to be met in the work of this Section the Drawings and Specifications are based upon a certain single ply membrane roofing system.

1. Duro-Last Roofing Inc.
2. Firestone
3. GAF Roofing Systems
4. Carlisle Syn Tec Systems
5. Johns Manville
6. Fiber Tite Roofing System
7. Other as approved by Architect

2.02 THERMOPLASTIC MEMBRANE ROOFING

A. General

1. Scope: Contractor shall furnish and install a 40 mil single-ply membrane roofing system that is fabricated of a weft inserted low-shrink, anti-wicking polyester fabric and has a thermoplastic coating of co-polymer alloy (CPA) material laminated to both sides.

B. Warranty

1. Provide manufacturer's standard written 15 year limited warranty at no additional charge. Upon warranty inspection and acceptance of the roof, the warranty shall be turned over to the Owner.
2. Warranty shall be no-dollar limit type and provide for completion of repairs, replacement of membrane or total replacement of the "roofing system" at the current material and labor prices throughout the life of the warranty.
3. Warranty shall contain no exclusions for ponded water, biological growth, incidental or consequential damages.

C. Weight Requirements

1. The total weight of the installed roofing system including all accessories, i.e., screws, plates, 2-way breather vents, etc., shall not exceed 27 pounds per square.

D. Submittals

1. Written confirmation from roof manufacturer that the installer is an authorized Dealer/Contractor.
2. Shop drawing showing the layout of the prefabricated roofing panels and tapered roof insulation areas. Show all slopes, thicknesses, perimeter equipment curb, roof sump and all stack conditions including the following:
 - a. Roofing membrane with dielectrically welded seams
 - b. Pre-manufactured parapet flashings
 - c. Pre-manufactured pipe flashing
 - d. Urethane sealant
 - e. P.V.C. weldable drip-edge, gravel/water stop, termination bar
 - f. Breathable 2-way vents
 - g. Self-leveling pourable sealer
 - h. Maintenance & repair instructions
3. 6" long samples of the following:
 - a. Gravel/water stop
 - b. Drip edge
 - c. Termination Bar
 - d. Sample of membrane
 - e. Mechanical fasteners
 - f. Lap splice sample (factory & field)
 - g. Roofing insulation
 - h. Walkway pad

E. Product Delivery, Storage & Handling Procedures

1. Follow roof manufacturer's instructions, cautions, warnings and procedures.
2. Roofing system shall not be applied when weather conditions are not within the range acceptable under roof manufacturer's recommendations.

2.03 PRODUCT

A. Roof Membrane

1. Membrane components to be products of the single manufacturer.
2. A special formulated, permanent, thermoplastic alloy, bonded to a high tenacity, low shrinkage weft inserted polyester fabric with resistance to ultraviolet rays, microorganisms and impervious to most caustic chemicals, animal fats, greases and oils typically found on a restaurant roof.
3. Membrane shall be factory dielectrically welded into prefabricated sheets up to 2,500 square feet or as determined by job condition.
4. The new roofing shall be a prefabricated mechanically fastened installation of single-ply reinforced co-polymer alloy (CPA) membrane, 40 mils thick.
5. Fire resistance of CPA roofing system shall meet UL Class A. All packaging of membrane and insulation shall be UL Class A label.
6. Membrane color shall be Lite Grey.
7. All membrane components, including pipe and curb flashings must be factory prefabricated from the same fabric reinforced material used for the deck membrane.
8. Termination Sealant: Compatible with materials to which membrane is to be bonded, conforming to Federal Specifications TT-598 and TT-S-00230C.
9. Distribution Plates: Factory Mutual approved stress distribution plates formed from a minimum 24 gauge G-90 C.Q. steel with a galvalume coating for insulation attachment, or 20 gauge G-90-C.Q. steel with galvalume coating or high strength polyblend for membrane attachment.
10. Water Cut-Off Mastic: Compatible with materials with which it is used and furnished by the membrane manufacturer.
11. Pitch Pocket Sealant: Shall be a single component, self-leveling silicone sealant.
12. Fasteners: Compatible with roof deck as furnished by the membrane manufacturer. The FM approved fastener is inserted through the hole in the distribution plate and properly secured to the roof deck.
13. Breather Vents: Two-way vents with factory-attached skirt shall be installed at a density of one per 1000 square feet of roof deck area.

14. Terminations/Edge Details: Shall be manufactured from rigid exterior vinyl with slotted holes for securement and furnished by membrane manufacturer. All other terminations/edge details must be approved and warranted by roof manufacturer.
15. Walkway Pads: Walkway pads made from the roofing membrane material installed in strict compliance with manufacturer's recommendations. Pads shall be non-skid, maintenance free, and restrained to remain in position. Pad installation minimum configuration is shown on the drawings. Walkway pads shall be a contrasting color to the roof membrane. Owner and/or Owner's representative shall choose from standard color samples.

B. Insulation

1. Board insulation shall be a minimum of 1/2 inch thick, fiberglass, or polyisocyanurate.
2. Extruded polystyrene (EXPS) insulation and expanded polystyrene (EPS) shall be installed with a separator sheet and shall meet the following requirements.
 - a. Thickness: 1" minimum
 - b. Density: 1-1/2 pounds per cubic foot
 - c. Absorption by volume: Less than 2.5% as measured by ASTM C2272
3. If re-roofing with no tear-off required, the minimum underlayment shall be
 - a. 3/8 inch thick extruded polystyrene with approved polyethylene or polypropylene facer.
 - b. 1/2 inch thick expanded polystyrene with approved polyethylene or polypropylene facer.

C. Tapered Crickets

Crickets shall be placed at all curbs to provide positive drainage around them and shall be formed of tapered material having the same requirements and characteristics as listed in the preceding paragraph.

D. Roofing Nails

Nails shall be galvanized "Stronghold" type: (for use on parapet walls, wood nailers)

E. Nailers & Blocking

1. Where required, nailers and wood blocking shall be S4S 1500 fc construction grade Douglas fir conforming to standard 15 grading and dressing rules of the West Coast Lumber Inspection Bureau, or other species of wood of equal strength. All lumber shall be grade marked at the mill.

2. All specified treated lumber shall be pressure treated by a method approved by the roofing membrane manufacturer: "Wolmanized" or "Osiose K-33" are acceptable.
3. Nailers shall be securely anchored to the deck to resist the minimum force required in Loss Prevention Data Sheet I-49, "Perimeter Flashing," Factory Mutual Systems, June, 1985. The thickness of the nailer shall be such that the top of the nailer is flush with the surface to which the membrane is to be applied.

F. Accessories

Primary accessories shall be factory prefabricated or manufactured by or under the direction of roof manufacturer.

PART THREE - EXECUTION

3.01 SUBSTRATE INSPECTION

- A. Inspect all surfaces to receive roofing for any condition that will adversely affect execution, performance, or quality of work.
- B. All roof surfaces and all slope surfaces to drains and outlets shall be checked and approved by the roofing contractor prior to the start of the roofing work.
- C. Install roofing material only under satisfactory conditions as specified by membrane manufacturer.
- D. General Requirements:
 1. Precautions
 - a. Do not lay out or expose any insulation on the deck that can not be covered by membrane on the same day.
 - b. In making all field heat welds, make sure all edges are clean and free of tar, mastic or other foreign items.
 - c. Do not expose membrane and accessories to a constant temperature in excess of 110 degrees Fahrenheit.
 - d. Sealants and adhesives should be applied according to roof manufacturer's specifications.
 - e. Start securing the membrane at the highest point and work towards the drains.

2. Protection of Roofing Surfaces
 - a. Storing, wheeling or tucking directly on roof insulation or membrane surface is not recommended. Smooth, clean plywood or plank walkways, runways and platforms shall be provided as necessary.

E. Insulation Installation

1. The roof insulation shall be installed with approved fasteners and distribution plates placed according to the manufacturer's most recent published specifications to achieve UL 1897FM requirements, FM 4470 Class I-90 wind storm and for issuance of the warranty.

F. Membrane Installation

1. Install the roofing system to roof manufacturer's most recent published specifications.
2. Flash all penetrations (pipes, conduits, etc.) in the membrane. Factory prefabricated pipe seals shall be used to flash all pipes where installation is possible. Where factory prefabricated pipe seals cannot be installed, field fabricated pipe seals may be used if approved. All flashings and termination shall be done in accordance with approved manufacturer's details.

G. Walkway Pads

1. Roof walkway pads shall be product manufactured by or acceptable to manufacturer of roofing materials for use in warranted membrane roofing system specified.
 - a. Provide 30" x 60" square pads where indicated on the drawings.
2. Pads shall be spaced apart minimum 1 inch and maximum 3 inches from each other.

END OF SECTION 07500

SECTION 07600 - FLASHING AND SHEET METAL

PART ONE - GENERAL

1.01 WORK INCLUDED

- A. Counterflashings for membrane roofing system
- B. Copings for membrane system

1.02 RELATED WORK

- A. Section 06100 - Carpentry
- B. Section 07500 - Membrane Roofing
- C. Section 07610 - Standing Seam Metal Roofing System

1.03 QUALITY ASSURANCE

- A. Requirements of current edition of "Architectural Sheet Metal Manual" published by Sheet Metal and Air Conditioning Contractors' National Association, Inc. ("SMACNA") shall form a part of these Specifications except as otherwise specified or shown on Drawings.

1.04 SUBMITTALS

- A. The Contractor shall submit a list of materials and description of installation methods proposed for this work for review by the Construction Manager and Architect.
- B. Shop drawings and color samples will be required for gravel stops in accordance with Spec Section 01330 Submittals. Fabrication of the work shall not commence until shop drawings bearing Subcontractor's final corrections have been reviewed and returned by the Owner's Representative.

1.05 WARRANTY/GUARANTEE

- A. The Contractor shall furnish a written Guarantee warranting all sheet metal including metal flashing to remain serviceable and in good condition for two (2) years from date of final acceptance of the building and to promptly repair and place in good condition without additional expense to the Owner any sheet metal and metal flashings which become defective within that period.

- B. Manufacturer's Standard Warranty: Warranted materials shall be free of defects in material and workmanship for five years after shipment. If, after inspection, the manufacturer agrees that materials are defective, the manufacturer shall, at their option, repair or replace them. For decorative finish warranty, consult manufacturer.
- C. Special Performance/20-Year Warranty: In addition to standard warranty listed above, manufacturer shall guarantee that a standard size roof edge system, when installed per manufacturer's instructions, will not blow off or cause membrane failure, even in wind conditions up to 110 mph, or the manufacturer shall replace or repair their materials.

PART TWO - PRODUCTS

2.01 MATERIALS

- A. Parapet coping for membrane roofing system shall be "Perma Tite Coping" as manufactured by Metal Era, Inc., Waukesha, WI. Coping shall be .050 aluminum (with welded miters) with Kynar 500 coating. Finish shall be spray applied Kynar 500 in color selected by Owners' representative from manufacturers standard color range. Support and cleat shall be 20 gauge pre-punched galvanized cleat with stainless steel spring mechanically locked to cleat normally 12" wide at 4'-0" o.c. mechanically fastened as indicated and detailed fasteners shall provide a minimum pull out resistance of 240# per substrate application. No exposed fasteners shall be permitted. Fasteners shall be electrolytically compatible. A concealed joint cover shall be installed on the face.
 - 1. Alternate Manufacturer: Permasnap with coping meeting above criteria by WP Hickman with 20 year excel warranty.
- B. Exposed and concealed metal flashings, including metal counterflashings at parapets and metal drip edge for concealed fabric flashing shall be of soft stainless steel cold rolled sheet or strip of Type 302/304 alloy having a 2-D dull fully annealed finish, which shall have at least its exposed portions painted after fabrication in a color to match adjoining metal work.

1. Counterflashing at parapets shall be two-piece type, with flashing of at least 20 gauge stainless steel having a receiver of at least 20 gauge stainless steel.
2. Metal drip flashing shall be placed over concealed flashing at lintels and all other metal flashings shall be of at least 18 gauge stainless steel.

PART THREE - EXECUTION

3.01 INSTALLATION

- A. Metal coping system shall be installed in accord with manufacturer's published instructions.
- B. Provide counterflashing for all base flashings of the membrane roofing system. Turn metal down at least four inches over upper portion of such base flashings. Provide flashings at roof curbs and where else required to make roofing and sheet metal watertight.
- C. Provide and install drip flashings for fabric concealed flashing over steel lintels at heads of openings, doors, and windows, and where else shown in exterior walls.
- D. Insulate sheet metal from other materials using roofing felt, roofer's mastic, bituminous paint or other materials acceptable to Owner's Representative.

END OF SECTION 07600

SECTION 07610 - STANDING SEAM METAL ROOFING SYSTEM

PART ONE - GENERAL

1.01 SECTION INCLUDES:

- A. Preformed, prefinished metal roofing and flashings.
- B. Miscellaneous trim, flashing, closures, drip flashing, and accessories.
- C. Sealant
- D. Fastening devices.

1.02 RELATED SECTIONS

- A. Section 06100: Carpentry.
- B. Section 07920: Sealants.

1.03 REFERENCES

- A. American Iron & Steel Institute (AISI) Specification for the Design of Cold formed Steel Structural Members.
- B. ASTM A-525 Steel Sheet, Zinc-Coated (Galvanized)
- C. ASTM E-1680
- D. ASTM E-1646
- E. ASTM E-1592
- F. Spec Data Sheet - Aluminum Zinc Alloy Coated Steel (Galvalume) Sheet Metal by Bethlehem Corp.
- G. SMACNA - Architectural Sheet Metal Manual.
- H. Building Materials Directory - Underwriter's Laboratories, Test Procedure 580.

1.04 ASSEMBLY DESCRIPTION

- A. The roofing assembly includes preformed sheet metal panels, related accessories, valleys, hips, ridges, eaves, corners, rakes, miscellaneous flashing and attaching devices.

1.05 SUBMITTALS

- A. Submit detailed drawings showing layout of panels, anchoring details, joint details, trim, flashing, and accessories. Show details of weatherproofing, terminations, and penetrations of metal work.
- B. Submit a sample of each type of roof panel, complete with factory finish.
- C. Submit results indicating compliance with minimum requirements of the following performance tests:
 - 1. Air Infiltration ASTM E 1680
 - 2. Water Infiltration ASTM E 1646
 - 3. Wind Uplift - U.L.90
- D. Submit calculations with registered engineer seal, verifying roof panel and attachment method resists wind pressures imposed on it pursuant to applicable building codes.

1.06 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in Architectural Sheet Metal Products with ten (10) years minimum experience.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Upon receipt of panels and other materials, installer shall examine the shipment for damage and completeness.
- B. Panels should be stored in a clean, dry place. One end should be elevated to allow moisture to run off.
- C. Panels with strippable film must not be stored in the open, exposed to the sun.
- D. Stack all materials to prevent damage and to allow for adequate ventilation.

1.08 WARRANTY

- A. Paint finish shall have a twenty year guarantee against cracking, peeling and fade (not to exceed 5 N.B.S. units).

- B. Galvalume material shall have a twenty year guarantee against failure due to corrosion, rupture or perforation.
- C. Applicator shall furnish guarantee covering watertightness of the roofing system for the period of two (2) years from the date of substantial completion.

PART 2 PRODUCT

2.01 ACCEPTABLE MANUFACTURERS

- A. Berridge Manufacturing Company, Houston, Texas.
- B. No Substitutions.

2.02 SHEET MATERIALS

- A. Prefinished Metal shall be Hot-Dipped Galvanized - ASTM A446-85 Grade C G90 Coating A525-86 24 Gauge core steel or prefinished galvalume-ASTM 792-86 AZ-55.
- B. Unfinished Metal shall be Grade C Galvalume ASTM 792-86, AZ 55, "Satin Finish".
- C. Finish shall be full strength Kynar 500 Fluoropolymer coating, applied by the manufacturer on a continuous coil coating line, with a top side dry film thickness of 0.70 to 0.90 mil over 0.25 to 0.35 mil prime coat, to provide a total dry film thickness of 0.95 to 1.25 mil. Bottom side shall be coated with primer with a dry film thickness of 0.25 mil. Finish shall conform to all tests for adhesion, flexibility, and longevity as specified by the Kynar 500 finish supplier.
- D. Strippable film shall be applied to the top side of the painted coil to protect the finish during fabrication, shipping and field handling. This strippable film must be removed immediately before installation.

2.03 ACCESSORY MATERIALS

- A. Fasteners: Stainless Steel with washers where required.

- B. Sealant: Sealant must be a ultra low modulus, high performance, one-part, moisture curing silicone joint sealant. (do not use a clear sealant or sealants which release a solvent or acid during curing).

Sealant must be resistant to environmental conditions such as wind loading, wind driven rain, snow, sleet, acid rain, ozone, ultraviolet light and extreme temperature variations.

Features must include joint movement capabilities of +100% & -50% ASTM C-719, capable of taking expansion, compression, transverse and longitudinal movement, service temperature range -65°F to 300°F (-54°C to 149°C), Flow, sag or slump: ASTM C-639; Nil, Hardness (Shore A): ASTM C-661; 15, Tensile strength at maximum elongation: ASTM D-412; 200 psi, Tensile strength at 100% elongation: ASTM D-412; 35 psi, Tear strength, (die "C"); ASTM D-624; 40 pli, Peel strength (Aluminum, Glass, Concrete): ASTM C-794; 30 pli

- C. Vinyl Weatherseal Insert.

2.04 FABRICATION

- A. All exposed adjacent flashing shall be of the same material and finish as the roof panels.
- B. Hem all exposed edges of flashing on underside, 1/2 inch.

2.05 PREFORMED METAL PANELS, STANDING SEAM METAL ROOF:

- A. BERRIDGE TEE-PANEL - STANDING SEAM ROOF PANEL

1. Panels shall have 12-3/4" on center seam spacing with a seam height of 1".
2. Panels shall be site-formed with the Berridge Model SS-14 Portable Roll Former in continuous lengths from eave to ridge or factory fabricated to 40' max.
3. Snap-on seams shall be 1" in height and shall contain the Berridge factory-applied Extruded Vinyl Weather Seal Insert (Patent No. 4641475) to prevent siphoning of moisture through the standing seam.
4. Concealed anchor clips shall be spaced as required to meet uplift loads (provide 12" on center maximum).

5. Panel assembly shall bear Underwriters Laboratories Label UL90, pursuant to Construction Number 296 and applicable Fire Ratings.
6. Certification shall be submitted based on independent testing laboratory, indicating no measurable water penetration or air leakage beyond allowable tolerances through the system when tested in accordance with ASTM E-331-86 and E-283-84.
7. Color: TBD from manufacturer's standard colors.

B. DRIP EDGE FLASHING:

1. Provide drip edge flashing along all eaves, gables and fascias, preformed of .032 inch aluminum.
2. Color finish to be selected from manufacturer's standard colors.

2.06 UNDERLAYMENT:

A. ICE & WATER SHIELD:

1. Provide ice and water shield membrane over entire roof sheathing surface under new metal roofing material.

2.07 SNOW GUARDS:

- A. Provide S-5 ColorGard snow guard rails with ice breaks/snow shoes in 6'-0" lengths above each door location in color to match roof panels. (www.S-5.com). Verify quantities in field.
- B. Snow guards are to clamp to standing seam ribs in accordance with manufacturers installation instructions.
- C. Install snow clip at every panel where a snow guard rail is shown on the drawings. Use 1 clip per panel.

PART 3 EXECUTION

3.01 INSPECTION

A. Substrate:

1. Examine plywood deck to ensure proper attachment to framing.

2. Inspect roof deck to verify deck is clean and smooth, free of depressions, waves or projections, level to $\frac{1}{4}$ " in 20', and properly sloped to eaves.
3. Verify roof openings, curbs, pipes, sleeves, ducts or vents through roof are solidly set, cant strips and reglets in place, and nailing strips located.
4. Verify deck is dry and free of snow or ice. Joints in wood deck to be solidly supported and nailed.

B. Underlayment:

1. Verify ice & water shield membrane has been installed in accordance with manufacturer's instructions.
2. Ensure ice & water shield is installed horizontally, starting at eave to ridge with a 6" minimum overlap and 18" endlaps.
3. Ensure that all nail heads are totally flush with the substrate. Nails shall be galvanized roofing nails.

3.02 INSTALLATION

- A. Comply with manufacturers standard instructions and conform to standards set forth in the Architectural Sheet Metal Manual published by SMACNA, in order to achieve a watertight installation.
- B. Install panels in such a manner that horizontal lines are true and level and vertical lines are plumb.
- C. Install starter and edge trim before installing roof panels.
- D. Remove protective strippable film prior to installation of roof panels.
- E. Attach panels using manufacturer's standard clips and fasteners, spaced in accordance with approved shop drawings.
- F. Install sealants for preformed roofing panels as approved on shop drawings.
- G. Do not allow panels or trim to come into contact with dissimilar materials.
- H. Do not allow traffic on completed roof. If required, provide cushioned walk boards.

- I. Protect installed roof panels and trim from damage caused by adjacent construction until completion of installation.
- J. Remove and replace any panels or components which are damaged beyond successful repair.
- K. Flash watertight around all existing penetrations such as: conduits, vent stacks, pipes, etc.
- L. Remove existing roof vents and provide new in same locations in color to match new metal roofing color. Flash watertight as required.

3.03 CLEANING

- A. Clean any grease, finger marks or stains from the panels per manufacturer's recommendations.
- B. Remove all scrap and construction debris from the site.

3.04 FINAL INSPECTION

- A. Final inspection will be performed in accordance with manufacturer's instructions by an independent firm.

END OF SECTION 07610

SECTION 07840 - FIRESTOPPING

PART I - GENERAL

1.01 RELATED DOCUMENTS:

- A. Attention is directed to Division 0, Bidding and Contract Requirements, and to Division 1, General Requirements, which are hereby made a part of this section.

1.02 DESCRIPTION OF WORK:

- A. Provide labor and materials necessary for complete installation of firestopping materials and systems. Section includes firestopping for the following:
 - 1. Penetrations through fire resistance rated floor and roof construction including both empty openings and openings containing cables, pipes, ducts, conduits, and other penetrating items.
 - 2. Penetrations through fire resistance rated walls and partitions including both empty openings and openings containing cables, pipes, ducts, conduits and other penetrating items.
 - 3. Penetrations through smoke barriers and construction enclosing compartmentalized area involving both empty openings and openings containing penetrating items.
 - 4. Sealant joints in fire resistance rated construction.

1.03 SUBMITTALS:

- A. Product Data: Manufacturer's specifications and technical data for each material including the composition and limitations, documentation of UL or other nationally recognized independent testing laboratories firestop systems to be used and manufacturer's installation instructions.
 - 1. Submit material safety data sheets (MSDS) provided with product delivered to jobsite.

- B. Product certificates signed by manufacturers of firestopping products certifying that their products and installation comply with specified requirements. Certification shall be signed by the Installer.

1.04 QUALITY ASSURANCE:

- A. Conform to applicable governing codes, including local governing authorities, but not limited to the following:
 - 1. NFPA 101 1997 edition and current edition
 - 2. 2009 MBC
- B. Meet requirements of ASTM E814 or UL 1479 tested assemblies that provide a fire rating equal to that of construction being penetrated and other ASTM Standards as applicable for the installation.
 - 1. ASTM E84 "Test Method for Surface Burning Characteristics of Building Materials".
 - 2. ASTM E119 "Test Methods for Fire Tests of Building Construction and Materials".

PARTS 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with through-penetration firestop systems (XHEZ) listed in Volume II of the UL Fire Resistance Directory, provide products by one of the following:
 - 1. Hilti Construction Chemicals, Tulsa, OK
 - 2. Specified Technologies Inc. (STI) Sommerville, NJ
 - 3. 3M Fire Protection Products, St. Paul, MN
 - 4. The Rectorseal Corp., Houston, TX
 - 5. Tremco, Inc. Beachwood, OH

2.02 FIRESTOPPING, GENERAL

- A. Compatibility: Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by firestopping manufacturer based on testing and field experience.

1. All materials shall comply with ASTM E814 or E119 (UL 1429) and shall be manufactured of non-toxic, non-hazardous, asbestos free materials, and unaffected by water or moisture when cured.
 2. Primers: Conform to manufacturer's recommendations for primers required for various substrate and conditions.
 3. Backup materials: Backup materials, supports, and anchoring devices shall be provided as required by UL testing.
- B. Accessories: Provide components for each firestopping system that are needed to install fill materials and to comply with "System Performance Requirements" in Part 1. Use only components specified by the firestopping manufacturer and approved by the qualified testing and inspecting agency for the designated fire resistance rated system. Accessories include but are not limited to the following items:
1. Permanent forming/damming/backing materials must be noncombustible and may include the following:
 - a. Semirefractory fiber (mineral wool) insulation.
 - b. Sealants used in combination with other forming/damming materials to prevent leakage of fill materials in liquid state.
 - c. Joint fillers for joint sealants.
 2. Temporary forming materials.
 3. Substrate primers.
 4. Collars.
 5. Steel sleeves.

2.03 FIRE STOPPING, MATERIALS

- A. Use only firestopping products that have been UL 1479 or ASTM E814 tested for specific fire rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire rating involved for each separate instance.

- B. For penetrations by noncombustible items including steel pipe, copper pipe, rigid steel conduit, and electrical metallic tubing (EMT), the following materials are acceptable:
1. Hilti FAS 601 Elastomeric Firestop Sealant
 2. STI SpecSeal Sealant SSS 100
 3. 3M Fire Barrier CP25
 4. The RectorSeal Corp. Metacaulk 1000, 950, 835, Putty, & Mortar.
 5. Fyre-Sil, Tremco, Inc.
 6. Biofireshield K10 and K2 Mortar, Biostop 500+, Biootherm 100/22200 & Biostop Putty, The RectorSeal Corp.
- C. For penetrations by combustible items (penetrants consumed by high heat and flame) including insulated metal pipe, PVC jacketed, flexible cable or cable bundles and plastic pipe (closed piping systems) the following materials are acceptable:
1. STI Wrap Strip SSW12
 2. Hilti FS One Intumescent Firestop Sealant
 3. 3M Fire Barrier FS-195 Wrap Strip
 4. Metacaulk Wrap Strip, Firestop Collars, Metacaulk 1000, 950 & 835.
 5. Biostop Wrap Strip, Collar, and Biostop 500+.
- D. For large size/complex penetrations made to accommodate cable trays, multiple steel and copper pipes, electrical busways in raceways, the following materials are acceptable:
1. STI SpecSeal lightweight mortar SSM22B or putty
 2. Hilti FS635 Trowelable Firestop Compound
 3. 3M Fire Barrier FS-195 Composite Sheet
 4. Biofireshield K-10 & K2 mortar
 5. Metacaulk Firestop Mortar
- E. For fire-rated construction joints and other gaps with movement, the following materials are acceptable:
1. Hilti FS 601 Elastomeric Firestop Sealant
 2. STI Pensil 300
 3. 3M (Dow Corning Fire Stop Sealant 2000)
 4. Fyre-Sil, Tremco, Inc.
 5. Biofireshield, Biostop 700, Biostop 500+
 6. Metacaulk 1000 & 1100

- F. Provide a firestopping system with an "F" rating as determined by UL 1479 or ASTM E814 which is equal to the time rating of construction being penetrated.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of firestopping. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Cleaning: Clean out openings and joints immediately prior to installing firestopping to comply with recommendations of firestopping manufacturer and the following requirements:
 - 1. Remove all foreign materials from surfaces of opening and joint substrates and from penetrating items that could interfere with adhesion of firestopping.
 - 2. Clean opening and joint substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with firestopping. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form release agent from concrete.

3.03 INSTALLING THROUGH-PENETRATION FIRESTOPS

- A. General: Comply with the manufacturer's installation instructions and drawings pertaining to products and applications indicated.
- B. Install forming/damming materials and other accessories of types required to support fill materials during their application and in the position needed to produce the cross sectional shapes and depths required to achieve fire ratings of designate through-penetration firestop systems. After installing fill materials, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.

- C. Install fill materials for through-penetration firestop systems by proven techniques to produce the following results:
 - 1. Completely fill voids and cavities formed by openings, forming materials, accessories, and penetrating items.
 - 2. Apply materials so they contact and adhere to substrate formed by openings and penetrating items.
 - 3. For fill materials that will remain exposed after completing work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.04 INSTALLING FIRE RESISTIVE JOINT SEALANTS

- A. General: Comply with the manufacturer's installation instructions and drawings pertaining to products and application indicated.

3.05 CLEANING

- A. Clean off excess fill materials and sealant adjacent to openings and joints as work progresses by methods and with cleaning materials approved by manufacturers of firestopping products and of products in which opening and joints occur.

END OF SECTION 07840

SECTION 07910 - JOINT FILLERS AND GASKETS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Attention is directed to Division 0, Bidding and Contract Requirements, and to Division 1, General Requirements, which are hereby made a part of this Section.

1.02 DESCRIPTION OF WORK:

- A. The extent of each type of joint filler and gasket work is indicated on the drawings and by provisions of this section, and is hereby defined to include required fillers and gaskets not specified in other sections of these specifications.
- B. The required applications of joint fillers and gaskets include, but are not necessarily limited to, the following general types and locations:
 - 1. Pavement, curb and sidewalk joint fillers.
 - 2. Isolation and expansion joint fillers in structural concrete.
 - 3. Exterior wall component joint fillers.
 - 4. Floor construction/expansion joint fillers.
 - 5. Joint fillers around penetrations of equipment and services through walls, floors and roofs.

1.03 SUBMITTALS:

A. Product Data:

- 1. Submit manufacturer's specifications, installation instructions and recommendations for each type of material required.

B. Samples:

- 1. Submit three, 12 inches long samples of each joint filler or gasket.

PART 2 - PRODUCTS

2.01 MATERIALS, GENERAL:

- A. Size and Shape: Provide sizes and shapes of units as shown or, if not shown, as recommended by manufacturer for joint size and condition shown. Where joint movement is a factor in a determination of size, consult with Architect to determine nature and magnitude of anticipated joint movements for the temperature and condition of project at time of installation.
- B. Compressibility: Specified hardness and compressibilities are intended to establish requirements for normal or average conditions of installation and use. Where a range of hardness or compressibility is available for a product, comply with manufacturer's recommendations for specific condition of use.
- C. Color: Provide each concealed material in manufacturer's standard color which has best overall performance characteristics for application shown. Provide exposed materials in black, except where another color is indicated.
- D. Compatibility: Before purchase of each filler or gasket material, confirm that it is compatible with substrate, sealants and other materials in joint system.
- E. Adhesives: Pressure sensitive adhesives, compatible with each material in joint system may be applied (at installer's option) to one face of joint fillers and gaskets to facilitate installation and permanent anchorage. Do not allow adhesives to contaminate sealant bond surface (if any) in joint system.

2.02 CONCRETE CONTROL/EXPANSION JOINT FILLERS:

- A. Bituminous and Fiber Joint Filler:
 - 1. Provide resilient and non-extruding type premolded bituminous impregnated fiberboard units complying with ASTM D 1751, FS HH-F-341, Type 1 and AASHO M 213.

2. Provide one of the following products:

- a. Flexcell-Knight-Celotex Corporation
- b. Expansion-Joint Filler; BASF/Sonneborn
- c. FF-14. Asphalt Fiber-Board; Progress Unlimited
- d. Fibre Expansion Joint; W.R. Meadows, Inc.
- e. Conflex Fiber Expansion Control Joint Filler, JD Russell

2.03 CELLULAR/FOAM EXPANSION JOINT FILLERS:

A. Closed-Cell PVC Joint Filler:

1. Provide flexible expanded polyvinyl chloride complying with ASTM D 1667. Grade VE 41 BL (3.0 psi compression deflection); except provide higher compression deflection grades as may be necessary to withstand installation forces.

2. Provide one of the following products:

- a. FF2 PVC: Progress Unlimited, Inc.
- b. Vinyl "U" 1000 Series: Williams Products, Inc.

2.04 GASKETS:

A. Molded Neoprene Gasket:

1. Provide extruded neoprene or EPDM gaskets complying with ASTM D 2000, Designation 2BC 415 to 3BC 620, black (40 to 60 Shore A durometer hardness); of the profile shown or, if not shown, as required by the joint shape, size and movement characteristics to maintain a watertight and airtight seal.

2. Provide products by one of the following manufacturers:

- a. D.S. Brown Company
- b. Hohmann & Barnard, Inc.
- c. Kirkhill Rubber Company
- d. Progress Unlimited, Inc.
- e. JD Russell
- f. Williams Products, Inc.

2.05 MISCELLANEOUS MATERIALS:

A. Oakum Joint Filler:

1. Provide untreated hemp or jute fiber rope, free of oil, tar and other compounds which might stain surfaces, contaminate joint walls or not be compatible with sealants.

B. Fire-Resistant Joint Filler:

1. Glass fiber or other inorganic non-combustible fiber formed with minimum of binder into resilient joint filler strips or blankets of sizes and shapes indicated, recommended by manufacturer specifically for increasing fire resistance or endurance of joint systems of type indicated, for service temperatures up to 2300 degrees F, 80% (min.) recovery 50% compression.

PART 3 - EXECUTION

3.01 INSPECTION:

- A. Installer must examine joint surfaces of units to receive fillers or gaskets and conditions under which the work is to be performed and notify the Construction Manager, in writing, of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 INSTALLATION:

- A. Comply with manufacturer's instructions and recommendations for installation of each type of joint filler or gasket required, unless more stringent requirements are shown or specified.
- B. Set units at proper depth of position in joint to coordinate with other work, including installation of bond breakers, backer rods, and sealants. Do not leave voids or gaps between ends of joint filler units.

- C. Recess exposed edges or faces of gaskets and exposed joint filler slightly behind adjoining surfaces, unless otherwise shown, so that compressed units will not protrude from joints.
- D. Bond ends of gaskets together with adhesive or by means as recommended by manufacturer to ensure continuous watertight and airtight performance. Miter-cut and bond ends at corners except where molded corner units are provided.

END OF SECTION 07910

SECTION 07920 - SEALANTS AND CAULKING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Attention is directed to Division 0, Bidding and Contract Requirements, and to Division 1, General Requirements, which are hereby made a part of this Section.

1.02 DESCRIPTION OF WORK:

- A. The extent of each type of sealant and caulking work is indicated on the drawings, and by provisions of this section.
- B. The required applications of sealants and caulking include, but are not necessarily limited to, the following general locations:
 - 1. Flashing reglets and retainers.
 - 2. Exterior wall joints.
 - 3. Masonry control joints, exterior and interior.
 - 4. Interior sound-sealed and air-sealed joints.
 - 5. Flooring joints.
 - 6. Isolation joints, between structure and other elements.
 - 7. Paving and sidewalk joints.
 - 8. Joints at penetrations of walls, decks and floors by piping and other services and equipment.
 - 9. Joints between items of equipment and other construction.
 - 10. Joints between dissimilar materials.

1.03 QUALITY ASSURANCE:

- A. Manufacturers: Firms with not less than 5 years of successful experience in production of types of sealants and caulking compounds required for this project.
 - 1. Obtain elastomeric sealants from a manufacturer which will, upon request, send a qualified technical representative to the project site for purpose of advising installer on proper procedures for use of products.

- B. Installer: A firm with a minimum of 5 years of successful experience in application of types of materials required.

1.04 SUBMITTALS:

A. Product Data:

- 1. Submit manufacturer's specifications, recommendations and installation and instructions for each type of sealant, caulking compound and associated miscellaneous material required.

B. Samples:

- 1. Submit three, 12" long samples of each color required (except black) for each type of sealant and caulking compound exposed to view. Install sample between two strips of material similar to or representative of typical surfaces where compound will be used, held apart to represent typical joint widths.

1.05 JOB CONDITIONS:

- A. Pre-Installation Meeting: At Construction Manager's direction, installer, sealant manufacturer's technical representative, and other trades involved in coordination with sealant work shall meet with Construction Manager at project site to review procedures and time schedule proposed for installation of sealants in coordination with other work. Review each major sealant application required on project.

- B. Weather Conditions: Do not proceed with installation of sealants under adverse weather conditions, or when temperatures are below or above manufacturer's recommended temperature range for installation. Proceed with the work only when forecasted weather conditions are favorable for proper cure and development of high early bond strength. Where joint width is affected by ambient temperature variations, install elastomeric sealants only when temperatures are in lower third of the manufacturer's recommended installation temperature range, so that sealant will not be subjected to excessive elongation and bond stress at subsequent low temperatures. Coordinate time schedule with Construction Manager to avoid delay of project.

- C. Statement of Non-Compliance: Where it is necessary to proceed with installation of sealants or caulking compound under conditions which do not fully comply with requirements (because of time schedule or other reasons which the Construction Manager determines to be crucial to project), prepare written statement for Owner's record (with copy to Architect) indicating the nature of non-compliance, reasons for proceeding, precautionary measures taken to ensure best possible work, and names of individuals concurring with decision to proceed with installation.

1.06 SPECIAL PROJECT WARRANTY (GUARANTEE):

- A. Sealant Warranty: Provide written warranty, signed by contractor and installer, agreeing to, within warranty period of 10 years after date of substantial completion, replace/repair defective materials and workmanship defined to include: Instances of significant leakage of water or air; failures in joint adhesion, material cohesion, abrasion resistance, strain resistance or general durability; failure to perform as required, and the general appearance of deterioration in any other manner not clearly specified in manufacturer's published product literature as an inherent characteristic of the sealant material. Warranty includes responsibility for removal and replacement of other work (if any) which conceals or obstructs the replacement of sealants.

PART 2 - PRODUCTS

2.01 MATERIALS, GENERAL:

- A. Colors: Provide black or other natural color where no other standard or custom color is available. Where material is not exposed to view, provide manufacturer's standard color which has best overall performance characteristics for application shown.
1. Provide manufacturer's standard colors as selected by Architect from manufacturer's standard colors.

- B. Hardnesses shown and specified are intended to indicate general range necessary for overall performance. Consult manufacturer's technical representative to determine actual hardness recommended for conditions of installation and use. Upon request, Architect will furnish information concerning anticipated joint movement related to actual joint width and installation temperature. Except as otherwise indicated or recommended, provide compounds within the following range of hardness (Shore A, fully cured, at 75 degrees F.).
1. 5 to 20 for high percentage of movement and minimum exposure to weather and abrasion (including no exposure to vandalism).
 2. 15 to 35 for moderate percentage of movement and moderate exposure to weather and abrasion.
 3. 30 to 60 for low percentage of movement and maximum exposure to weather and abrasion (including foot traffic on horizontal joints).
- C. Modulus of Elasticity: For joints subjected to movement, either thermal expansion or dynamic movement, select sealants from among available variations which have lowest modulus of elasticity which is consistent with exposure to abrasion or vandalism. For horizontal joints subject to traffic, select sealants with high modulus of elasticity as required to withstand indentation by stiletto heels. Comply with manufacturer's recommendations where no other requirements are indicated.
- D. Compatibility: Before selection and purchase of each specified sealant, investigate its compatibility with joint surfaces, joint fillers and other materials in joint system. Provide only materials (manufacturer's recommended variation of specified materials) which are known to be fully compatible with actual installation conditions as shown by manufacturer's published data or certification.

2.02 SEALANTS:

- A. One Part Elastomeric Sealant (Silicone)
 - 1. One component elastomeric sealant, complying with ASTM C 920, Class 25, Type NS (nonsag), unless Type S (self-leveling) recommended by manufacturer for the application shown.
 - a. Acceptable Standard
 - 1. "Pecora 864 Architectural Silicone Sealant; Pecora Corp.
 - 2. Dow Corning 791; Dow Corning Corp.
 - 3. Silpruf; General Electric
 - 4. Omniseal; Sonneborn Building Products, Inc.
 - 5. Spectrem 2; Tremco Mfg. Co.
 - 2. One-Component mildew resistant silicone sealant: (Around countertops and backsplashes and other wet interior locations).
 - a. Acceptable Standard
 - 1. Rhodorsil 6B white; Rhone-Poulenc Inc.
 - 2. Dow Corning 786; Dow Corning Corp.
 - 3. Sanitary 1700; General Electric
 - 3. One Component high movement joints (+100/-50): Where locations of high movement are indicated.
 - a. Dow Corning 790; Dow Corning Corp.,
 - b. Spectrem 1; Tremco
- B. Elastomeric Sealant (Polyurethane)
 - 1. One component polyurethane sealant, complying with ASTM C 920, Type S, Grade NS, Class 25 (nonsag).
 - a. Acceptable Standard
 - 1. Sonolastic NP 1; Sonneborn Building Products Inc.
 - 2. Dymonic; Tremco Mfg. Co.
 - 3. Dynatrol I; Pecora Corp.
 - 4. Vulkem 921; Mameco
 - 5. CS 2130; Hilti
 - 6. Sikaflex 1A; Sika Corp.
 - 7. Sikaflex 15LM; Sika Corp.

2. Two Component polyurethane sealant, complying with ASTM C 920, Type M, Grade NS, Class 25 (nonsag).
 - a. Acceptable Standard
 1. Sonolastic NP 2; Sonneborn Building Products Inc.
 2. Dymeric; Tremco Mfg. Co.
 3. Dynatrol II; Pecora Corp.
 4. Vulkem 922; Mameco
 5. Sikaflex LCNSEZ; Sika Corp.

- C. One-part self-leveling polyurethane sealant (for traffic areas).
 1. One Component polyurethane self-leveling sealant, complying with ASTM C 920, Type S, Grade P, Class 25.
 - a. Acceptable Standard
 1. Sonolastic SL 1; Sonneborn Building Products Inc.
 2. NR-201 Urexpan; Pecora Corp.
 3. Vulkem 45; Mameco
 4. Sikaflex 1CSL; Sika Corp.

 2. Two-component polyurethane self-leveling sealant, complying with ASTM C 920, Type M, Grade P, Class 25.
 - a. Acceptable Standard
 1. Sonolastic SL 2; Sonneborn Building Products Inc.
 2. NR-200 Urexpan; Pecora Corp.
 3. Vulkem 245; Mameco
 4. THC900/THC901; Tremco
 5. Sikaflex

- D. Security Sealant (Polyurethane)
 1. One component or two component polyurethane sealant, complying with ASTM C 920, Grade NS, Class 12.5, with a Shore A Hardness of 55.
 - a. Acceptable Standard
 1. Dynaflex; Pecora Corp.
 2. Ultra; Sonneborn Building Products, Inc.

2.04 CAULKING COMPOUNDS:

A. Caulking Compounds: (Acrylic Latex Sealant)

1. Latex rubber modified, acrylic emulsion polymer sealant compound; manufacturer's standard, one part, nonsag, mildew resistant, acrylic emulsion sealant complying with ASTM C 834, formulated to be paintable and recommended for exposed applications on interior locations involving joint movement of not more than plus or minus 5 percent.
2. Acceptable Standard
 - a. Sonolac, Sonneborn Building Products Inc.
 - b. Acrylic Latex Caulk 834, Tremco Inc.
 - c. Acrylic Latex Caulk with Silicone, DAP
 - d. AC-20, Pecora Corp.

2.05 MISCELLANEOUS MATERIALS:

- A. Joint Cleaner: Provide type of joint cleaning compound recommended by sealant or caulking compound manufacturer, for joint surfaces to be cleaned.
- B. Joint Primer/Sealer: Provide type of joint primer/sealer recommended by sealant manufacturer, for joint surfaces to be primed or sealed.
- C. Bond Breaker Tape: Polyethylene tape or other plastic tape as recommended by sealant manufacturer, to be applied to sealant-contact surfaces where bond to substrate or joint filler must be avoided for proper performance of sealant. Provide self-adhesive tape where applicable.
- D. Sealant Backer Rod: Compressible rod stock polyethylene foam, polyethylene jacketed polyurethane foam butyl rubber foam, neoprene foam or other flexible, permanent, durable non-absorptive material as recommended for compatibility with sealant by the sealant manufacturer.
- E. Provide size and shape of rod which will control joint depth for sealant placement, break bond of sealant at bottom of joint, form optimum shape of sealant bead on back side, and provide a highly compressible backer to minimize possibility of sealant extrusion when joint is compressed.

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. The installer must examine joint surfaces, backing and anchorage of units forming sealant rabbet and condition under which sealant work is to be performed and notify the Construction Manager in writing of conditions detrimental to proper completion of the work and performance by sealants. Do not proceed with sealant work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 SELECTION OF MATERIAL

- A. Caulking compounds shall be used for interior nonmoving joints and at locations indicated.
- B. One component elastomeric silicone sealants shall be used at exterior and interior joints where thermal or dynamic movement is anticipated including, but not limited to, the following locations:
 - 1. Metal to metal joints.
 - 2. Sheet metal flashing, coping, preformed metal caps, fascias, extenders, trim, and panels.
- C. One or two component elastomeric polyurethane sealants shall be used at exterior and interior joints where weatherproofing or waterproofing is required and at exterior joints between dissimilar materials including, but not limited to, the following locations:
 - 1. Expansion and control joints.
 - 2. Exterior side of hollow metal frames to adjacent materials.
 - 3. Exterior side of aluminum frames to adjacent dissimilar materials.
 - 4. Lintels and shelf angles to masonry construction.
 - 5. Louvers to adjacent construction.
 - 6. Vertical interior expansion joints and horizontal interior and exterior control joints and expansion joints in the building.
 - 7. Joints in concrete site improvements (sidewalks, ramps, retaining walls) and the joint between the concrete slabs and dissimilar materials.
 - 8. Sealant in pipe sleeves where materials must perforate the floor slab.

9. Perimeter of floor slabs or concrete curbs which abut vertical surfaces.
 10. Exterior joints between dissimilar materials where the joining of the two surfaces leaves a gap between the meeting materials or components as may be dictated by the various methods of construction to make watertight.
 11. Exterior locations which are noted "caulked" or "sealant" and not specifically listed herein or included in the work of other sections of the Specifications.
 12. Interior joints between dissimilar materials where the joining of the 2 surfaces leave a gap between the meeting materials and components.
 13. Exterior insulation and finish system:
 - a. Joints, including actual and false joints in system, at openings and penetrations in the system, and joints where the wall system abuts other materials.
- D. One or two part self-leveling polyurethane sealants shall be used for exterior and interior horizontal joints subject primarily to pedestrian traffic and light and moderate vehicular traffic.
- E. Security sealant shall be used in vertical control joints in the interior side of building.

3.03 JOINT SURFACE PREPARATION:

- A. Clean joint surfaces immediately before installation of sealant or caulking compound. Remove dirt, insecure coatings, moisture and other substances which would interfere with bond of sealant or caulking compound.
- B. For elastomeric sealants, do not proceed with installation of sealant over joint surfaces which have been painted, lacquered, waterproofed or treated with water repellent or other treatment or coating unless a laboratory test for durability (adhesion), in compliance with paragraph 4.3.9. of FS TT-S-00227 has successfully demonstrated that sealant bond is not impaired by coating or treatment. If laboratory test has not been performed or shows bond interference, remove coating or treatment from joint surfaces before installing sealant.

- C. Etch concrete and masonry joint surfaces to remove excess alkalinity, unless sealant manufacturer's printed instructions indicate that alkalinity does not interfere with sealant bond and performance. Etch with 5% solution of muriatic acid; neutralize with dilute ammonia solution, rinse thoroughly with water and allow to dry before sealant installation.
- D. Roughen joint surfaces on vitreous coated and similar non-porous materials, where sealant manufacturer's data indicated lower bond strength than for porous surfaces. Rub with fine abrasive to produce a dull sheen.

3.04 INSTALLATION:

- A. Comply with sealant manufacturer's printed instructions except where more stringent requirements are shown or specified and except where manufacturer's technical representative directs otherwise.
- B. Prime or seal joint surfaces where shown or recommended by sealant manufacturer. Do not allow primer/sealer to spill or migrate onto adjoining surfaces.
- C. Install sealant backer rod for liquid sealants, except where shown to be omitted or recommended to be omitted by sealant manufacturer for the application shown.
- D. Install bond breaker tape where shown and where required by manufacturer's recommendations to ensure that elastomeric sealants will perform properly.
- E. Employ only proven installation techniques, which will ensure that sealants will be deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of joint bond surfaces equally on opposite sides. Except as otherwise indicated, fill sealant rabbet to a slightly concave surface, slightly below adjoining surfaces. Where horizontal joints are between a horizontal surface and a vertical surface, fill joint to form a slight cove, so that joint will not trap moisture and dirt.
- F. Install sealants to depths as shown or if not shown as recommended by sealant manufacturer but within the following general limitations, measured at center (thin) section of bead.

1. For sidewalks, pavement and similar joints sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to a depth equal to 75% of joint width and neither more than 5/8" deep nor less than 3/8" deep.
 2. For normal moving joints sealed with elastomeric sealants, but not subject to traffic, fill joints to a depth equal to 50% of joint width, but neither more than 1/2" deep nor less than 1/4" deep.
 3. For joints sealed with non-elastomeric sealants and caulking compounds, fill joints to a depth in the range of 75% to 125% of joint width.
- G. Spillage: Do not allow sealants or compounds to overflow or spill onto adjoining surfaces or to migrate into voids of adjoining surfaces including exposed aggregate panels and similar rough textures. Use masking tape or other precautionary devices to prevent staining of adjoining surfaces but either primer/sealer or the sealant/caulking compound.
- H. Remove excess and spillage of compounds promptly as the work progresses. Clean adjoining surfaces by whatever means may be necessary to eliminate evidence of spillage without damage to adjoining surfaces or finishes.
- I. Polysulfide Sealant Installation: Comply with standards issued by Thiokol Chemical Corp., except where more stringent requirements have been shown or specified, or have been issued by sealant manufacturer as either requirements or recommendations.

3.04 CURE AND PROTECTION:

- A. Cure sealants and caulking compounds in compliance with manufacturer's instructions and recommendations to obtain high early bond strength, internal cohesive strength and surface durability. Do not cure in a manner which would significantly alter materials modulus of elasticity or other characteristics.

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2015 RENOVATIONS
HIGH SCHOOL RENOVATIONS

151626C

FEBRUARY 1, 2016

- B. Installer shall advise the Construction Manager of procedures required for curing and protection of sealants and caulking compounds during construction period, so that they will be without deterioration or damage (other than normal wear and weathering) at time of Owner's acceptance.

END OF SECTION 07920

SECTION 08112 - HOLLOW METAL WORK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Attention is directed to Division 0, Bidding and Contract Requirements, and to Division 1, General Requirements, which are hereby made a part of this Section.

1.02 DESCRIPTION OF WORK:

- A. The extent of hollow metal work is shown on the drawings and schedules.
- B. This section includes hollow metal doors and pressed steel frames for doors and related openings.
- C. Related Work Specified Elsewhere:
 - 1. Glass and Glazing: Section 08800.
 - 2. Fire Rated Glass: Section 08810

1.03 QUALITY ASSURANCE:

- A. Provide doors and frames complying with Steel Door Institute "Recommended Specifications: Standard Steel Doors and Frames" (SDI-100) and as herein specified.
- B. Fire-rated door assemblies shall be Underwriter Laboratory.: Where fire-rated door assemblies are indicated or required, provide fire-rated door and frame assemblies that comply with NFPA 80 "Standard for Fire Doors and Windows", and have been tested, listed, and labeled in accordance with ASTM E 152 "Standard Methods of Fire Tests for Door Assemblies". All metal labels to be riveted to door and frames mylar labels not acceptable.

1.04 SUBMITTALS:

- A. Product Data: Submit manufacturer's specifications for fabrication and installation, including data substantiating that products comply with requirements.

- B. Shop Drawings: Submit shop drawings for the fabrication and installation of hollow metal work. Include details of each frame type, elevations of door design types, conditions at openings, details of construction, location and installation requirements of finish hardware and reinforcements, and details of joints and connections.
 - 1. Provide a schedule of doors and frames using same reference numbers for details and openings as those on the contract drawings.

1.05 DELIVERY, STORAGE AND HANDLING:

- A. Deliver hollow metal work cartoned or crated to provide protection during transit and job storage.
- B. Inspect hollow metal work upon delivery for damage. Minor damages may be repaired provided the finish items are equal in all respects to new work and acceptable to the Architect; otherwise remove and replace damaged items as directed.
- C. Store doors and frames at the building site under cover. Place units on at least 4" high wood sills or on floors in a manner that will prevent rust and damage. Avoid the use of non-vented plastic or canvas shelters which could create a humidity chamber. If the cardboard wrappers on doors become wet, remove carton immediately. Provide 1/4" spaces between stacked doors to promote air circulation.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Hot-Rolled Steel Sheets and Strips: Commercial quality carbon steel, pickled and oiled, complying with ASTM A 569 and ASTM 568.
- B. Cold-Rolled Steel Sheets: Commercial quality carbon steel, complying with ASTM A 366 and ASTM A 568.
- C. Galvanized Steel Sheets: Zinc-coated carbon steel sheets of commercial quality, complying with ASTM A 526, with ASTM A 525, G90 zinc coating, mill phosphatized.

- D. Supports and Anchors: Fabricate of not less than 16 gage sheet metal. Galvanize after fabrication units to be built into exterior walls, complying with ASTM A 153, Class B.
- E. Inserts, Bolts and Fasteners: Manufacturer's standard units, except hot-dip galvanize items to be built into exterior walls, complying with ASTM A 153, Class C or D as applicable.
- F. Shop-Applied Paint: Rust-inhibitive enamel or paint, either air-drying or baking, suitable as base for specified finish paints on steel surfaces.

2.02 FABRICATION, GENERAL:

- A. Fabricate hollow metal units to be rigid, neat in appearance, and free from defects, warp or buckle. Accurately form metal to required sizes and profiles. Wherever practicable, fit and assemble units in the manufacturer's plant. Clearly identify work that cannot be permanently factory-assembled before shipment to assure proper assembly at the project site. Weld exposed joints continuously; grind, dress, and make smooth, flush, and invisible. Metallic filler to conceal manufacturing defects is not acceptable.
- B. Exposed Fasteners: Unless otherwise indicated, provide countersunk flat Phillips or Jackson heads for exposed screws and bolts.
- C. Finish Hardware Preparation:
 - 1. Prepare hollow metal units to receive mortised and concealed finish hardware, including cutouts, reinforcing, drilling, and tapping in accordance with final Finish Hardware Schedule and templates provided by hardware supplier. Comply with applicable requirements of ANSI A 115 series specifications for door and frame preparation for hardware.
 - 2. Reinforce hollow metal units to receive surface-applied hardware. Drilling and tapping for surface-applied finish hardware may be done at project site.

3. Locate finish hardware as shown on final shop drawings, or if not shown, in accordance with "Recommended Locations for Builder's Hardware", published by Door and Hardware Institute.

D. Shop Painting:

1. Clean, treat and paint exposed surfaces of fabricated hollow metal units, including galvanized surfaces.
2. Clean steel surfaces of mill scale, rust, oil, grease, dirt and other foreign materials before application of paint.
3. Apply pretreatment to cleaned metal surfaces, using cold phosphate solution (SSPC-PT-2), hot phosphate solution (SSPC-PT4) or basic zinc chromate-vinyl butyral solution (SSPC-PT3).
4. Apply shop coat or prime paint within time limits recommended by pretreatment manufacturer. Apply a smooth coat of even consistency to provide a uniform dry film thickness of not less than 2.0 mils.

E. Manufacturer: Provide hollow metal work by one of the following:

1. Ceco Door Products
2. Curries
3. Steelcraft/Div of Ingersol Rand

2.03 DOORS:

A. General:

1. Provide flush design doors, 1-3/4" thick, seamless hollow construction, unless otherwise indicated. Bevel both vertical edges 1/8" in 2".
2. Insulated doors: Interior core of doors to be foamed in place, closed cell, polyurethane foam chemically bonded to door face sheets. Voids in foam will not exceed 1/2" in any direction. Compressive strength of polyurethane to be minimum of 20 PSI. Foam density not less than 1-8 PCF. Polystyrene core doors not acceptable. Doors to have R factor of not less than 14.81 U factor of .068.

B. Exterior Doors:

1. Fabricate exterior doors of 2 outer, galvanized, stretcher-level steel sheets not less than 16 gage. Construct doors with smooth, flush surfaces without visible joints or seams on exposed faces or stile edges except around glazed or louvered panel inserts. Provide weephole openings in the bottom of doors to permit escape of entrapped moisture.
2. Reinforce inside of doors with vertical galvanized sheet steel sections not less than 22 gage. Space vertical reinforcing 6" o.c. and extend full door height. Spot-weld at not more than 5" o.c. to both face sheets.
 - a. Continuous truss-form inner core of 28 gage galvanized sheet steel reinforcing may be provided as inner reinforcement in lieu of above. Spot-weld truss-form reinforcement 3" o.c. vertically and horizontally over entire surface of both sides.
3. Reinforce tops and bottoms of doors with 16 gage horizontal steel channels welded continuously to outer sheets. Close top and bottom edges to provide weather seal as integral part of door construction or by addition or inverted steel channels.

C. Interior Doors:

1. Fabricate interior doors of two outer, cold-rolled, stretcher-leveled steel sheets not less than 16 gage. Construct doors with smooth, flush surfaces, without visible joints or seams on exposed faces or stile edges except around glazed or louvered panel inserts.
2. Reinforce inside of doors with vertical, hot-rolled, not less than 22 gage steel sections. Space vertical reinforcing 6" o.c. and extend full door height. Spot weld at not more than 5" o.c. to both face sheets.
 - a. Continuous truss-form inner core of 28 gage sheet metal reinforcing may be provided as inner reinforcement in lieu of above. Spot-weld truss-form reinforcement 3" o.c. vertically and horizontally over entire surface of both sides.

3. Reinforce tops and bottoms of doors with 16 gage, horizontal steel channels, welded continuously to outer sheets.
- D. Finish Hardware Reinforcement: Reinforce doors for required finish hardware as follows:
1. Hinges: Steel plate 3/16" thick x 1-1/2" wide x 6" longer than hinge, secured by not less than 6 spot-welds.
 2. Mortise Locksets and Dead Bolts: 14 gage steel sheet, secured with not less than two spot-welds.
 3. Cylinder Locks: 12 gage steel sheet, secured with not less than two spot-welds.
 4. Flush Bolts: 12 gage steel sheet, secured with not less than two spot-welds.
 5. Surface-Applied Closers: 12 gage steel sheet, secured with not less than six spot-welds.
 6. Plush Plates and Bars: 16 gage steel sheet (except when through bolts are shown or specified), secured with not less than two spot-welds.
 7. Surface Panic Devices: 14 gage sheet steel (except when through bolts are shown or specified), secured with not less than two spot-welds.

2.04 FRAMES:

- A. Provide hollow metal frames for doors, side-lights, borrowed lights, and other openings of sizes and profiles as indicated.
- B. Fabricate frames of full-welded unit construction with corners mitered, reinforced, continuously welded full depth and width of frame, unless otherwise indicated.
 1. Knock-down type frames are not acceptable.
- C. Form frames of galvanized steel sheets for exterior and either cold or hot-rolled sheet steel for interior.
 1. Gage: Not less than 14, for exterior openings up to and including 4'-0" wide.

2. Gage: Not less than 14, for interior openings up to and including 4'-0" wide.
 3. For openings over 4'-0" wide, increase thickness by at least two standard gages.
- D. Finish Hardware Reinforcement: Reinforce frames for required finish hardware as follows:
1. Hinges and Pivots: Steel plate 3/16" thick x 1-1/2" wide x 6" longer than hinge, secured by not less than six spot-welds.
 2. Strike Plate Clips: Steel plate 3/16" thick x 1-1/2" wide x 3" long.
 3. Surface-Applied Closers: 12 gage steel sheet, secured with not less than six spot-welds.
 4. Concealed Closers: Removable steel access plate, 12 gage internal reinforcement of size and shape required, and enclosing housing to keep closer pocket free of mortar or other materials.
- E. Head Reinforcing: Where installed in masonry, leave vertical mullions in frames open at top for grouting.
- F. Jamb Anchors: Furnish jamb anchors as required to secure frames to adjacent construction, formed of not less than 18 gage galvanized steel.
1. Masonry Construction: Adjustable, flat, corrugated or perforated T-shaped to suit frame size, with leg not less than 2" wide by 10" long. Furnish at least three anchors per jamb up to 7'-6" height; four anchors up to 8'-0" jamb height; one additional anchor for each 24" or fraction thereof over 8'-0" height.
 2. Metal Stud Partitions: Insert type with notched clip to engage metal stud, welded to back of frames. Provide at least four anchors for each jamb for frames up to 7'-6" in height; five anchors up to 8'-0" jamb height; one additional anchor each 24" or fraction thereof over 8'-0" height.

3. In-Place Concrete or Masonry: Anchor frame jambs with minimum 3/8" concealed bolts into expansion shields or inserts at 6" from top and bottom and 26" o.c., unless otherwise shown. Reinforce frames at anchor locations. Apply removable stop to cover anchor bolts unless otherwise indicated.
- G. Floor Anchors: Provide floor anchors for each jamb and mullion which extends to floor, formed of not less than 14 gage galvanized steel sheet as follows:
 1. Monolithic Concrete Slabs: Clip type anchors with two holes to receive fasteners, welded to bottom of jambs and mullions.
- H. Head Anchors: Provide two anchors at head of frames exceeding 42" wide for frames mounted in steel stud walls.
- I. Head Strut Supports: Provide 3/8" x 2" vertical steel struts extending from top of frame at each jamb to supporting construction above, unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction above. Provide adjustable bolted anchorage to frame jamb members.
- J. Structural Reinforcing Members: Provide as part of frame assembly, where indicated at mullions, transoms, or other locations which are to be built into frame.
- K. Head Reinforcing: For frames over 4'-0" wide in masonry wall openings, provide continuous steel channel or angle stiffener not less than 12 gage for full width of opening welded to back of frame at head.
- L. Spreader Bars: Provide removable spreader bar across bottom of frames, tack welded to jambs and mullions.
- M. Rubber Door Silencers: Except on weatherstripped doors, drill stops to receive three silencers on single-door frames and four silencers on double door frames. Install plastic plugs to keep holes clear during construction.
- N. Plaster Guards: Provide 26 gage steel plaster guards or dust cover boxes, welded to frame at back of finish hardware cutouts where mortar or other materials might obstruct hardware installation.

2.05 STOPS AND MOLDINGS:

- A. Provide stops around glazed panels in hollow metal units and in frames to receive doors where indicated.
- B. Form fixed stops integral with frame, unless otherwise indicated.
- C. Provide removable stops and molds where indicated or required, formed of not less than 20 gage steel sheets matching steel on frames. Secure with countersunk machine screws spaced uniformly not more than 12 o.c.. Form corners with butted hairline joints.

PART 3 - EXECUTION

3.01 INSPECTION:

- A. Installer must examine substrate and conditions under which hollow metal work is to be installed and must notify Contractor, in writing, of any conditions detrimental to proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 INSTALLATION:

- A. Install hollow metal units and accessories in accordance with final shop drawings, manufacturer's data, and as herein specified.
- B. Setting Masonry Anchorage Devices:
 - 1. Provide masonry anchorage devices where required for securing hollow metal frames to in-place concrete or masonry construction.
 - 2. Set anchorage devices opposite each anchor location, in accordance with details on final shop drawings and anchorage device manufacturer's instructions. Leave drilled holes rough, not reamed, and free from dust and debris.
 - 3. Floor anchors may be set with powder-actuated fasteners instead of masonry anchorage devices and machine screws, if so indicated on final shop drawings.

C. Placing Frames:

1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After all construction is complete, remove temporary braces and spreaders leaving surfaces smooth and undamaged.
2. Protective Coating: In masonry walls, protect inside (concealed) faces of door frames using fibered asphalt emulsion coating. Apply approximately 1/8" thick over shop primer and allow to dry before handling.
3. In masonry construction, building-in of anchors and grouting of frames is included in Section 04300 of these specifications.
4. At in-place concrete or masonry construction, set frames and secure in place with machine screws and masonry anchorage devices.
5. Place frames at fire-rated openings in accordance with NFPA Standard No. 80.
6. Make field splices in frames as detailed on final shop drawings, welded and finished to match factory work.
7. Remove spreader bars only after frames or bucks have been properly set and secured.

D. Door Installation:

1. Fit hollow metal doors accurately in their respective frames with the following clearances:
 - a. Jambs and Head: 3/32".
 - b. Meeting Edges, Pairs of Doors: 1/8".
 - c. Bottom: 1/4" at threshold or carpet.
 - d. Bottom: 1/4" to threshold or tile.
 - e. Head: 1/8" to bottom of head or transom panel.
2. Place fire-rated doors with clearances as specified in NFPA Standard No. 80.
3. Finish Hardware installation is specified in Section 08710.

3.03 ADJUST AND CLEAN:

- A. Final Adjustments: Check and re-adjust operating finish hardware items in hollow metal work just prior to final inspection. Leave work in complete and proper operating conditions. Remove and replace defective work, including doors or frames which are warped, bowed or otherwise unacceptable.
- B. Prime Coat Touch-Up: Immediately after erection, sand smooth any rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer.

END OF SECTION 08112

SECTION 08151 - INTEGRATED METAL DOOR SYSTEMS

PART 1 GENERAL

1.01 GENERAL NOTE

- A. The General Conditions, Supplementary General Conditions, and Division 1 - General Requirements are hereby made a part of this Section as fully as if repeated herein.

1.02 SUMMARY

- A. Section Includes
 - 1. Integrated metal door systems with doors, operating hardware, accessories, and installation for a complete assembly.

1.03 RELATED SECTIONS

- A. Section 01340, Submittal Procedures.
- B. Section 08710, Door Hardware.

1.04 REFERENCES

- A. ANSI/BHMA A156.3 - Exit Devices, American National Standards Institute/ Building Hardware Manufacturers Association, 2001.
- B. ANSI/BHMA A156.4 - Closers, American National Standards Institute/ Building Hardware Manufacturers Association, 2000.
- C. ANSI/BHMA A156.13 - Mortise Locks/Latches, American National Standards Institute/ Building Hardware Manufacturers Association, 2002.
- D. ANSI/BHMA A156.26 - Continuous Hinges, American National Standards Institute/ Building Hardware Manufacturers Association, 2000.
- E. ANSI/SDI - A250.8 Recommended Specifications for Standard Steel Doors and Frames, American National Standards Institute/Steel Door Institute, 2003.
- F. ANSI/UL 10C -- Positive Pressure Fire Tests of Door Assemblies, American National Standards Institute/Underwriters Laboratories, 2001.

- G. ASTM A1008 - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, American Society of Testing and Materials; 2004a.
- H. NFPA 101 - Life Safety Code, National Fire Protection Association, 2003.
- I. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies, National Fire Protection Association, 2003.
- J. SDI 111 A - Recommended Steel Door Frame Details, Steel Door Institute; 2002.
- K. SDI 112 - Zinc-Coated (Galvanized/Galvannealed) Standard Steel Doors and Frames, Steel Door Institute, 1997.
- L. UL 10C - Positive Pressure Fire Tests of Door Assemblies, Underwriters Laboratories Inc., 2001.
- M. UL 305 - Standard for Panic Hardware, Underwriters Laboratories Inc., 1997

1.05 SYSTEM DESCRIPTION

A. Performance Requirements

- 1. Integrated metal door opening assemblies: Exceed minimum performance standards.
 - a. Steel Doors: In accordance with ANSI/SDI A250.8, Grade 1, but not less than 5,000,000 cycles.
 - b. Exit Devices: In accordance with ANSI/BHMA A156.3, Grade 1, but not less than 5,000,000 cycles.
 - c. Closers: In accordance with ANSI/BHMA A156.4, Grade 1.
 - d. Mortise Locks/Latches: In accordance with ANSI/BHMA A156.13, Grade 1, but not less than 5,000,000 cycles.
 - e. Full-height Hinges: In accordance with ANSI/BHMA A156.26, Grade 1, but not less than 5,000,000 cycles.

1.06 SUBMITTALS

A. Shop Drawings

- 1. In accordance with Section 01340.
- 2. Indicate each door and frame condition; frame type, profile and installation detail; items of finish hardware, finishes and electrical rough-in requirements.

B. Samples

- 1. In accordance with Section 01340.

1.07 QUALITY ASSURANCE

A. Qualifications

1. Manufacturer: Firm with not less than 5 years successful experience in fabrication of integrated metal door opening assemblies with full-height latch/lock and full-height hinge.
2. Supplier: Authorized distributor of manufacturer.
3. Installer: Manufacturer certified, employed by supplier.

B. Regulatory Requirements

1. Rated door assemblies shall have been tested to meet conditions of NFPA 252 as required by NFPA 101 section 6-2.3.3.

1.08 DELIVERY, STORAGE AND HANDLING

A. Packaging: Polyvinyl wrapped, palette by floor, and clearly marked for each opening.

B. Delivery: Deliver to site in original unopened containers and pallets bearing system manufacturers name, and brand.

C. Store: Horizontally on level surface, not less than 2 inches off floor in a clean, dry well-ventilated area protected from sunlight, extreme heat, dryness and moisture.

D. Receiving, off loading, and site distribution should be handled by an authorized Total Door Distributor unless otherwise stipulated by contract. If the G.C. or other entity handles all or any portion of the receiving, off loading, and site distribution, they are held responsible for any and all damages that may result from potential miss handling of the product.

1.09 WARRANTY

A. Integrated metal door opening assembly: Manufacturer's standard 2 year warranty against defects in material and workmanship.

B. Locksets, hanger rods, and panic exit devices: Manufacturer's lifetime limited warranty against defects in material and workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Integrated metal door systems
 - 1. Total Door: www.totaldoor.com.
 - 2. Substitutions: **Not permitted.**
- B. Hardware
 - 1. Total Door: www.totaldoor.com.

2.02 MATERIALS

- A. Frames
 - 1. In accordance with ANSI/SDI A250.8, SDI 111A, and SDI 112.
 - 2. Construction: **All-welded unit** type.
 - 3. Material: Steel, cold rolled, ASTM A1008, 16 gauge.
 - 4. Fire Resistance Rating: As indicated in Door Schedule.
 - 5. Spreader Bar: Removable, at sill.
- B. Frame Anchorage Devices
 - 1. To securely fasten to wall construction without distortion or stress.
 - 2. In accordance with fire resistance rating indicated in Door Schedule.
- C. Door Systems
 - 1. In accordance with ANSI/SDI A250.8.
 - 2. Abuse Resistant
 - a. Stiles: Steel, galvanized, 16 gauge, MIG spot welded.
 - b. Top and Bottom Rails: Based on fire label.
 - c. Cores
 - 1) Solid polystyrene continuously bonded to faces.
 - d. Thickness: 1-3/4 inches.
 - e. Faces
 - 1) Steel, stretcher leveled, without seams or spot welds, galvanized and bonderized, 16 gauge.
 - f. Weld pattern: Enhanced in accordance with manufacturer's standard details.
- D. System Hardware
 - 1. Full-height Hinge
 - a. Full-height, semi-concealed.
 - b. Acceptable products:
 - 1) Total Door: H-13.

2. Full-height Latching/Locking Channel
 - a. Full-height.
 - b. Acceptable products:
 - 1) Total Door: L-11.

2.03 FINISHES

- A. Frames: Factory prime painted for field-applied finish.
- B. Hinge and Locking Channel
 1. Finish: 2 part infrared baked polyurethane paint.
 - a. Custom color selected by Architect.
- C. Door Faces
 1. Prime painted to receive field applied finish.
 2. Factory applied, 2-part, infrared baked polyurethane paint.
 - a. Custom color selected by Architect.

2.04 FABRICATION

- A. Unless modified by Contract Documents, construct integrated metal door opening assemblies in accordance with manufacturer's published specifications and applicable Code requirements.
- B. Factory assemble with full-height hinges and latching/locking channels, locksets, exit devices, closers, kickplates, stretcher plates, and armor plates.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Field Conditions
 1. Prior to commencing installation, examine parts of building structure, which are to receive door systems and component parts.
 2. Report, in writing, conditions which would prevent proper execution or endanger permanency of the work to the Architect.
- B. Field Dimensions
 1. Where possible, verify frame tolerances before fabrication of door systems.
 2. Notify Architect of variances with reviewed shop drawings.
- C. Corrective measures, when necessary, shall be determined and approved prior to commencing fabrication.

- D. Coordinate door opening assembly details with adjacent work to assure proper attachments, clean junctions, etc.

3.02 INSTALLATION

- A. Install work in accordance with Contract Documents and reviewed shop drawings.
1. Install door systems and hardware according to Manufacturer's recommendations.
 2. Deliver frames to be installed by others.
- B. Frames
1. Set plumb and square in accordance with DHI standards.
 - a. Out-of-square at frame head: Not to exceed 1/16 inch.
 - b. Out-of-plumb for each frame jamb: Not to exceed 1/16 inch.
 - c. Out-of-alignment for each side in plan: Not to exceed 1/16 inch.
 - d. Twist dimension: Not to exceed 1/16 inch.
 2. Brace until adjacent wall is constructed.
 3. Securely anchor to adjacent wall.
 4. Furnish and install clips, fastenings, and anchorages and conceal unless otherwise noted.
- C. Door systems
1. Hang to maintain manufacturer's installation tolerances.
 2. Adjust to freely swing without binding, sticking, or sagging, and to eliminate excessive clearances.
- D. Hardware: When installation is otherwise complete, adjust hardware for proper operation and function.

PART 4 SCHEDULE

A. Hardware

Panic Exit Device	PF200	FPEO	OPN	628
Pocket Closer	90°	4003T	Wall mounted	LCN Alum
Mag Holder	1504 AQ	24V	EDW	628

END OF SECTION 08151

SECTION 08210 - FLUSH WOOD DOORS

PART 1. GENERAL

1.1 SECTION INCLUDES: Wood doors non-rated and fire-rated

- A. Solid core flush wood doors

1.2 RELATED SECTIONS

- A. Section 08112 - Hollow metal work
- B. Section 08710 - Finish hardware

1.3 REFERENCES AND REGULATORY REQUIREMENTS

- A. ASTM E152 - Methods of Fire Tests and Door Assemblies.
- B. NFPA 252 - Standard Methods for Fire Assemblies.
- C. UBC 7-2-1994
- D. UBC 7-2, 1997
- E. MBC 2009
- F. UL 10 (c) - Fire Tests for Door Assemblies - Positive Pressure
- G. UL 10 (b) - Fire Tests for Door Assemblies - Neutral Pressure
- H. NFPA 80 - Fire Doors and Windows.
- I. Quality Standards:
 - 1. WDMA Industry Standard I.S. 1A-04
 - 2. ANSI A115. W Series, Wood Door Hardware Standards. (American National Standard Institute)
- J. Labeling Agencies
 - 1. Intertek Testing Services-Warnock Hersey (ITS-WH)
 - 2. Underwriters Laboratories (UL)

1.4 SUBMITTALS

- A. Shop drawings: Indicate location, size, and hand of each door; elevation of each kind of door; location and extent of hardware blocking; and other pertinent data.
 - 1. Indicate dimensions and locations of mortises and holes for hardware.
 - 2. Indicate dimensions and locations of cutouts.
 - 3. Indicate requirements for veneer matching.
 - 4. Indicate doors to be factory finished and finish requirements.
 - 5. Indicate fire ratings for fire doors.
- B. Samples for Initial Selection: Color charts consisting of actual materials in small sections for the following:

1. Faces for Factory Finished doors: Show the full range of colors available for stained finishes.

C. Samples for Verification:

1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches, for each material and finish. For each wood species and transparent finish, provide one piece of the expected finished work.

1.5 QUALITY ASSURANCE

- A. Source limitations: Obtain flush wood doors through one source from a single manufacturer.
- B. Quality standard: Comply with WDMA I.S.1-A 04
- C. Fire-rated Doors: Doors complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UBC 7-2-1997 (Positive Pressure)

1.6 DELIVERY STORAGE AND HANDLING AND SITE CONDITIONS

- A. Deliver, store, protect and handle products under provisions of WDMA.
- B. Package doors individually and wrap bundles of doors. Inspect for damage. Do not store in damp or wet areas. HVAC systems should be operating and balanced prior to arrival of doors. Acceptable humidity shall be no less than 25% nor greater than 55%.
- C. Certain wood species are light sensitive. Protect doors from exposure to natural and artificial light after delivery.

1.7 WARRANTY

- A. Provide manufacturer's warranty for Interior Solid Core Doors:

1. Full Lifetime Warranty

PART 2. PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following:
 - 1. Flush wood doors:
 - a. Marshfield DoorSystems. Basis of Design-Signature Series Doors
 - 2. Or Equal Products by:
 - a. Algoma Hardwoods, Inc.
 - b. Eggers Industries
 - c. Oshkosh Door Company
 - d. Mohawk Flush Doors - Masonite Company
- B. Substitutions allowed only with written approval by architect prior to bid date.

2.2 DOOR CONSTRUCTION, GENERAL

- A. WORKMANSHIP
 - 1. Comply with WDMA I.S. 1A-04
- B. PERFORMANCE STANDARD
 - 1. Comply with WDMA I.S. 1A-04 Extra Heavy Duty
- C. DOORS FOR TRANSPARENT FINISH:
 - 1. Grade: Premium, with A Grade Faces
 - 2. Wood veneer Species and Cut: Plain sliced red oak
 - 3. Match between veneer leaves: Book match
 - 4. Assembly of spliced veneers: Running
 - 5. Pair and Set match: Provide for doors hung in same opening or separated only by mullions.
 - 6. Door with Transom: Continuous match
- D. DOORS FOR OPAQUE FINISH:
 - 1. Medium Density Overlay
- E. Interior Veneer-faced doors:
 - 1. Stiles and rails bonded to core, then entire unit abrasive planed before veneering.

- F. Rating: Positive pressure Category A (concealed intumescent).

2.3 SOLID-CORE DOORS

A. NON-FIRE RATED WOOD DOORS

1. Non-rated and 20-minute rated
 - a. LD-2 Particleboard, PC-5
 - b. Structural Composite Lumber, SCLC-5
 - c. Stave lumber core, SLC-5
2. Provide manufacturers standard laminated-edge construction with improved screw-holding capability and split resistance.
3. 20-minute rated pairs:
 - a. Provide with fire-retardant stiles matching face veneer that are labeled and listed for kinds of applications indicated without formed-steel edges and astragals.
 - b. As required by manufacturer to permit positive pressure "S" label per Category H.

B. FIRE RATED WOOD DOORS

1. Manufacturer's standard mineral-core construction as needed to provide fire rating indicated.
2. Blocking: provide composite blocking with improved screw-holding capability approved for use in doors of fire ratings indicated as needed to eliminate through-bolting hardware for surface applied hardware.
3. Provide manufacturers standard laminated-edge construction with improved screw-holding capability and split resistance that are labeled and listed to provide fire rating indicated.
4. Pairs: Metal edges.

2.4 FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated, with the following uniform clearances and bevels, unless otherwise indicated:
 - 1. WDMA prefit clearances for factory fit doors
 - 2. NFPA 80 for fire rated doors
 - 3. Manufacturers hardware templates

- B. Factory machine doors for hardware that is not surface applied. Comply with final hardware schedules, door frame Shop Drawings, and hardware templates.
 - 1. Coordinate measurements of hardware mortises in metal frames to verify dimensions and alignment before factory machining.

- C. Openings: Cut and trim openings through doors to comply with applicable requirements of referenced standard for kind(s) of doors(s) required.
 - 1. Light openings: Trim openings with moldings of material and profile indicated.
 - 2. Louvers: Factory install louvers in prepared openings.

- D. Apply appropriate labels.

2.5 FACTORY FINISH

- A. General: Comply with WDMA finish requirements.

- B. Finish doors at factory.

- C. Transparent Finish:
 - 1. Finish: WDMA TR-6 catalyzed polyurethane.
 - 2. Staining: As selected from manufacturers standard colors.

- D. Factory finished doors to be installed just prior to substantial completion.

2.6 FACTORY GLAZING

- A. Glazing in wood doors to be installed by wood door manufacturer.

2.7 ACCESSORIES

A. GLAZING STOPS

1. Non-Rated:

- a. Wood, of the same species/compatible with door species.

2. Fire-Rated:

- a. Veneer wrapped rolled steel, of same species as door facing.

B. APPLIED MOLDINGS:

- 1. As selected from manufacturer's standard profiles and install as detailed.

- 2. Applied moldings to be affixed to the door without the use of nails or staples.

PART 3. EXECUTION

3.1 EXAMINATION

- A. Examine doors and installed frames before hanging doors.
 - 1. Verify that frames comply with indicated requirements for type, size, location and swing characteristics and have been installed with level heads and plumb jambs.
 - 2. Reject doors with defects prior to hanging.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Hardware: For installation, Refer to Division 8 Section 08710 "Finish Hardware."

- B. Manufacturer's written instructions: Install doors to comply with manufacturer's written instructions, referenced quality standard, and as indicated.
 - 1. Install fire-rated doors in corresponding fire-rated frames according to NFPA 80.

- C. Align all doors for uniform clearance at each edge.
- D. Factory finished doors: Restore finish before installation if fitting or machining is required at Project site.

3.3 ADJUSTING

- A. Operation: Adjust all doors to swing and operate freely.

END OF SECTION 08210

SECTION 08410 - FRP DOORS-ALUMINUM FRAMING SYSTEMS

1. GENERAL

1.1. RELATED DOCUMENTS

- A. Drawings and General Provisions of contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work in this section.

1.2. DESCRIPTION OF WORK

- A. The extent of each type of door and frame is shown on the drawings and in schedules.
- B. The following types of doors and frames are required:
 - 1. FRP flush doors
 - 2. Aluminum frames for flush FRP doors.

1.3. RELATED WORK SPECIFIED ELSEWHERE

- A. For Finish Hardware, see Section 08710.
- B. For Sealants & Caulking, see Section 07920.
- C. For Glass & Glazing, see Section 08800.
- D. Aluminum Framed Entrance and Storefronts - See Section 08421

1.4. SYSTEM PERFORMANCE
FRP AND ALUMINUM FLUSH DOORS

- A. Provide door assemblies that have been designed and fabricated to comply with requirements for system performance characteristics listed below, as demonstrated by testing manufacturer's corresponding stock systems according to test methods designated.
- B. Thermal Transmission (exterior doors); U-value of not more than 0.09 (BTU/Hr. x sf x degrees F.) per AAMA 1503.01.
- C. Flame Spread/Smoke Developed: Provide FRP doors and panels with the following ratings in accordance with ASTM E 84-79a: Flame Spread: Exterior faces not greater than 145 (Class C); interior faces not greater than 10 (Class A). Smoke Developed: Exterior faces not greater than 345 (Class C); interior faces not greater than 320 (Class A).
- D. Additional Criteria: Provide FRP doors and panels with the

following performance:

ASTM D 256 - nominal value of 13.5
ASTM D 1242 - nominal value of .23 percent
ASTM D 570 - nominal value of .20 to .40 percent
ASTM D 2583 - nominal value of 50

1.5. QUALITY ASSURANCE - **ALL BIDDERS SHALL BE FACTORY DIRECT
AUTHORIZED DISTRIBUTORS OF THE SPECIFIED PRODUCTS.**

- A. Standards: Comply with the requirements and recommendations in applicable specification and standards by NAAMM and AAMA, including the terminology definitions and specifically including the "Entrance Manual" by NAAMM, except to the extent more stringent requirements are indicated.
- B. Performance: A minimum ten year record of production of frames, doors and panels and completion of similar projects in type and size.
- C. Instruction: The manufacturer or his representative will be available for consultation to all parties engaged in the project including instruction to installation personnel.
- D. Field Measurement: Field verify all information prior to fabrication and furnish of materials. Furnish and install materials omitted due to lack of verification at no additional cost to Owner.
- E. Regulation and Codes: Comply with the current edition in force at the project location of all local, state and federal codes and regulations, including the Americans with Disabilities Act of 1992.

1.6. SUBMITTALS

- A. Product Data: Submit Manufacturer's product data, specifications and instructions for each type of door and frame required in accordance with Section 01300 and the following:
 - 1. Include details of core, stile and rail construction, trim for lites and all other components.
 - 2. Include details of finish hardware mounting.
 - 3. Include sample of each aluminum alloy to be used on this project. Where normal finish color and texture variations are expected, include two or more samples to show the range of such variations.

4. Include one sample of typical fabricated section, showing joints, fastenings, quality of workmanship, hardware and accessory items before fabrication of the work proceeds.
 - B. Submit shop drawings for the fabrication and installation of the doors and frames, and associated components. Details to be shown full scale. Include glazing details and finish hardware schedule.
- 1.7. PRODUCT DELIVERY, STORAGE AND HANDLING
- A. Deliver materials to jobsite in their original, unopened packages with labels intact. Inspect materials for damage and advise manufacturer immediately of any unsatisfactory materials.
 - B. Package door assemblies in individual corrugated cartons so no portion of the door has contact with the outer shell of the container. Package and ship frames preassembled to the greatest possible extent.
- 1.8. PROJECT WARRANTY
- A. Provide a written warranty signed by manufacturer, installer and contractor, agreeing to replace, at no cost to the Owner, any doors, frames or factory hardware installation which fail in materials or workmanship, within the warranty period. Failure of materials or workmanship includes: excessive deflection, faulty operation of entrances, deterioration of finish, or construction in excess of normal weathering and defects in hardware installation. The minimum time period of warranty is ten (10) years from acceptance.
2. PRODUCTS
- 2.1. ACCEPTABLE MANUFACTURERS
- A. Manufacturer: Subject to compliance with requirements, provide products of the following:
 1. Special-Lite, Inc., Decatur, Michigan.
- 2.2. MATERIALS AND ACCESSORIES
- A. Aluminum Members: Alloy and temper as recommended by manufacturer for strength, corrosion resistance and application

of required finish and control of color; ASTM B 221 for extrusions, ASTM B 209 for sheet/plate with aluminum wall thickness of 0.125".

- B. Components: Furnish door and frame components from the same manufacturer. "Splitting" of door and frame components is not permitted.
- C. Fasteners: Aluminum non-magnetic stainless steel or other non-corrosive metal fasteners, guaranteed by the manufacturer to be compatible with the doors, frames, stops, panels, hardware, anchors and other items being fastened. For exposed fasteners (if any) provide oval Phillips head screws with finish matching the item to be fastened.
- D. Glazing Gaskets: For glazing factory-installed glass, and for gaskets which are factory-installed in "captive" assembly of glazing stops. Manufacturer's standard stripping of molded neoprene, complying with ASTM D 2000 (Designation 2BC415 to 3BC620), or molded PVC complying with ASTM C 509 Grade 4.

2.3. FABRICATION

- A. Sizes and Profiles: The required sizes for door and frame units, and profile requirements are shown on the drawings.
- B. Coordination of Fabrication: Field measure before fabrication, and show recorded measurements on final shop drawings.
- C. Complete the cutting, fitting, forming, drilling and grinding of all metal work prior to assembly. Remove burrs from cut edges, and ease edges and corners to a radius of approximately 1/64".
- D. No welding of doors or frames is acceptable.
- E. Maintain continuity of line and accurate relation of planes and angles. Secure attachments support at mechanical joints, with hairline fit at contacting members.
- F. Attachment of all hardware shall be made using machine screws which are supplied by the manufacturer.
- G. All holes shall be drilled and tapped using the recommended drill size for the tap required.
- H. Frames stops shall be applied stops, Minimum 5/8" high x Minimum 1 1/4" wide.

- I. Door attachment points shall be minimum of 1/8" thickness.
- J. Where hardware is to be attached to frame stop (Example: exit device strike, door closer shoe, O.H. stop & Etc.) a piece of solid bar stock aluminum sized to fill the frame stop void x 18" long shall be securely attached to the frame tube.
- K. Where it is practical to have solid bar stock reinforcement at attachment points, use "RIV-NUTS for attachment of hardware items.

2.4. FIBERGLASS REINFORCED POLYESTER FRP FLUSH DOORS

A. Materials and Construction

1. Construct 1 3/4 inch thickness doors of 6063 T5 aluminum alloy stiles and rails minimum 25/16 inch dept. Provide joinery of 3/8 inch diameter full width tie rods through extruded splines top and bottom as standard .125 inch tubular shaped stiles and rails reinforced to accept hardware as specified.
2. Extrude top and bottom rail legs for interlocking continuous rail rigidity weather bar. Lock face sheet material in place with extruded interlocking edges to be flush with aluminum stiles and rails.
3. Door face sheeting. Spec Lite 3, 120 inch thickness fiber glass reinforced polyester. SL17 doors with pebble-like embossed pattern. Color: As selected by the Architect.
4. Core of Door Assembly: Minimum five pounds per cubic foot density poured-in-place polyurethane free of CFC and HCFC. Minimum "R" value of 11. Ballistic rating is as indicated. Meeting stiles on pairs of doors and weather bars with nylon brush weather-stripping.
5. Manufacture doors with cutouts for visor-lites, louvers or panels as scheduled. Factory furnish and install all glass, louvers and panels prior to shipment.
6. Premachine doors in accordance with templates from the specified hardware manufacturers and approved hardware schedule. Factory install hardware.
7. Furnish FRP doors with flush pull SL86. Color as selected by the Architect.

8. Provide door with adjustable brush insert.

2.5. ALUMINUM FRAMING SYSTEMS (For flush FRP doors)

A. Tubular Framing

1. Framing system from the door manufacturer of the size and type shown. .125" minimum wall thickness and type 6063-T5 aluminum alloy .625" high applied stops with screws and weather-stripping. Frame members are to be box type with four (4) enclosed sides. Open back framing will not be acceptable.
2. Caulk joints before assembling frame members. Secure joints with fasteners and provide a hairline butt joint appearance. Prefit doors to frame assembly at factory prior to shipment. Field fabrication of framing using "stick" material is not acceptable.
3. Applied stops for side, transom and borrowed lites and panels, with fasteners exposed on interior or unsecure portion only. Premachine and reinforce frame members for hardware in accordance with manufacturer's standards and the approved hardware schedule. Factory install hardware.
4. Anchors appropriate for wall conditions to anchor framing to wall materials. A minimum of five anchors up to 7'4" on jamb members, and one additional anchor for each foot over 7'4". Secure head and sill members of transom, sidelites and similar conditions.
5. Factory pre-assemble sidelites to the greatest extent possible, and mark frame assemblies according to location.
6. Refer to Section 08710 for removable mullions which shall be furnished and installed by this Contractor. Finish of removable mullions to match frames.
7. NOTE: All framing at Hillside Elem to be custom color to match the existing window framing at the school.

2.6. GLAZING

- A. Design system for replacement of glass.

1. Manufacturer's standard flush glazing system of recessed channels and captive glazing gaskets or applied stops as shown.
2. Allow for thermal expansion on exterior units.
3. Glass as shown and factory glazed into doors.
4. Provide 1'' insulated low ''E'' glass units. Refer to Spec Section 08800 for additional information.

2.7 ALUMINUM FINISHES

- A. All exposed aluminum to be factory finished with AZKO Nobel ''Trinar'', color to be determined from manufacturer's standard and/or custom colors by Architect.

3. EXECUTION

3.1. INSTALLATION

- A. Comply with manufacturer's recommendations (maintain 3/16'' gap between leafs of pairs of doors) and specifications for the installation of the doors and frames. Factory install hardware, glass and louvers in doors. Factory assemble sidelites and transoms to the greatest extent possible.
- B. Set units plumb, level and true to line, without warp or rack of doors or frames. Anchor securely in place. Separate aluminum and other metal surfaces with bituminous coatings or other means as approved by architect.
- C. Set thresholds in a bed of mastic and backseal.
- D. Clean surfaces promptly after installation of doors and frames, exercising care to avoid damage to the protective coatings.
- E. Ensure that the doors and frames will be without damage or deterioration (other than normal weathering) at the time of acceptance.
- F. Provide Owner with all adjustment tools and instruction sheets. Arrange an inservice session to Owner at Owner's convenience. Any workmanship which is defective or deficient shall be corrected to the Owner's satisfaction and at no additional cost to the Owner per Paragraph 1.8 Project Warranty of this specification.

FARMINGTON PUBLIC SCHOOLS
2017 RENOVATIONS-BID PACK #5
ELEMENTARY SCHOOLS

161664B

NOVEMBER 30, 2016

END OF SECTION 08410

SECTION 08520 - ALUMINUM WINDOWS - **FIXED WINDOW**

PART 1 - GENERAL

1.01 Summary

A. Section Includes: Kawneer Sealair® Commercial Grade and Heavy Commercial Architectural Aluminum Windows, including glass and glazing at window manufacturer's factory, perimeter trims, sills and stools, window installation hardware and accessories, shims and anchors, and perimeter sealing of window units.

1. Types of Kawneer Sealair Aluminum Windows include:

- a. Series 8400TL, Model 8410; Thermal, 4" Deep Frame, Fixed/Offset Fixed (HC100-AW100).

1.02 System Description

A. Reference Standard Compliance: Comply with ANSI/AAMA 101 and AAMA 910 for minimum performance criteria for aluminum windows, including grade designation windows units.

1. Test Units: Conform to minimum size in accordance with ANSI/AAMA 101 and AAMA 910 for each test unit sizes and configurations. Units submitted for laboratory testing shall be manufacturer's standard construction, glazed and assembled in accordance with manufacturer's specifications and ANSI/AAMA 101.

B. Window Performance Requirements:

1. Air Infiltration: The test specimen shall be tested in accordance with ASTM E283 at a minimum frame size of 72" x 72" (HC), 60" x 96" (AW). Air infiltration rate shall not exceed 0.06 cfm/ft of sash perimeter at a static air pressure differential of 6.24 psf.
2. Water Resistance: The test specimen shall be tested in accordance with ASTM E547 and ASTM E331 at a minimum frame size of 72" x 72" (HC), 60" x 96" (AW). There shall be no leakage as defined in test method at a static air pressure differential of 12 psf.

3. Uniform Load Deflection: A minimum static air pressure difference of 100 psf shall be applied in the positive and negative direction in accordance with ASTM E330. There shall be no deflection in excess of L/175 of the span of any framing member.
4. Uniform Load Structural Test: A minimum static air pressure difference of 150 psf shall be applied in the positive and negative direction in accordance with ASTM E330. The unit shall be evaluated after each load.
5. Thermal Transmittance (U-value): When tested to AAMA Specification 503.1, the thermal transmittance (U-value) shall not be more than 0.60 BTU/hr/sf/°F.
6. Condensation Resistance (CRF): When tested to AAMA Specification 1503, the condensation resistance factor shall not be less than 58.
7. Forced Entry Resistance: Windows shall conform to ASTM F588, Performance Level 10, or AAMA 1302.5.

- C. System Performance Requirements: Provide aluminum windows which have been manufactured, fabricated and installed to withstand uniform loads from 100 psf and to maintain (manufacturer's performance criteria) without defects, damage, or failure.

1.03 Submittals

- A. General: Prepare, review, approve, and submit product data, shop drawings, samples, and other submittals in accordance with "Conditions of the Contract" and Division 1 Submittals Sections. Product data, shop drawings, samples, and similar submittals are defined in "Conditions of the Contract."

1.04 Warranty

- A. Project Warranty: Refer to "Conditions of the Contract" for project warranty provisions.
- B. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty.
1. Warranty Period: Two (2) years from Date of Substantial Completion of the project provided however that the Limited Warranty shall begin

- in no event later than six months from date of shipment by Kawneer.
2. Insulating Glass: Warranted to be free from defects (excluding breakage) for a period of five (5) years.

1.05 Quality Assurance

A. Qualifications:

1. Installer Qualifications: Installer experienced (as determined by contractor) to perform work of this section who has specialized in the installation of work similar to that required for this project and who is acceptable to product manufacturer.
2. Manufacturer Qualifications: Manufacturer capable of providing field service representation during construction, approving acceptable installer and approving application method.

- ##### **B. Pre-Installation Meetings:** Conduct pre-installation meeting to verify project requirements, substrate conditions, manufacturer's installation instructions, and manufacturer's warranty requirements

PART 2 - PRODUCTS

2.01 Manufacturer's (Acceptable Manufacturer's/Products)

- ##### **A. Acceptable Manufacturer's:** Kawneer Company, Inc., EFCO, Wausau and Graham.
1. Spec is based on Kawneer Sealair Architectural Windows.
 - a. Series: SealAir 8400TL, model 8410 fixed window.
 - b. Finish color: Fluoropon (70% PBDF), AAMA2605 fluoropolymer coating. Color: To be determined.
 2. Product/Systems Testing:
 - a. ANSI/AAMA: Comply with ANSI/AAMI 101 and AAMA 910 floor minimum product performance criteria.
 3. Manufacturer is to provide single source for all windows, curtain wall and storefront on project. Mixing and matching of more than one manufacturer is not allowed.

2.02 Materials

- A. Aluminum (Windows and Components):
1. Material Standard: ASTM B221, G.S. 10A-T5; 6063-T5 alloy and temper.
 2. Frame Depth: Not less than 4" (101.6 mm).
 3. Member Wall Thickness: Each master frame member shall have minimum wall thickness of 0.070" (1.78 mm) and shall provide structural strength to meet specified performance requirements.
 4. Dimensions: Reference to dimensions for wall thickness and other cross-sectional dimensions of window members are nominal and in compliance with ANSI H35.2-1990.
- B. Mullions and Cover Plates: Shall be extruded aluminum of 6063-T5 alloy and temper of profile and dimensions indicated on drawings. Mullions shall provide structural properties to resist wind pressure required by performance criteria and standards.
- C. Thermal Barrier.
1. Frame thermal barrier shall be Kawneer Isolock® with a minimum of 5/16" (7.9) separation consisting of a two-part, chemically curing high density polyurethane which is mechanically and adhesively bonded to the aluminum.
 2. Sash thermal barrier shall be Kawneer Isolock® with a minimum of 1/4" (6.4) separation consisting of a two-part, chemically curing high density polyurethane in conditioned thermal pockets which is mechanically and adhesively bonded to the aluminum.

2.03 Accessories

- A. Fasteners: Where exposed, shall be 300 Series, Stainless Steel.
- B. Perimeter Anchors: Aluminum. When steel anchors are used, provide insulation between steel material and aluminum material to prevent galvanic action.

2.04 Glass and Glazing

- A. General: Glass thickness and type shall be in accordance with manufacturer's recommendations for prescribed design pressure. Factory glazing shall be in accordance with manufacturer's standard requirements.
1. Material Compatibility: Glazing materials shall be compatible with aluminum and FRP panels (where indicated).
 2. Manufacturer's Standards: Glazing method shall be a wet/dry type in accordance with manufacturer's standards. Exterior glazing shall be pre-shimmed glazing tape. Interior glazing shall be snap-in type .062" (1.57 mm) glazing beads and a compression gasket of dense elastomer in accordance with ASTM C864.
- B. Glass Materials:
1. Insulating Glass: ASTM E774, NAMI Single-Seal.
 2. Safety Glazing: ANSI Z97.1 or CPSC 16 CRF 1201.
 3. Tempered Glass: ASTM C1043.
 4. Glass Type: Laminated interior and exterior panes of glass.
 5. Glass Thickness 1" consisting of ¼" laminated exterior ½" spacer ¼" laminated interior - Refer to Spec Section 08800 - Glass & Glazing.

PART 3 - EXECUTION

3.01 Manufacturer's Instructions/Recommendations

- A. Compliance: Comply with manufacturer's product installation data and recommendations for installation requirements of window units, hardware, and other components in accordance with manufacturer's warranty provisions.

3.02 Examination

- A. Site Verification of Conditions: Verify substrate conditions (which have been previously installed under other sections) are acceptable for product installation in accordance with manufacturer's instructions. Verify openings are sized to receive window units and sill plate is level in accordance with manufacturer's acceptable tolerances.

1. Field Measurements: Verify field measurements for window installation.

3.03 Preparation

- A. Adjacent Surfaces Protection: Protect adjacent work areas and finish surfaces from damage during product installation.

3.04 Installation

- A. General: Install window units plumb, level, and true to line, without warp or rack of frames or sash with manufacturer's prescribed tolerances. Provide support and anchor in place.

1. Dissimilar Materials: Provide separation of aluminum materials and other corrodible surfaces from sources of corrosion or electrolytic action contact points by complying with AAMA 101, Appendix, titled "Dissimilar Materials."
2. Weathertight Construction: Install sill members and other members in a bed of sealant or with joint filler or gaskets, to provide weathertight construction. Coordinate installation with wall flashings and other components of construction.
 - a. Refer to Division 7 Joint Treatments (Sealants) for installation requirements.

- B. Related Products Installation Requirements:

1. Insulation (Window): Refer to Division 7 Building Insulation Section.
2. Sealants (Perimeter): Refer to Division 7 Joint Treatment (Sealants) Section.
3. Glass: Refer to Division 8 Glass and Glazing Section.

3.05 Field Quality Control

- A. Field Tests: Architect shall select window units to be tested as soon as a representative portion of the project has been installed, glazed, perimeter caulked and cured. Conduct tests for air infiltration and water penetration with manufacturer's representative present. Tests not meeting specified performance requirements and units having deficiencies shall be corrected as part of the contract amount.

1. Testing: Testing shall be performed by a qualified independent testing agency. Refer to Division 1 Testing Section for payment of testing and testing requirements. Testing Standard per AAMA 502, including reference to ASTM E 783 for Air Infiltration Test and ASTM E 1105 Water Infiltration Test.
 - a. Air Infiltration Tests: Conduct tests in accordance with ASTM E 783. Allowable air infiltration shall not exceed 1.5 times the amount indicated in the performance requirements or 0.15 cfm per foot of crack length, whichever is greater.
 - b. Water Penetration Tests: Conduct tests in accordance with ASTM E 1105. No uncontrolled water leakage is permitted when tested at a static test pressure of two-thirds the specified water penetration pressure but not less than 6.24 psf.

- B. Manufacturer's Field Services: Provide manufacturer's field service consisting of product use recommendations and periodic site visit for inspection of product installation in accordance with manufacturer's instructions.

3.06 Adjusting and Cleaning

- A. Adjusting: Adjust operating window components to provide a tight fit at contact points and at weatherstripping for smooth operation and a weathertight closure.
- B. Cleaning: Remove temporary coverings and protection of adjacent work areas. Repair or replace damaged installed products. Clean installed products in accordance with manufacturer's instructions prior to owner's acceptance. Remove construction debris from project site and legally dispose of debris.
- C. Protection: Protect installed product's finish surfaces from damage during construction. Protect aluminum windows from damage from grinding and polishing compounds, plaster, lime, acid, cement, or other harmful contaminants. Remove and replace damaged aluminum windows at no extra cost.

END OF SECTION 08520

SECTION 08520 - ALUMINUM WINDOWS - **SLIDING WINDOW**

PART 1 - GENERAL

1.01 Summary

A. Section Includes: Kawneer Sealair® Commercial Grade and Heavy Commercial Architectural Aluminum Windows, including glass and glazing at window manufacturer's factory, perimeter trims, sills and stools, window installation hardware and accessories, shims and anchors, and perimeter sealing of window units.

1. Types of Kawneer Sealair Aluminum Windows include:
 - a. Series 8400TL, Model 8470; Thermal, 4" Deep Master Frame, Horizontal Sliding (HC55).

1.02 System Description

A. Reference Standard Compliance: Comply with ANSI/AAMA 101 for minimum performance criteria for aluminum windows, including grade designation windows units.

1. Test Units: Conform to minimum size in accordance with ANSI/AAMA 101 for each test unit sizes and configurations. Units submitted for laboratory testing shall be manufacturer's standard construction, glazed and assembled in accordance with manufacturer's specifications and ANSI/AAMA 101.

B. Window Performance Requirements:

1. Air Infiltration: When closed and locked, the test specimen shall be tested in accordance with ASTM E283 at a minimum frame size of 96" x 80" (HC). Air infiltration rate shall not exceed 0.30 cfm/ft of sash perimeter at a static air pressure differential of 1.57 psf.
2. Water Resistance: When closed and locked, the test specimen shall be tested in accordance with ASTM E547 and ASTM E331 at a minimum frame size of 96" x 80" (HC). There shall be no leakage as defined in test method at a static air pressure differential of 10 psf.

3. Uniform Load Deflection: When closed and locked, a minimum static air pressure difference of 55 psf shall be applied in the positive and negative direction in accordance with ASTM E330. There shall be no deflection in excess of L/175 of the span of any framing member.
4. Uniform Load Structural Test: When closed and locked, a minimum static air pressure difference of 82.5 psf shall be applied in the positive and negative direction in accordance with ASTM E330. The unit shall be evaluated after each load.
5. Thermal Transmittance (U-value): When tested to AAMA Specification 503.1, the thermal transmittance (U-value) shall not be more than 0.74 BTU/hr/sf/°F.
6. Condensation Resistance (CRF): When tested to AAMA Specification 1503, the condensation resistance factor shall not be less than 51.
7. Forced Entry Resistance: Windows shall conform to ASTM F588, Performance Level 10, or AAMA 1302.5.

- C. System Performance Requirements: Provide aluminum windows which have been manufactured, fabricated and installed to withstand uniform loads from 65 psf and to maintain (manufacturer's performance criteria) without defects, damage, or failure.

1.03 Submittals

- A. General: Prepare, review, approve, and submit product data, shop drawings, samples, and other submittals in accordance with "Conditions of the Contract" and Division 1 Submittals Sections. Product data, shop drawings, samples, and similar submittals are defined in "Conditions of the Contract."

1.04 Warranty

- A. Project Warranty: Refer to "Conditions of the Contract" for project warranty provisions.
- B. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty.
1. Warranty Period: Two (2) years from Date of Substantial Completion of the project provided

however that the Limited Warranty shall begin in no event later than six months from date of shipment by Kawneer.

2. Insulating Glass: Warranted to be free from defects (excluding breakage) for a period of five (5) years.

1.05 Quality Assurance

A. Qualifications:

1. Installer Qualifications: Installer experienced (as determined by contractor) to perform work of this section who has specialized in the installation of work similar to that required for this project and who is acceptable to product manufacturer.
2. Manufacturer Qualifications: Manufacturer capable of providing field service representation during construction, approving acceptable installer and approving application method.

- ##### **B. Pre-Installation Meetings:** Conduct pre-installation meeting to verify project requirements, substrate conditions, manufacturer's installation instructions, and manufacturer's warranty requirements

PART 2 - PRODUCTS

2.01 Manufacturer's (Acceptable Manufacturer's/Products)

- ##### **A. Acceptable Manufacturer's:** Kawneer Company, Inc., EFCO, Wausau and Graham.

1. Spec is based on Kawneer Sealair Architectural Windows.
 - a. Series: SealAir 8400TL, model 8470 sliding window.
 - b. Finish color: Fluoropon (70% PBDF), AAMA2605 fluoropolymer coating. Color: To be determined.

2. Product/Systems Testing:
 - a. ANSI/AAMA: Comply with ANSI/AAMI 101 and AAMA 910 floor minimum product performance criteria.
3. Manufacturer is to provide single source for all windows, curtain wall and storefront on project. Mixing and matching of more than one manufacturer is not allowed.

2.02 Materials

- A. Aluminum (Windows and Components):
 1. Material Standard: ASTM B221, G.S. 10A-T5; 6063-T5 alloy and temper.
 2. Frame Depth: Not less than 4" (101.6 mm).
 3. Member Wall Thickness: Each master frame member shall have minimum wall thickness of 0.070" (1.78 mm) and shall provide structural strength to meet specified performance requirements. Each sash member shall have a minimum wall thickness of 0.080" (2.03 mm). All vertical sash members shall be tubular construction. Meeting rail shall have a continuous interlock with double weather stripping.
 4. Dimensions: Reference to dimensions for wall thickness and other cross-sectional dimensions of window members are nominal and in compliance with ANSI H35.2-1990.
- B. Mullions and Cover Plates: Shall be extruded aluminum of 6063-T5 alloy and temper of profile and dimensions indicated on drawings. Mullions shall provide structural properties to resist wind pressure required by performance criteria and standards.
- C. Thermal Barrier.
 1. Frame thermal barrier shall be Kawneer Isolock® with a minimum of 5/16" (7.9) separation consisting of a two-part, chemically curing high density polyurethane which is mechanically and adhesively bonded to the aluminum.

2. Sash thermal barrier shall be Kawneer Isolock® with a minimum of 1/4'' (6.4) separation consisting of a two-part, chemically curing high density polyurethane in conditioned thermal pockets which is mechanically and adhesively bonded to the aluminum.

2.03 Accessories

- A. Fasteners: Where exposed, shall be 300 Series, Stainless Steel.
- B. Perimeter Anchors: Aluminum. When steel anchors are used, provide insulation between steel material and aluminum material to prevent galvanic action.
- C. Hardware: Manufacturer's standard corrosion resistant hardware material compatible with aluminum.
 1. Manufacturer's cast white bronze cam lock.
- D. Insect Screens: Extruded aluminum frames, 6063-T5 alloy and temper, joined at corners; 18 x 16 mesh aluminum screen cloth; frames finished to match aluminum windows; splines shall be extruded vinyl, removable to permit rescreening.
- E. Muntin Grids: Extruded aluminum profiles, 6063-T5 alloy and temper and as follows:
 1. True Muntins.

2.04 Glass and Glazing

- A. General: Glass thickness and type shall be in accordance with manufacturer's recommendations for prescribed design pressure. Factory glazing shall be in accordance with manufacturer's standard requirements.
 1. Material Compatibility: Glazing materials shall be compatible with aluminum and FRP panels (where indicated).

2. Manufacturer's Standards: Glazing method shall be a wet/dry type in accordance with manufacturer's standards. Exterior glazing shall be pre-shimmed glazing tape. Interior glazing shall be snap-in type 0.062" (1.57 mm) glazing beads and a compression gasket of dense elastomer in accordance with ASTM C864.
- B. Glass Materials: (Specifier To Choose)
1. Insulating Glass: ASTM E774, NAMI Dual-Seal or Single-Seal as selected.
 2. Safety Glazing: ANSI Z97.1 or CPSC 16 CRF 1201.
 3. Tempered Glass: ASTM C1048.
 4. Glass Type: Temp. glass-exterior pane, laminated glass-interior pane.
 5. Glass Thickness 1'' consisting of ¼'' exterior 1/2" spacer 1/4" interior.

PART 3 - EXECUTION

3.01 Manufacturer's Instructions/Recommendations

- A. Compliance: Comply with manufacturer's product installation data and recommendations for installation requirements of window units, hardware, and other components in accordance with manufacturer's warranty provisions.

3.02 Examination

- A. Site Verification of Conditions: Verify substrate conditions (which have been previously installed under other sections) are acceptable for product installation in accordance with manufacturer's instructions. Verify openings are sized to receive window units and sill plate is level in accordance with manufacturer's acceptable tolerances.
1. Field Measurements: Verify field measurements for window installation.

3.03 Preparation

- A. Adjacent Surfaces Protection: Protect adjacent work areas and finish surfaces from damage during product installation.

3.04 Installation

- A. General: Install window units plumb, level, and true to line, without warp or rack of frames or sash with manufacturer's prescribed tolerances. Provide support and anchor in place.

1. Dissimilar Materials: Provide separation of aluminum materials and other corrodible surfaces from sources of corrosion or electrolytic action contact points by complying with AAMA 101, Appendix, titled "Dissimilar Materials."
2. Weathertight Construction: Install sill members and other members in a bed of sealant or with joint filler or gaskets, to provide weathertight construction. Coordinate installation with wall flashings and other components of construction.
 - a. Refer to Division 7 Joint Treatments (Sealants) for installation requirements.

- B. Related Products Installation Requirements:

1. Insulation (Window): Refer to Division 7 Building Insulation Section.
2. Sealants (Perimeter): Refer to Division 7 Joint Treatment (Sealants) Section.
3. Glass: Refer to Division 8 Glass and Glazing Section.

3.05 Field Quality Control

- A. Field Tests: Architect shall select window units to be tested as soon as a representative portion of the project has been installed, glazed, perimeter caulked and cured. Conduct tests for air infiltration and water penetration with manufacturer's representative present. Tests not meeting specified performance requirements and units having deficiencies shall be corrected as part of the contract amount.

1. Testing: Testing shall be performed by a qualified independent testing agency. Refer to Division 1 Testing Section for payment of testing and testing requirements. Testing Standard per AAMA 502, including reference to ASTM E 783 for Air Infiltration Test and ASTM E 1105 Water Infiltration Test.
 - a. Air Infiltration Tests: Conduct tests in accordance with ASTM E 783. Allowable air infiltration shall not exceed 1.5 times the amount indicated in the performance requirements or 0.15 cfm per foot of crack length, whichever is greater.
 - b. Water Penetration Tests: Conduct tests in accordance with ASTM E 1105. No uncontrolled water leakage is permitted when tested at a static test pressure of two-thirds the specified water penetration pressure but not less than 6.24 psf.

- B. Manufacturer's Field Services: Provide manufacturer's field service consisting of product use recommendations and periodic site visit for inspection of product installation in accordance with manufacturer's instructions.

3.06 Adjusting and Cleaning

- A. Adjusting: Adjust operating window components to provide a tight fit at contact points and at weatherstripping for smooth operation and a weathertight closure.
- B. Cleaning: Remove temporary coverings and protection of adjacent work areas. Repair or replace damaged installed products. Clean installed products in accordance with manufacturer's instructions prior to owner's acceptance. Remove construction debris from project site and legally dispose of debris.
- C. Protection: Protect installed product's finish surfaces from damage during construction. Protect aluminum windows from damage from grinding and polishing compounds, plaster, lime, acid, cement, or other harmful contaminants. Remove and replace damaged aluminum windows at no extra cost.

END OF SECTION 08520

SECTION 08710 - FINISH HARDWARE

PART 1 - GENERAL

1.1 Refer to "General and Special Conditions", and "Instructions to Bidders", Division 1 of Specifications. Requirements of these Sections and the project drawings shall govern work in this section.

1.2 Work Included:

A. Furnish all items of Finish Hardware specified, scheduled, shown or required herein except those items specifically excluded from this section of the specification.

B. Related work:

1. Division 1 - General Requirements
2. Division 6 - Rough Carpentry
3. Division 6- Finish Carpentry: Installation of Finish Hardware
4. Division 8 - Steel Doors and Frames
5. Division 8 - Wood Doors
6. Division 8 - Special Doors
7. Division 8 - All Glass Entrances and Storefronts
8. Division 8 - Aluminum Framed Entrances and Storefronts
9. Division 10 - Operable Partitions
10. Division 16 - Smoke Detection Systems
11. Division 16 - Security Access Systems

C. Specific Omissions: Hardware for the following is specified or indicated elsewhere, unless specifically listed in the hardware sets:

1. Cabinet Hardware.
2. Signs, except as noted.
3. Folding partitions, except cylinders where detailed.
4. Sliding aluminum doors
5. Chain link and wire mesh doors and gates
6. Access doors and panels

7. Overhead and Coiling doors

1.3 Quality Assurance

A. Requirements of Regulatory Agencies:

1. Furnish finish hardware to comply with the requirements of laws, codes, ordinances, and regulations of the governmental authorities having jurisdiction where such requirements exceed the requirements of the Specifications.
2. Furnish finish hardware to comply with the requirements of the regulations for public building accommodations for physically handicapped persons of the governmental authority having jurisdiction and to comply with Americans with Disabilities Act.
3. Provide hardware for fire-rated openings in compliance with NFPA 80 and state and local building code requirements. Provide only hardware that has been tested and listed by UL for types and sizes of doors required and complies with requirements of door and door frame labels.

B. Hardware Supplier:

1. Shall be an established firm dealing in contract builders' hardware. He must have adequate inventory, qualified personnel on staff and be located within 100 miles of the project. The distributor must be a factory-authorized dealer for all materials required. The supplier shall be or have in employment an Architectural Hardware Consultant (AHC).

C. Electrified Door Hardware Supplier:

1. Shall be an experienced door hardware supplier who has completed projects with electrified door hardware similar in material, design, and extent to that

indicated for this project, whose work has resulted in construction with a record of successful in-service performance, and who is acceptable to manufacturer of primary materials.

2. Shall prepare data for electrified door hardware, including shop drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this project.
3. Shall have experience in providing consulting services for electrified door hardware installations.

D. Pre-installation Meeting:

1. Before hardware installation, General Contractor/Construction Manager will request a hardware installation meeting be conducted on the installation of hardware; specifically that of locksets, closers, exit devices, overhead stops and coordinators. Manufacturer's representatives of the above products, in conjunction with the hardware supplier for the project, shall conduct the meeting. Meeting to be held at job site and attended by installers of hardware for aluminum, hollow metal and wood doors. Meeting to address proper coordination and installation of hardware, per finish hardware schedule for this specific project, by using installation manuals, hardware schedule, templates, physical product samples and installation videos.
2. When any electrical hardware is specified this meeting shall also include the following trades/installers: Electrical, Security, Alarm systems and Architect.
3. Convene one week or more prior to commencing work of this Section.
4. The Hardware Supplier shall include the cost of this meeting in his proposal.

E. Manufacturer:

1. Obtain each type of hardware (latch and locksets, hinges, closers, etc.) from a single manufacturer, although several may be indicated as offering products complying with requirements.

2. Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated.

1.4 Submittals:

A. Hardware Schedule

1. Submit number of Hardware Schedules as directed in Division 1.
2. Follow guidelines established in Door & Hardware Institute Handbook (DHI) Sequence and Format for the Hardware Schedule unless noted otherwise.
3. Schedule will include the following:
 - a. Door Index including opening numbers and the assigned Finish Hardware set.
 - b. Preface sheet listing category only and manufacturer's names of items being furnished as follows:

CATEGORY	SPECIFIED	SCHEDULED
Hinges	Manufacturer A	Manufacturer B
Lock sets	Manufacturer X	Manufacturer X
Kick Plates	Open	Manufacturer Z

- c. Hardware Locations: Refer to Article 3.1 B.2 Locations.
- d. Opening Description: Single or pair, number, room locations, hand, active leaf, degree of swing, size, door material, frame material, and UL listing.
- e. Hardware Description: Quantity, category, product number, fasteners, and finish.
- f. Headings that refer to the specified Hardware Set Numbers.
- g. Scheduling Sequence shown in Hardware Sets.
- h. Product data of each hardware item, and shop drawings where required, for special conditions and specialty hardware.
- i. Electrified Hardware system operation description.

j. "Vertical" scheduling format only. "Horizontal" schedules will be returned "Not Approved."

k. Typed Copy.

l. Double-Spacing.

m. 8-1/2 x 11 inch sheets

n. U.S. Standard Finish symbols or BHMA Finish symbols.

B. Product Data:

1. Submit, in booklet form Manufacturers Catalog cut sheets of scheduled hardware.
2. Submit product data with hardware schedule.

C. Samples:

1. Prior to submittal of the final hardware schedule and prior to final ordering of finish hardware, submit one sample, if required, of each type of exposed hardware unit, finished as required and tagged with full description for coordination with schedule.
2. Samples will be returned to the supplier. Units, which are acceptable and remain undamaged through submittal, review and field comparison procedures may, after final check of operation, be used in the work, within limitations of keying coordination requirements.

D. Key Schedule:

1. Submit detailed schedule indicating clearly how the Owner's final keying instructions have been followed.
2. Submit as a separate schedule.

E. Electrified Hardware Drawings:

1. Submit elevation drawings showing relationship of all electrical hardware components to door and frame. Indicate number and gage of wires required.
 - a. Include wiring drawing showing point to point wire hook up for all components.
 - b. Include system operations descriptions for each type of opening; describe each possible condition.

- F. Submit to General Contractor/Construction Manager, the factory order acknowledgement numbers for the various hardware items to be used on the project. The factory order acknowledgement numbers shall help to facilitate and expedite any service that may be required on a particular hardware item. General Contractor/Construction Manager shall keep these order acknowledgement numbers on file in the construction trailer.

1.5 Product Delivery, Storage, and Handling:

- A. Label each item of hardware with the appropriate door number and Hardware Schedule heading number, and deliver to the installer so designated by the contractor.

1.6 Warranties:

- A. Refer to Division 1 for warranty requirements.
- B. During the warranty period, replace defective work, including labor, materials and other costs incidental to the work. Replace work found to be defective as defined in the General Conditions.

PART 2 - PRODUCT

- 2.1 Furnish each category with the products of only one manufacturer unless specified otherwise; this requirement is mandatory whether various manufacturers are listed or not.
- 2.2 Provide the products of manufacturer designated or if more than one manufacturer is listed, the comparable product of one of the other manufacturers listed. Where only one

manufacturer or product is listed, it is understood that this is the owner's Building Standard and "no substitution" is allowed.

A. Hinges:

1. Furnish hinges of class and size as listed in sets.
2. Numbers used are Ives (IVE).
3. Products of a BHMA member are acceptable.

B. Continuous Gear Hinge:

1. 6063-T6 aluminum alloy, anodized finish (cap on entire hinge painted if specified). Manufacture to template, uncut hinges non-handed, pinless assembly, three interlocking extrusions, full height of door and frame, lubricated polyacetal thrust bearing, fasteners 410 stainless steel plated and hardened. All hinge profiles to be manufactured to template bearing locations, with standard duty bearing configurations at 5-1/8" spacing with a minimum of 16 bearings: and heavy duty at 2-9/16" spacing with a minimum of 32 bearings. Anodizing of material shall be done after fabrication of components so that all bearing slots are anodized.
2. Length: 1" less than door opening height. Fastener 12-24 x 1/2" #3 Phillips keen form stainless steel self-tapping at aluminum and hollow metal doors, 12-1/2" #3 Philips, flathead full thread at wood doors.
3. Furnish fire rated hinges "FR" at labeled openings.
4. Numbers used are Select Products, Ltd.
 - a. For Aluminum and FRP frames;
 - 1) Select Products Ltd. SL11HD

C. Locksets and Latchsets - Mortise Type:

1. Locksets shall be manufactured from heavy gauge steel, minimum lockcase thickness 1/8", containing components of steel with a zinc dichromate plating for corrosion resistance.
2. Locks are to have a standard 2 3/4" backset with a full 3/4" throw two-piece stainless steel mechanical anti-

- friction latchbolt. Deadbolt shall be a full 1" throw, constructed of stainless steel.
3. Lockcase shall be easily handed without chassis disassembly by removing handing screw on lockcase and installing in opposite location on reverse side. Changing of door hand bevel from standard to reverse hand shall be done by removing the lockcase scalp plate, and pulling and rotating the latchbolt 180 degrees.
 4. Lock trim shall be through-bolted to the door to assure correct alignment and proper operation. Lever trim shall have external spring cage mechanism to assist in support of the lever weight. Thumb turns shall have "EZ" thumbturn equal to IR-Schlage L583-363.
 5. Function numbers are IR-Schlage.
 - a. IR-Schlage L9000
 6. Lockset Trim:
 - a. IR-Schlage 93N
 7. Provide strikes with extended lips where required to protect trim from being marred by latch bolt. Provide strike lips that do not project more than 1/8" beyond door frame trim at single doors and have 7/8" lip to center at pairs of 1-3/4" doors.

D. Exit Devices:

1. Exit devices shall be touchpad style, fabricated of brass, bronze, stainless steel, or aluminum, plated to the standard architectural finishes to match the balance of the door hardware.
2. All exit devices shall incorporate a fluid damper, which decelerates the touchpad on its return stroke and eliminates noise associated with exit device operation. Touchpad shall extend a minimum of one half of the door width. All latchbolts to be deadlatching type, with a self-lubricating coating to reduce wear.
3. End-cap will be sloped to deflect any impact from carts and they shall be flush with the external

- mechanism case. End caps that overlap and project above the mechanism case are unacceptable. End cap shall utilize a two-point attachment to the mounting bracket.
4. Touchpad shall match exit device finish, and shall be stainless steel for US26, US26D, US28, US32, and US32D finishes. Only compression springs will be used in devices, latches, and outside trims or controls.
 5. Plastic templates shall be included with each exit device to facilitate a quick, easy and accurate installation.
 6. Strikes shall be roller type and come complete with a locking plate to prevent movement.
 7. All rim and vertical rod exit devices shall have passed a 5 million(5,000,000) cycle test based on ANSI A156.3, 1994, Grade 1 test standards and certified by an independent testing lab.
 8. All mortise exit devices shall have passed a 10 million(10,000,000)cycle test based on ANSI A156.3, 1994, Grade 1 test standards and certified by an independent testing lab.
 9. Exit devices shall be UL listed panic exit hardware. All exit devices for fire rated openings shall be UL labeled fire exit hardware.
 10. Lever trim for exit devices shall be vandal-resistant type, which will travel to a 90-degree down position when more than 35 pounds of torque are applied, and which can easily be re-set.
 11. IR-Von Duprin 98 Series. Series and function numbers as listed in sets.
 12. Trim:
 - a. As specified in sets.
 - b. Levers to match lockset design where specified.
- E. Electric Power Transfer:
1. Transfer power from door frame to edge of door, UL listed R4504.
 2. IR-Von Duprin EPT
- F. Removable Mullion:
- a. Interior/Exterior doors, mullion is removable only through the use of building keys.

- 1) IR-Von Duprin KR4954
- b. Interior Doors - UL listed, Mullion is removable only through the use of building keys.
 - 1) IR-Von Duprin KR9954

G. Push and Pull Hardware:

1. Push Plates: Ives 8200 Series 6 x 16 x .050 inches. If stile widths will not accept 6 inches, provide stile width less two inches.
2. Push Bars: IR-Von Duprin 330/350
3. Pull, Offset: One inch round rod, 90 degree offset, 12 inch centers.
4. Pulls: One inch round rod, straight 12 inch centers.
5. Pull Plates: IR-Ives 8303-8 4 x 16 x .050 inches. 8" center.
6. Pull, Wire: 3/4 inch diameter, 6 inch centers.
7. Vandal Resistant Pulls: IR-Ives VR900 Series. Stainless steel construction 0.120 inches thick.
8. Manufacturer: Provide push and pull hardware from any member of B.H.M.A.

H. Closers:

1. Door closers shall have fully hydraulic, full rack and pinion action with a high strength cast iron cylinder. Cylinder body shall be 1 1/2" in diameter, and double heat treated pinion shall be 11/16" in diameter with double D slab drive arm connection.
2. Hydraulic fluid shall be of a type requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
3. Spring power shall be continuously adjustable over the full range of closer sizes, and allow for reduced opening force for the physically handicapped. Hydraulic regulation shall be by tamper-proof, non-critical valves. Closers shall have separate adjustment for latch speed, general speed, and backcheck.
4. All closers shall have solid forged steel main arms (and forged forearms for parallel arm closers).

5. All surface mounted mechanical closers shall be certified to exceed ten million (10,000,000) full load cycles by a recognized independent testing laboratory.
6. Closers will have Powder coating finish certified to exceed 100 hours salt spray testing by ETL, an independent testing laboratory used by BHMA for ANSI certification.
7. Refer to door and frame details and furnish accessories such as drop plates, panel adapters, spacers and supports as required to correctly install door closers. State degree of door swing in the hardware schedule.
8. IR-LCN Series as listed in sets.

I. ADA Special Closers

1. Where "Low Energy Power Operated Door" as defined by ANSI Standard A156.19 is indicated for doors required to be accessible to the disabled, provide electrically powered 4640 Series operators complying with the ADA requirements for opening force and time to close standards.
2. Full closing force shall be provided when the power or assist cycle ends.
3. Modular design, adjustments easily accessible from the front, UL listed for use on labeled doors.
4. Shall have "Second Chance" function to accommodate momentary resistance, "Breakaway" function in the electronically controlled clutch, "Soft Start" motor control function and "Maintain Hold-Open Switch" to hold the door open at 90 degree.
5. Shall have built in 12V and 24V power supply for actuators, card readers, electric strikes and magnetic door locks, inputs for both swing and stop side sensors and available to accept either 120VAC or 220VAC input power. All wiring connections between operator modules made by easy-to-handle electrical connectors. Shall comply with both UL and NEC requirements for Class 1 and Class 2 wiring by providing separate conduits for each.
6. Shall have seven independent electronic adjustments to tailor the operator for specific site conditions. Opening speed, holding force at 90 deg., sequential

trigger and time delay, hold-open time at 90 deg., opening force, clutch "breakaway" force setting, electric strike trigger and time delay.

7. Shall have separate and independent adjustments for back check, main speed and latch speed.
8. Furnish actuators and other controls as shown in Hardware Sets.

J. Overhead Holders and Stops:

1. Type, function and fasteners must be same as Glynn-Johnson specified. Size per manufacturer's selector chart. Plastic end caps, hold open mechanisms and shock blocks are not allowed. End caps must be finished same as balance of unit.
2. Manufacture products using base material of Brass/Bronze for US3, US4, & US10B finished products and 300 Stainless Steel for US32 & US32D finished products.
3. Type, function, and fasteners must be the same as Glynn-Johnson specified. Size per manufacturer's selector chart.
 - a. IR-Glynn-Johnson
 - b. Equal products of any BHMA manufacturer

K. Kick Plates:

1. Furnish .050 inches thick 10" high x door width less 2" at single doors and less 1" at pairs. Where glass or louvers prevent this height, supply with height equal to height of bottom rail less 2".
2. Any BHMA manufacturing product meeting above is acceptable.

L. Wall Stops:

1. Length to exceed projection of all other hardware. Provide with threaded studs and expansion shields for masonry wall construction. Install with slope at top.
 - a. IR-Ives WS33(X)

b. BHMA L12011 or L12021

M. Wall Holders:

1. Products specified by series only; furnish strike length to exceed projection of all other hardware.
 - a. IR-Ives WS40
 - b. Equal products of any BHMA manufacturer

N. Door Holding Magnets:

1. Electrically controlled, fail-safe, holds door open until current is interrupted.
2. Furnish model to hold door away from wall to allow for any trim or levers on pull side of door.
 - a. IR-LCN SEM 7800 series

O. Thresholds:

1. 1/2" high - 5" wide. Cope at jambs.
2. Furnish full wall opening width when frames are recessed.
3. Cope in front of mullions if thresholds project beyond door faces.
4. Furnish with non-ferrous Stainless Steel Screws and Lead Anchors.
 - a. National Guard as listed in sets
 - b. Equal of Zero or Reese

P. Door Sweeps:

1. Surface Sweeps:
 - a. National Guard as listed in sets
 - b. Equal by Zero or Reese

Q. Miscellaneous:

1. Furnish items not categorized in the above descriptions but specified by manufacturer's names in Hardware Sets.

R. Fasteners:

1. Furnish fasteners of the proper type, size, quantity and finish. Use machine screws and expansion shields for attaching hardware to concrete or masonry, and wall grip inserts at hollow wall construction. Furnish machine screws for attachment to reinforced hollow metal doors and frames and reinforced aluminum doors and frames. Furnish full thread wood screws for attachment to solid wood doors and frames. "TEK" type screws are not acceptable.
2. **Sex bolts will not be permitted on reinforced metal doors or wood doors where blocking is specified.**

2.3 Finishes:

- A. Generally, Dull Chrome, US26D / BHMA 626. Provide finish for each item as indicated in sets.

2.4 Templates and Hardware Location:

- A. Furnish hardware made to template. Supply required templates and hardware locations to the door and frame manufacturers.
- B. Furnish metal template to frame/door supplier for continuous hinge.
- C. Refer to Article 3.1 B.2, Locations, and coordinate with templates.

2.5 Cylinders and Keying:

- A. The Finish Hardware Supplier shall meet with Architect and Owner to finalize keying requirements and obtain keying instructions in writing. Supplier shall include the cost of this service in his proposal.
- B. Provide a cylinder for all hardware components capable of being locked.

- C. Provide cylinders factory master and grand master keyed to existing Bets system, according to Owner's instructions. Provide two change keys for each cylinder, three master keys for each master key set, and three grand master keys for system.
- D. Provide cylinders with removable construction cores for use during the construction period. When so directed, and in the presence of the Owner's security department or representative, Bets representative shall replace construction cores with final cores.
- E. Provide construction master keys as required by Contractor.
- F. Furnish visual key control - stamp key bows only with key set symbol.
- G. At the request of the Architect and when performing changeover from construction key system to final key system, deliver to the Architect or Owners Representative the following;
 - 1. Grand Master Keys
 - 2. Master Keys
 - 3. Extractor Key
 - 4. Copy of Finish Hardware Schedule

PART 3 - EXECUTION

3.1 Installation

A. General:

- 1. Install hardware according to manufacturers installations and template dimensions. Attach all items of finish hardware to doors, frames, walls, etc. with fasteners furnished and required by the manufacture of the item.
- 2. Provide blocking/reinforcement for all wall mounted Hardware.

3. Reinforced hollow metal doors and frames and reinforced aluminum door and frames will be drilled and tapped for machine screws.
4. Solid wood doors and frames: full thread wood screws. Drill pilot holes before inserting screws.
5. Continuous gear hinges attached to hollow metal doors and frames and aluminum doors and frames: 12-24 x 1/2" #3 Phillips Keenform self-tapping. Use #13 or 3/16 drill for pilot.
6. Continuous Gear Hinges require continuous mortar guards of foam or cardboard 1/2" thick x frame height, applied with construction adhesive.
7. Install weather-strip gasket prior to parallel arm closer bracket, rim exit device or any stop mounted hardware. Gasket to provide a continuous seal around perimeter of door opening. Allow for gasket when installing finish hardware. Door closers will require special templating. Exit devices will require adjustment in backset.

B. Locations:

1. Dimensions are from finish floor to center line of items.
2. Include this list in Hardware Schedule.

<u>CATEGORY</u>	<u>DIMENSION</u>
Hinges	Door Manufacturer's Standard
Levers	Door Manufacturer's Standard
Exit Device Touchbar	Per Template
Wall Stops/holders	At Head

C. Final Adjustment:

1. Provide the services of a representative to inspect material furnished and its installation and adjustment, to make final hardware adjustment, and to instruct the Owner's personnel in adjustment, care and maintenance of hardware.
2. Locksets, closers and exit devices shall be inspected by the factory representative and adjusted after installation and after the HVAC system is in operation, to insure correct installation and proper adjustment in operation. The manufacturer's

representative shall prepare a written report stating compliance, and also recording locations and kinds of noncompliance. The original report shall be forwarded to the Architect with copies to the Contractor, hardware distributor, hardware installer and building owner.

D. Technical and Warranty Information:

1. At the completion of the project, the technical and warranty information coalesced and kept on file by the General Contractor/Construction Manager shall be given to the Owner or Owner's Agent. In addition to both the technical and warranty information, all factory order acknowledgement numbers supplied to the General Contractor/Construction Manager during the construction period shall be given to the Owner or Owner's Agent. The warranty information and factory order acknowledgement numbers shall serve to both expedite and properly execute any warranty work that may be required on the various hardware items supplied on the project.
2. Submit to General Contractor/Construction Manager, two copies each of parts and service manuals and two each of any special installation or adjustment tools. Include for locksets, exit devices, door closers and any electrical products.

3.2 Hardware Sets:

TBD

END OF SECTION

SECTION 08800 - GLASS AND GLAZING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Attention is directed to Division 0, Bidding and Contract Requirements, and to Division 1, General Requirements, which are hereby made a part of this Section.

1.02 DESCRIPTION OF WORK:

- A. The extent of glass and glazing work is shown on the drawings.
- B. The required applications of glass and glazing include (but are not necessarily limited to) the following:
 - 1. Glazing interior openings.
 - 2. Glazing interior doors.
 - 3. Glazing aluminum windows.
 - 4. Glazing aluminum curtain wall.
 - 5. Glazing FRP flush doors.
 - 6. Glazing aluminum stile and rail doors.
 - 7. Skylight glazing.
- C. Related Work Specified Elsewhere:
 - 1. Fire Rated Glass: Section 08810.

1.03 QUALITY ASSURANCE:

- A. Prime Glass Standard: Comply with FS DD-G-451.
- B. Heat-Treated Glass Standard: Comply with the following as applicable.
 - 1. Consumer Product Safety Commission 16 CFR 1201.
 - 2. Industry Standards ANSI 297.1.
- C. Insulating Glass Seal Standard: Comply with proposed standard ASTM E6-P-3, Test Methods P1 and P2.

- D. Manufacturers: Provide each type of glass and primary sealant/gasket from a single manufacturer with not less than 5 years of successful experience in the production of materials similar to those required.
- E. Installer (Glazier): Firm with not less than five (5) years of successful experience in glazing work similar to required work.

1.04 SUBMITTALS:

A. Product Data:

- 1. Submit manufacturer's product specifications, including documentation to compliance with requirements and instructions for handling, storing, installing, cleaning and protecting each type of glass and glazing materials.

B. Samples:

- 1. Submit two (2) samples of each type of glass and glazing material required, except for single-pane clear glass (including annealed and tempered). Submit 12" square glass samples and 12" lengths of installed (mocked-up) glazing materials.
 - a. Submit insulating glass samples with completed edge-seal construction, but hermetic seal need not be maintained.

C. Warranties:

- 1. Warranty on Insulating Glass Units: Provide written warranty signed by fabricator (manufacturer) and countersigned by Contractor agreeing to within 10 years from date of substantial completion replace glass units with defective hermetic seal of air spaces (but not including that due to glass breakage); defined to include intrusion of dirt or moisture, internal condensation or fogging at temperature above -20 degrees F., deterioration of protected internal glass coatings resulting from seal failure, and other visual evidence of seal failure or performance; provide the manufacturer's printed and submitted instructions for handling, protecting, and maintaining units that have been adhered to during the warranty period.

2. Warranty on Laminated Glass: Provide written warranty signed by laminator (manufacturer) and countersigned by Contractor agreeing to within five (5) years after date of acceptance, replace glass units with defective lamination, defined to include evidence of delamination, changes in required strengths, transmittances, color, transparency, and other required performance.

1.05 PRODUCT HANDLING:

- A. Comply with manufacturer's instructions for shipping, handling, storing, and protecting glass and glazing materials. Exercise exceptional care to prevent edge damage to glass, and damage/deterioration to coatings on glass.

1.06 JOB CONDITIONS:

- A. Pre-Installation Meeting: Comply with General Requirements for pre-installation meeting of Glazier and other trades affected by glass installation.
- B. Weather: Do not proceed with glazing under adverse weather conditions. Install liquid sealants when temperatures are within lower or middle third of temperature range recommended by manufacturer.

PART 2 - PRODUCTS

2.01 GLASS

A. Non-processed Glass:

1. Clear Float/Plate: Type I, Class 1, Quality q3.
2. Tinted Glass: Manufacturer's standard bronze tint plate.
3. Laminating Film: Except as otherwise indicated, provide clear transparent permanent film of polyvinyl butyryl (PVB), not less than 30 mils thick (60 mils @ skylight), as adhesive plastic interlayer for laminating sheets of glass of a composition which has successfully withstood a minimum of 20 years exposure to sunlight and severe weather/temperature changes.

B. Processed Glass:

1. Tempered Glass: Heat treat to strengthen glass in bending to not less than 4.5 times annealed strength.

2. Tong Marks: Wherever the glazing system shown for the installation of tempered glass will not conceal the tong marks inherent from normal tempering processes, provide tempered glass produced by special process which eliminates tong marks.

C. Fabricated Products:

1. Laminated Glass:

- a. Laminate units at the factory using manufacturer's standard pressure-plus-heat process to produce units of the required sizes, thicknesses, and component make-up to comply with the details and performance requirements shown and specified herein. Exercise extreme precautions and plant control in the laminating process to exclude dirt and other foreign matter from the lamination, and to eliminate voids and achieve complete lamination at each glass surface.

- b. Fabricate units to proper size and shape at the factory so that no cutting, seaming, or nipping will be required for installation at the project site.

- c. Provide the following type:

- (1) 1/4" Clear of Solexia (transparent) by PPG or equal consisting of:

Exterior Glass: 1/8" tempered
Laminating Film: 30 mils thick
Interior Glass: 1/8" tempered glass

A. ``Solexia Glass``

Visible light transmission	69%
U value winter	0.47
U value summer	0.50
SHGC	0.49
Shading Coefficient	0.57
Outdoor visible light reflectance	13%
Outdoor appearance:	Light green color, low reflective glass product

- (2) 1/4" clear:

Exterior Glass: 1/8" clear plate tempered

glass

Laminating Film: 60 mils thick

Interior Glass: 1/8" clear plate temp. glass

(3) Skylight Safety Glazing:
Comply with UL972
Interior Glass (of insulated units):
7/16'' gray heat strengthened laminated
with .060 clear PVB.

2. Insulating Glass:

- a. Fabricate and label units to match units which have been tested and certified by the Insulating Glass Certification Council in accordance with proposed standard ASTM E6-P3, Test Methods, P1 and P2 (as sponsored by the Sealed Insulating Glass Manufacturers Association); and passed tests for glass seal classification "A".
- b. Fabricate units with a permanent, hermetically sealed dry air or glass filled space of the width indicated between sheets of glass as indicated. Provide an edge seal consisting of twin primary sealant beads of silicone positioned and retained by a tubular aluminum or galvanized steel spacer-bar frame with soldered/welded sealed corners, and filled with desiccant with breather ports into sealed space; with secondary edge sealant completely encapsulating outer face of spacer bar and sealed to the opposing sheets of glass. Provide silicone elastomeric sealant as secondary edge seal.
 - (1) Extend secondary sealant to provide minimum of 1/16" thick elastomeric coating on edges of glass sheets in each insulating glass unit (to form a protective edge cushion).
 - (2) Width: Except as otherwise indicated, fabricate units with 1/2" wide air spaces.
 - (3) Fill air spaces by fabricator's standard process, using either gas or dry air with a maximum dew point of -20 degrees F. Exercise extreme care to exclude dirt and other foreign substances.
- c. Label each unit to show compliance with required standards and regulations, and to list generically each component including elements of edge seal. Indicate which face of unit is for exposed to exterior of weather. Provide removable label except where regulations require a permanent label.

- (1) Label interior-exposed edge of spacer bar with fabricator's name and date of completing hermetic seal.

d. Provide the following types:

- (1) At all exterior locations except skylight:
1" Clear:
Exterior Glass: 1/4" laminated ("Solexia" transparent by PPG).
Interior Glass: 1/2" air space
 1/4" laminated clear plate
- (2) Skylight Safety Glazing:
Comply with UL 972
Interior Glass: (of insulated units)
7/16" gray heat strengthened laminated with .060 clear PVB.

D. Design Thickness:

1. Verify all glass thicknesses will comply with performance requirements.

E. Manufacturer of Glass: One of the following:

1. Old Castle Building Envelope
2. Saint-Gobain North America
3. Pilkington North America, Inc.
4. PPG Industries, Inc.
5. Guardian Industries, North America
6. Viracon, Inc., Owatonna, MN

F. Edges:

1. Polish edges wherever exposed to view.

G. Coatings:

1. Provide low emissivity (low-E) pyrolytic coating (on #3 surface of insulated units unless noted otherwise).

2.02 GLAZING SEALANTS, COMPOUNDS AND GASKETS:

- A. Colors: Provide black or other natural color where no other color is available. Where material is not exposed to view, provide manufacturer's standard color which has the best overall performance characteristics for application shown.
- B. Hardnesses shown and specified are intended to indicate general range necessary for overall performance. Consult manufacturer's technical representative to determine actual hardness recommended for conditions of installation and use. Architect will furnish information concerning anticipated glass movement related to actual glazing channel width and installation temperature upon request. Except as otherwise indicated or recommended, provide glazing materials within the following ranges of hardness (Shore A, fully cured, at 75 degrees F.):
1. 15 to 35 for elastomeric compounds and tapes used with rigid stops and frames for large glass sizes (in excess of 100 united inches). Provide material sufficiently hard to withstand exposure (if any) to abrasion and vandalism.
 2. 25 to 50 for rubber-like curing compounds used with rigid stops and frames for medium and small glass sizes (less than 100 united inches). Provide materials sufficiently hard to withstand impact where used on moving sash and doors.
 3. 35 to 60 for molded gaskets used with rigid stops and frames, depending upon strength needed for applications or insertion of units and open profile of gasket.
 4. 70 to 80 for structural gaskets (not supported by stops).
 5. Non-Elastomeric Compounds: (Shore A not applicable) 2 to 12 mm penetration for 5.0 seconds of penetrometer needle on nominally cured compound (ASTM D 2451).
- C. Compatibility: Before purchase of specified glazing materials, investigate compatibility with channel surfaces, joint fillers, and other materials in glazing channel. Provide only materials (manufacturer's recommended variation of specified materials) which are known to be fully compatible with actual installation condition, as shown by manufacturer's published data or certification.

- D. Provide size and shape of gaskets and preformed glazing units as shown, or if not shown, as recommended by manufacturer, either in published data or upon consultation with technical representative.
- E. Two-Component Polysulfide Glazing Sealant:
1. Polysulfide-based, 2-part elastomeric sealant, comply with FS TT-S-00227, Class A, Type 2 (non-sag); certified by manufacturer to be specifically compounded for glazing application, with sufficient resistance to UV deterioration to show no significant change for 20 years of normal glazing exposure to the sun.
 2. Product/Manufacturer:
 - a. Lasto-Meric; Tremco, Inc.
 3. Use for cap bead on all sloped glazing.
- F. Nonporous Bond Silicone Rubber Glazing Sealant"
1. One-part acid-type silicone rubber elastomeric sealant, complying with FS TT-S-001543, Class A, non-sag, recommended by manufacturer for non-porous exterior joint surfaces and for glazing.
 2. Products/Manufacturers: Provide one of the following:
 - a. 781 Building Sealant; Dow Corning Corporation
 - b. Silicone Construction 1200 Sealant; General Electric Company
 - c. Rhodorsil Sealant 3B; Rhodia Inc. Chemical Division
- G. Preformed Butyl Rubber Glazing Sealant:
1. Preformed ribbon or tape (coiled with release paper) of polymerized butyl (or mixture of butyl and polyisobutylene) with inert fillers (pigments), solvent-based with minimum 95% solids, non-sag consistency, tack-free time of 24 hours or less, paintable, non-staining, pre-shimming to prevent stretch (as required by Glazier to facilitate proper application and glass installation).
 2. Product/Manufacturer:
 - a. Polyshim Tape: Tremco, Inc.

3. Use for exterior glazing of all glass in aluminum window wall metal framed skylight and in all interior glazing.

H. Gaskets:

1. Refer to Section 07812 for gaskets part of metal framed skylight.

2.03 MISCELLANEOUS GLAZING MATERIALS:

- A. Channel Cleaner: Use type compound recommended by sealant manufacturer for channel surfaces to be cleaned.
- B. Channel Primer/Sealer: Provide type of primer or sealer recommended by sealant manufacturer for application of sealant to channel surfaces.
- C. Setting Blocks: Neoprene or other resilient blocks of 70 to 90 Shore A durometer hardness, tested for compatibility with specified glazing sealants.
- D. Spacers: Neoprene or other resilient blocks of 40 to 50 Shore A durometer hardness, adhesively backed on one face only, tested for compatibility with specified glazing sealants.
- E. Compressible Filler Rod: Closed-cell or waterproof-jacketed foam of polyethylene, butyl rubber, neoprene, polyurethane, or vinyl tested for compatibility with specified glazing sealants of 5 to 10 psi compression strength(25% deflection) as recommended by sealant manufacturers for use in glazing channel to prevent sealant exudation from channel.

PART 3 - EXECUTION

3.01 INSPECTION:

- A. Glazier must examine framing and substrate work to receive glass and glazing materials and conditions under which glass is to be installed, and notify Contractor, in writing, of conditions detrimental to proper completion of the work. Do not proceed with glazing until unsatisfactory conditions have been corrected in a manner acceptable to Glazier.

3.02 PERFORMANCE REQUIREMENTS:

- A. Watertight and airtight installation of each piece of glass is required, except as otherwise shown. Each installation must withstand normal temperature changes wind loading, and impact loading (for operating sash and doors) without failure, including loss or breakage of glass, failure of sealants or gaskets to remain watertight and airtight, deterioration of glazing materials and other defects in the work.
- B. Protect glass from edge damage during handling, installation and operation of building systems/equipment. Glass breakage during warranty period is a form of faulty material or workmanship (resulting from edge damage) unless known to result from vandalism or other causes not related to materials and workmanship.
- C. Glazing channel dimensions as shown are intended to provide for necessary minimum bite on glass, minimum edge clearance, and adequate sealant thickness with reasonable tolerances. Glazier is responsible for correct glass size for each opening within tolerances and necessary dimensions established.

3.03 INSTALLATION

A. General and Standards:

- 1. Comply with combined recommendations of glass manufacturer and manufacturer of sealants and other materials used in glazing, except where more stringent requirements are shown or specified, and except where manufacturers' technical representatives direct otherwise.
- 2. Unify appearance of each series of lights by setting each piece to match others as nearly as possible. Inspect each piece and set with pattern, drawn, and bow oriented in the same direction as other pieces.
- 3. Inspect each piece of glass immediately before installation and eliminate pieces which have observable edge damage or face imperfections.
- 4. Do not attempt to cut, seam, nip or abrade glass which is tempered, heat strengthened, or coated.

5. Cut and install colored (tinted) and heat absorbing glass as recommended in "Technical Services Report No. 104" (latest edition) by PPG Industries, or similar report by other glass manufacturer.
6. Comply with applicable publications by Flat Glass Marketing Association, except as shown and specified otherwise, and except as specifically recommended otherwise by the manufacturers of the glass and glazing materials.

B. Preparation of Substrate:

1. Clean the glazing channel or other framing member to receive glass, immediately before glazing. Remove coatings which are not firmly bonded to the substrate. Remove lacquer from metal surfaces where elastomeric sealants are used.
2. Apply primer or sealer to joint surfaces where recommended by sealant manufacturer.

C. Sealant/Compound Glazing:

1. Install setting blocks of proper size in sill rabbet, locate at one-fourth of glass width measured from each jamb. Set blocks in thin course of the heel bead compound if heel bead is to be installed.
2. Provide spacers inside and out, and of proper size and spacing for glass sizes larger than 50 united inches, except where pre-shimmed tape or gaskets are used for glazing. Provide 1/8" minimum bite of spacers on glass and use thickness equal to sealant width, except with butyl rubber sealant tape use thickness 1/32" less than final compressed thickness of tape.
3. Voids and Filler Rods: Prevent exudation of sealant or compound by forming voids or installing filler rods in channels at heel of jambs and heads (do not leave voids in sill channels), except as otherwise indicated. In general, voids or filler rods are required for insulating glass and for laminated glass larger than 75 united inches, and for other glass more than 9/32" thick or larger than 120 united inches.

4. Force sealants into channel to eliminate air pockets and voids (other than expansion voids), and to ensure complete "wetting" and bond of sealant to glass and channel surfaces.
5. Tool exposed surfaces of glazing sealants and compounds to provide a substantial "wash" away from glass.
6. When installing processed glass, exercise extraordinary care to avoid contact of glazing materials with processed surfaces, except where concealed in glazing channel. Use masking tape to ensure limitation of compounds to channel area.
7. Clean and trim excess glazing materials from glass and stops or frames promptly after installation, and eliminate stains and discolorations.

D. Gaskets and Tapes:

1. Miter cut and bond ends together at corners where gaskets are used for channel glazing so that gaskets will not pull away from corners and result in voids or leaks in glazing system.
2. Install pressurized tapes and gaskets to protrude slightly out of channel so as to eliminate dirt and moisture pockets. Trim to straight line as required.

3.04 CURE AND PROTECTION:

- A. Cure glazing sealants and compounds in compliance with manufacturer's instructions and recommendations to obtain high early bond strength, internal cohesive strength, and surface durability.
- B. Glazier shall advise the Construction Manager of procedures required for protection of glass and glazing sealants and compounds during construction period so that they will be without deterioration or damage (other than normal weathering) at time of Owner's acceptance.
 1. Furnish specific instruction to the Construction Manager on precautions and provisions required to prevent glass damage resulting from the alkaline wash from green concrete surfaces and similar sources of possible damage.

2. Protect exterior glass from breakage immediately upon installation by attachment of crossed streamers to framing held away from glass. Do not apply markers directly on surfaces of glass. Except as otherwise indicated, remove applied labels from glass surfaces immediately after glass installation.
3. Remove and replace glass which is broken, chipped, cracked, abraded or damaged in other ways during the construction period, including pieces damaged through natural causes, accidents and vandalism.

3.05 CLEANING GLASS:

- A. Maintain glass in a reasonably clean condition during construction so that it will not be damaged by corrosive or erosive action and will not contribute (by wash-off) to deterioration of glazing materials and other work.
 1. Clean glass in accordance with manufacturer's recommendations. Do not use abrasive materials. On glass, do not use broken razor blades for cleaning.
- B. Wash and polish glass on both faces not more than 4 days prior to Owner's acceptance of the work in each area. Comply with glass manufacturer's recommendations.

END OF SECTION 08800

SECTION 08810-FIRE RATED GLASS AND FRAMING SYSTEMS-HEAT BARRIER SERIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Fire rated glazing and framing systems for installation as walls.
- B. Related Sections:
 - 1. Section 09250 "Gypsum board Assemblies" for gypsum board and metal stud framed area separation partition walls.
 - 2. Section 08210 "Flush Wood Doors" for Vision Panels in interior doors.

1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. ASTM E119: Methods for Fire Tests of Building Construction and Materials.
- B. National Fire Protection Association (NFPA):
 - 1. NFPA 251: Fire Tests of Building Construction & Materials
- C. Underwriters Laboratories, Inc. (UL):
 - 1. UL 263: Fire tests of Building Construction and Materials
- D. American National Standards Institute (ANSI):
 - 1. ANSI Z97.1: Standard for Safety Glazing Materials Used in Buildings
- E. Consumer Product Safety Commission (CPSC):
 - 1. CPSC 16 CFR 1201: Safety Standard for Architectural Glazing Materials
- F. MBC 2009 Ed., NFPA 101 1997 Ed.

1.3 SYSTEM DESCRIPTION

- A. Performance Requirements
 - 1. Duration of Fire Rating - Window/Walls: Capable of providing a fire rating for 60 minutes.

2. Fire Resistive Rating: Glaze applications in occupancy or area separation walls and corridors where glazing exceeds 25% of the wall area, or as otherwise specified with a fire resistive assembly meeting the radiant heat requirements of ASTM E119. Per ASTM E119 and UL 263 requirements temperature on the non-fire side of glazing and framing at conclusion of fire test exposure shall be below 250°F above ambient room temperature.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01330.
- B. Shop Drawings: Show doors, frames, hardware and steel frame components as shown on shop drawings and schedules
- C. Obtain Architect's approval before fabrication.
- D. Samples for Initial Powder Coating Color Selection: For steel frames with factory-applied powder coat color finishes.
 1. Triplicate copies of manufacturer's powder coating color charts showing the full range of colors available.
- E. Samples: For following products:
Two 8-inch by 10-inch Samples for glass.
- F. Glazing Schedule: Use same designations indicated on Drawings for glazed openings in preparing a schedule listing glass types and thicknesses for each size opening and location.
- G. Technical Information: Submit latest edition of manufacturer's product data providing product descriptions, technical data and installation instructions.
- H. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for this Project; whose work has resulted in

glass installations with a record of successful in-service performance; and who employs glass installers for this Project who are certified under the National Glass Association Glazier Certification Program as Level 2 (Senior Glaziers) or Level 3 (Master Glaziers).

- B. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for Project and whose work has resulted in construction with a record of successful in-service performance.
- C. Source Limitations for Glazing Accessories: Obtain glazing accessories from one source for each product and installation method indicated.
- D. Certification: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements.
 - 1. Wall assemblies shall be tested to the acceptance criteria of ASTM E119, NFPA 251, UL 263 Standard Test Methods for Fire Tests of Building Construction and Materials.
 - 2. Underwriters Laboratories (UL) shall conduct fire test.
- E. Listings and Labels - Fire Rated Assemblies: Under current follow-up service by an approved independent agency maintaining a current listing or certification. Label assemblies accordance with limits of manufacturer's listing.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle under provisions specified by manufacturer. For details on storage and product handling, please contact Technical Glass Products and request information on storage and product handling.
- B. Deliver materials to specified destination in manufacturer or distributor's packaging undamaged, complete with installation instructions.
- C. Store off ground, under cover, protected from weather and construction activities.

1.7 WARRANTY

- A. Provide the Pyrostop and Forster Frame supplier's limited five year warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS - FIRE RATED WALL ASSEMBLY

- A. Manufacturer Glazing Material: ``Pyrostop®`` fire-rated glazing as manufactured by the Pilkington Group and distributed by Technical Glass Products, 2425 Carillon Point, Kirkland, WA 98033 (800-426-0279) fax (800-451-9857) e-mail sales@fireglass.com, web site <http://www.fireglass.com>
- B. Frame System: ``Heat Barrier Frames`` fire-rated steel frame system as manufactured by Herman Forster AG and supplied by Technical Glass Products, 2425 Carillon Point, Kirkland, WA 98033 (800-426-0279) fax (800-451-9857) e-mail sales@fireglass.com web site <http://www.fireglass.com>
- C. Substitutions: Equal Products by Safti-Superlite II-XL as manufactured by O'Keefe's, Inc. will be considered, if installed as part of their fire rated heat barrier system.

2.2 MATERIALS - GLASS

- A. Fire Rated Glazing: Composed of multiple sheets of ``Optiwhite`` high visible light transmission glass laminated with an intumescent interlayer.
- B. Properties:
 - 1. Thickness: For Interior Use: 15/16'', #60-101 (nominal 7/8'').
 - 2. Weight: Varies with thickness 10.85 lbs/sf .
 - 3. Approximate Visible Transmission: Varies with thickness 88 percent).
 - 4. Fire-rating: 60 min..
 - 5. Impact Safety Resistance: ANSI Z97.1 and CPSC 16CFR1201 (Cat. I and II).
 - 6. STC Rating: 41 dB.
- C. Logo: Each piece of fire-rated glazing shall be labeled with a permanent logo including name of product, manufacture, testing laboratory (UL), fire rating period, safety glazing standards, and date of manufacture.

2.3 MATERIALS - STEEL FRAMING

- A. Steel Framing System 60 min.:
1. Steel Frame: Profiled steel tubing permanently joined with steel bolts.
 2. Insulation: Insulate framing system against effects of fire, smoke, and heat transfer from either side. Insulate profiled steel tubing using a shell construction that incorporates Promatect-H intermediate interlayer. Firmly pack perimeter of framing system to rough opening with mineral wool fire stop insulation or appropriately rated intumescent sealant.
 3. Steel Glazing Beads: Extruded steel beads with dimensions recommended by manufacturer to securely hold glazing material in place.
 4. Fasteners: Type recommended by manufacturer
 5. Glazing Accessories: Line glazing pockets with intumescent tape supplied by frame manufacturer. Set Pyrostop glass using neoprene setting blocks.
 6. Glazing Compounds: Glaze Pyrostop glass with approved vinyl supplied by manufacturer.

2.4 FABRICATION

- A. Furnish frame assemblies pre-welded. When necessary, splice frames too large for shop fabrication or shipping or to fit in available building openings. Fit with suitable fasteners. Knock-down frames NOT PERMITTED.
- B. Field glaze door and frame assemblies.
- C. Factory prepare steel door assemblies field mounting of hardware
- D. Fabrication Dimensions: Fabricate fire rated assembly to approved dimensions. Guarantee dimensions where practicable within required tolerance.
- E. Obtain approved Shop Drawings prior to fabrication.

2.5 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish frames after assembly.

- C. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- D. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable. Noticeable variations in the same piece are not acceptable.

2.6 FACTORY FINISHES

- A. Color-Coated Finish: Apply manufacturer's standard powder coating finish system applied to factory-assembled frames before shipping, complying with manufacturer's written instructions for surface preparation including pretreatment, application, and minimum dry film thickness.
 - 1. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and members to which the work of this section attaches or adjoins prior to frame installation.
- B. Provide openings plumb, square and within allowable tolerances.
- C. Notify Architect of any conditions which jeopardize the integrity of the proposed fire wall / door system. Do not proceed until such conditions are corrected.

3.2 INSTALLATION

- A. Install fully welded fire wall by a specialty contractor with appropriate experience qualifications; and in strict accordance with the approved shop drawings. Employ experienced mechanics familiar with this type of specialized work.
- B. Install glazing in strict accordance with fire resistant glazing material manufacturer's specifications. Field cutting or tampering is not permissible.

3.3 PROTECTION AND CLEANING

- A. Protect glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do

not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.

- B. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove them immediately as recommended by glass manufacturer.
- C. Remove and replace glass that is broken, chipped, cracked, abraded, or damaged in any way, including natural causes, accidents, and vandalism, during construction period.
- D. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended by glass manufacturer.

END OF SECTION 08810

SECTION 09200 - EXTERIOR PLASTER SYSTEM

PART 1 GENERAL

1.01 SUMMARY

- A. Provide new EIFS finish over existing EIFS surfaces as indicated on drawings.

1.02 SUBMITTALS

- A. Manufacturer's specifications, details, installation instructions and product data.
- B. Manufacturer's code compliance report.
- C. Manufacturer's standard warranty.
- D. Manufacturer's certificate of compliance with EIMA standards.
- E. Applicator's certificate of instruction.
- F. Samples for approval as directed by architect or owner.
- G. EPS board manufacturer's certificate of compliance with the current edition of EIMA Guideline Specifications for the use of Expanded Polystyrene (EPS) Insulation Board.
- H. Sealant manufacturer's certificate of compliance with ASTM C 1382.
- I. Prepare and submit project-specific details (when required by contract documents).

1.03 REFERENCES

- A. ASTM Standards:
 - 1. B 117 Test Method for Salt Spray (Fog) Testing
 - 2. C 1396 Standard Specification for Gypsum Board
 - 3. C 150 Specification for Portland Cement
 - 4. C 297 Test Method for Tensile Strength of Flat Sandwich Constructions in Flatwise Plane
 - 5. C 578 Specification for Preformed, Cellular Polystyrene Thermal Insulation

6. C 1177 Specification for Glass Mat Gypsum for Use as Sheathing
7. C 1280 Specification for Installation of Sheathing
8. C 1382 Test Method for Determining Tensile Adhesion Properties of Sealants When Used in Exterior Insulation and Finish Systems (EIFS) Joints
9. D 522 Test Methods for Mandrel Bend Test of Attached Organic Coatings
10. D 882 Standard Test Methods for Tensile Properties of Thin Plastic Sheeting
11. D 968 Test Method for Abrasion Resistance of Organic Coatings by Falling Abrasive
12. D 1382 Test Method for Determining Tensile Adhesion Properties of Sealants When Used in Exterior Insulation and Finish System (EIFS) Joints
13. D 1784 Specification for Rigid Poly (Vinyl Chloride) (PVC) and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
14. D 2247 Practice for Testing Water Resistance of Coatings in 100% Relative Humidity
15. D 2370 Test Method for Tensile Properties of Organic Coatings
16. D 3273 Test for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber
17. D 4541 Test Method for Pull-Off Strength of Coatings using Portable Adhesion-Testers
18. E 84 Test Method for Surface Burning Characteristics of Building Materials
19. E 96 Test Methods for Water Vapor Transmission of Materials
20. E 108 Method for Fire Tests of Roof Coverings
21. E 119 Method for Fire Tests of Building Construction and Materials
22. E 283 Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors under Specified Pressure Differences Across the Specimen
23. E 330 Test Method for Structural Performance of Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference
24. E 331 Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference

25. E 1233 Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls and Doors by Cyclic Static Air Pressure Difference
26. E 2098 Test Method for Determining Tensile Breaking Strength of Glass Fiber Reinforcing Mesh for Use in Class PB Exterior Insulation and Finish System after Exposure to a Sodium Hydroxide Solution
27. E 2134 Test Method for Evaluating the Tensile-Adhesion Performance of an Exterior Insulation and Finish System (EIFS) (101.03 Standard Test Method for Determining Tensile Adhesion Strength of Exterior Insulation and Finish System (EIFS), and Components, Class PB (Modified ASTM C 297)
28. E 2430 Specification for Expanded Polystyrene (EPS) Thermal Insulation Boards for use in Exterior Insulation and Finish Systems (EIFS) (EIMA Guideline Specification for Expanded Polystyrene (EPS) Insulation Board)
29. E 2570 Test Method for Water-Resistive (WRB) Coatings used Under Exterior Insulation and Finish Systems (EIFS) or EIFS with Drainage
30. G 153 Recommended Practice for Operating Light-and Water-Exposure Apparatus (Carbon-Arc Type) for Exposure of Nonmetallic Materials
31. G 154 Recommended Practice for Operating Light-and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials

B. Building Code Standards

1. UBC Standard 26-4, (formerly 17-6), "Method of Test for the Evaluation of Flammability Characteristics of Exterior, Nonload-Bearing Wall Panel Assemblies Using Foam Plastic Insulation," International Conference of Building Officials (ICBO), Inc.
2. Section 1407.0, 1999 National Building Code, Building Officials and Code Administrators International (BOCA), Inc.
3. Section 2603.4.7, 1997 Standard Building Code, Southern Building Code Congress International (SBCCI), Inc.
4. AC235 Acceptance Criteria for EIFS Clad Drainage Wall Assemblies (October 1, 2004)
5. 2012 Edition of the Michigan Building Code.

- C. National Fire Protection Association (NFPA) Standards
 - 1. NFPA 268, "Standard Test Method for Determining Ignitability of Exterior Wall Assemblies Using a Radiant Heat Energy Source"
 - 2. NFPA 285, "Standard Method of Test for the Evaluation of Flammability Characteristics of Exterior Non-Load-Bearing Wall Assemblies containing Combustible Components Using the Intermediate-Scale, Multistory Test Apparatus"

- D. EIMA (EIFS Industry Members Association) Standards and Publications
 - 1. 101.01 Standard Test Method for Freeze-Thaw Resistance of Exterior Insulation and Finish Systems (EIFS), Class PB (Modified ASTM C 67)
 - 2. 101.02 Standard Test Method for Resistance to Water Penetration of Exterior Insulation and Finish Systems (EIFS), Class PB (Modified ASTM E 331)
 - 3. 101.86 Standard Test Method for Resistance of Exterior Insulation and Finish Systems (EIFS), Class PB, to the Effects of Rapid Deformation (Impact)

- E. Gypsum Association
 - 1. GA-253 Recommended Specifications for the Application of Gypsum Sheathing
 - 2. GA-254 Fire Resistant Gypsum Sheathing
 - 3. GA-600 Fire Resistance Design Manual

- F. APA Engineered Wood Association
 - 1. E 30 Residential and Commercial Construction Guide

- G. Other Referenced Documents
 - 1. American Association of Textile Chemists and Colorists AATCC-127 Water Resistance: Hydrostatic Pressure Test
 - 2. ICC-ES ESR-1748, Evaluation Report for StoTherm NExT EIFS.
 - 3. ICC-ES ESR-1233, Evaluation Report for StoGuard™

1.04 DESIGN REQUIREMENTS

A. Wind Load

1. Design for maximum allowable system deflection, normal to the plane of the wall, of L/240.
2. Design for wind load in conformance with code requirements.

B. Moisture Control

1. Prevent the accumulation of water behind the EIF system, either by condensation or leakage through the wall construction, in the design and detailing of the wall assembly.

C. Impact Resistance

1. Provide ultra-high impact resistance at all areas.

D. Color Selection:

1. Select finish coat with a light reflectance value of 20 or greater. (The use of dark colors is not recommended with EIF Systems that incorporate expanded polystyrene (EPS). EPS has a service temperature limitation of approximately 160° F [71°C]).

E. Joints

1. Install minimum 3/4 inch (19 mm) wide expansion joints in the EIFS where they exist in the substrate or supporting construction, where the EIFS adjoins dissimilar construction or materials, at changes in building height, unless noted otherwise.
2. Install minimum 1/2 inch (13 mm) wide sealant joints at all penetrations through the EIFS (windows, doors, etc.), unless noted otherwise.
3. Provide compatible backer rod and sealant that has been evaluated in accordance with ASTM C 1382, "Test Method for Determining Tensile Adhesion Properties of Sealants When Used in Exterior Insulation and Finish System (EIFS) Joints," and that meets minimum 50% elongation after conditioning.
4. Install joints so that Air Barrier continuity is maintained across the joint and drain joints to the exterior.

1.05 PERFORMANCE REQUIREMENTS

Table 1–Air/Moisture Barrier Performance

TEST	METHOD	CRITERIA	RESULT
1. Water Penetration Resistance	AATCC 127 (Water Column)	Resist 21.6 in (55 cm) water for 5 hours before and after aging	Pass
2. Water Penetration Resistance after Cyclic Wind Loading	ASTM E 1233 / ASTM E 331	No water at exterior plane of sheathing after 10 cycles @ 80% design load and 75 minutes water spray at 6.24 psf (299 Pa) differential	No water penetration on Plywood, OSB, Gypsum and Dens-Glass® Gold sheathings
3. Water Resistance Testing	ASTM D 2247	Absence of deleterious effects after 14 day exposure	No deleterious effects
4. Water Vapor Transmission	ASTM E 96 Method B (Water Method)	Measure	Sto Gold Fill*: 7.1 perms ($4.08 \times 10^{-10} \text{ kg/Pa}\cdot\text{s}\cdot\text{m}^2$)
5. Air Leakage	ASTM E 283	$<0.06 \text{ cfm/ft}^2$ ($0.00030\text{m}^3/\text{s}\cdot\text{m}^2$)	$<0.0044 \text{ cfm/ft}^2$ ($0.000022 \text{ m}^3/\text{s}\cdot\text{m}^2$)
6. Structural Integrity	ASTM E 330	2-inches (51 mm) H ₂ O pressure (positive & negative) for 1 hour.	Pass
7. Dry Tensile Strength	ASTM D 882	20 lbs/in (3503 N/m), minimum before and after aging	Sto Gold Fill:* 159 lbs/in (27845 N/m) before aging 213 lbs/in (37302 N/m) after aging
8. Pliability	ASTM D 522	No Cracking or Delamination using $\frac{1}{8}$ " (3 mm) mandrel at 14°F (-10°C) before and after aging	Pass
9. Surface Burning	ASTM E 84	Flame Spread 0 - 25 for NFPA Class A, UBC Class I	Flame Spread: 5 Smoke Density: 10
10. Tensile Adhesion	ASTM C 297	>15 psi (103 kPa)	>30 psi (207 kPa) to Plywood, OSB, Gypsum and Dens-Glass® Gold sheathings

* Note: Sto Gold Fill testing with Sto Detail Mesh reinforcement

Table 2–EIFS Weather Resistance and Durability Performance

TEST	METHOD	CRITERIA	RESULTS
1. Accelerated Weathering	ASTM G 153 (Formerly ASTM G 23)	No deleterious effects* at 2000 hours when viewed under 5x magnification	Pass
2. Accelerated Weathering	ASTM G 154 (Formerly ASTM G 53)	No deleterious effects* at 2000 hours when viewed under 5x magnification	Pass at 5000 hours
3. Freeze/Thaw Resistance	EIMA 101.01 (Modified ASTM C 67)	No deleterious effects* at 60 cycles when viewed under 5 x magnification	Pass at 90 cycles

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NOVEMBER 30, 2016

4. Water Penetration	EIMA 101.02 (Modified ASTM E 331)	No water penetration beyond the plane of the base coat/EPS board interface after 15 minutes at 6.24 psf (299 Pa) or 20% of design wind pressure, whichever is greater	Pass at 12.0 psf (575 Pa) after 30 minutes
5. Drainage Efficiency	EIMA 200.02	90% minimum	> 99%
6. Tensile Adhesion	EIMA 101.03 (modified ASTM C 297)	No failure in the adhesive, base coat, or finish coat. Minimum 5 psi (34 kPa) tensile strength before/after accelerated weathering and freeze/thaw exposure	Pass
7. Water Resistance	ASTM D 2247	No deleterious effects* at 14 day exposure	Pass at 42 days
8. Salt Spray	ASTM B 117	No deleterious effects* at 300 hours	Pass at 700 hours
9. Abrasion Resistance	ASTM D 968	No cracking or loss of film integrity at 528 quarts (500 L) of sand	Pass at 1057 quarts (1000 L) sand
10. Mildew Resistance	ASTM D 3273	No growth supported during 28 day exposure period	Pass at 60 days

*No deleterious effects: no cracking, checking, crazing, erosion, rusting, blistering, peeling or delamination
 Currently method G 153 or G 155
 Currently method G 154

Table 3—EIFS Component Performance

TEST	METHOD	CRITERIA	RESULT
1. Alkali Resistance of Reinforcing Mesh	EIMA 105.01	Greater than 120 pli (21 dN/cm) retained tensile strength	Pass
2. Physical properties and Requirements for EPS Board	ASTM C 578	Refer to EIMA Guideline Specification for Expanded Polystyrene (EPS) Insulation Board	Pass
3. Requirements for Rigid PVC Accessories	ASTM D 1784	Meets cell classification 13244C	Pass

Table 4-EIFS and Air/Moisture Barrier Fire Performance

TEST	METHOD	CRITERIA	RESULT
1. Fire Endurance	ASTM E 119	Maintain fire resistance of existing rated assembly	Pass*
2. Intermediate Scale Multi-Story Fire Test	UBC Standard 26-9 (NFPA 285)	1. Resistance to vertical spread of flame within the core of the panel from one story to the next 2. Resistance to flame propagation over the exterior surface 3. Resistance to vertical spread of flame over the interior surface from one story to the next 4. Resistance to significant lateral spread of flame from the compartment of fire origin to adjacent spaces	Pass with 12 inches of EPS insulation
3. Radiant Heat Ignition	1996 National Building Code, Section 1406.0 (NFPA 268)	No ignition @ 20 minutes	Pass
	1997 Standard Building Code, Section 2603.4.7 (NFPA 268)	No ignition @ 20 minutes	Pass

Note: results based on extrapolation of data from E-119 series testing

Table 5-EIFS Component Fire Performance

TEST	METHOD	CRITERIA	RESULT
1. Surface Burning	ASTM E 84	Insulation board and reinforced coating system shall each have a flame spread of 25 or less, and smoke developed of 450 or less	Pass

Table 6-EIFS Impact Resistance Performance

TEST	METHOD	CRITERIA	RESULT
1. Impact Resistance	EIMA 101.86	Level 1: 25-49 in-lbs (2.83-5.54J) Level 2: 50-89 in-lbs (5.65-10.1J) Level 3: 90-150 in-lbs (10.2-17J) Level 4: >150 in-lbs (>17J)	Pass with one layer Sto Mesh Pass with two layers Sto Mesh Pass with one layer Sto Intermediate Mesh Pass with one layer Sto Armor Mat and one layer Sto Mesh

Table 7-Structural Performance Test

TEST	METHOD	CRITERIA	RESULT
1. Wind Load	ASTM E 330	Withstand negative and positive wind loads required by prevailing building code	Consult applicable code compliance report for design pressure rating

1.06 QUALITY ASSURANCE

A. Contractor requirements

1. Engaged in application of EIFS for a minimum of three (3) years.
2. Knowledgeable in the proper use and handling of EIFS materials and listed and/or certified by the EIFS manufacturer as having the required training for installation of their EIFS product.
3. Employ skilled mechanics who are experienced and knowledgeable in EIFS application, and familiar with the requirements of the specified work.
4. Successful completion of minimum of three (3) projects of similar size and complexity to the specified project.
5. Provide the proper equipment, manpower and supervision on the job site to install the system in compliance with Sto's published specifications and details and the project plans and specifications.

B. Insulation board manufacturer requirements

1. Recognized by the EIFS manufacturer as capable of producing insulation board to meet system requirements, and hold a valid licensing agreement with the EIFS manufacturer.
2. Listed by an approved agency.
3. Label insulation board with information required by the EIFS manufacturer, the approved listing agency and the applicable building code.

C. Mock-up Testing

1. Construct full-scale mock-up of typical EIFS/window wall assembly with specified tools and materials and test air and water infiltration and structural performance in accordance with ASTM E 283, E 331 and E 330, respectively, through independent laboratory. Mock-up shall comply with requirements of project specifications. Where mock-up is tested at job site maintain approved mock-up at site as reference standard. If tested off-site accurately record construction detailing and sequencing of approved mock-up for replication during construction.

D. Inspections

1. Refer to Specification Section 01450 Testing and Inspection Services for testing requirements and responsibilities.
2. Conduct inspections in accordance with code requirements and contract documents.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver all materials in their original sealed containers bearing manufacturer's name and identification of product.
- B. Protect coatings (pail products) from freezing and temperatures in excess of 90°F (32° C). Store away from direct sunlight.
- C. Protect Portland cement based materials (bag products) from moisture and humidity. Store under cover off the ground in a dry location.

1.08 PROJECT/SITE CONDITIONS

- A. Maintain ambient and surface temperatures above 40°F (4°C) during application and drying period, minimum 24 hours after application of Air/Moisture barrier and EIFS.
- B. Provide supplementary heat for installation in temperatures less than 40°F (4°C).
- C. Provide protection of surrounding areas and adjacent surfaces from application of materials.

1.09 COORDINATION/SCHEDULING

- A. Coordinate installation of roofing installation, windows, doors and other wall penetrations to provide a continuous air barrier.
- B. Provide protection of rough openings before installing windows, doors, and other penetrations through the wall.
- C. Coordinate installation of windows and doors so air barrier components are connected to them to provide a continuous air barrier.
- D. Install window and door head flashing immediately after windows and doors are installed.
- E. Install diverter flashings wherever water can enter the wall assembly to direct water to the exterior.
- F. Install copings and sealant immediately after installation of the EIF system and when EIFS coatings are dry.
- G. Attach penetrations through EIFS to structural support and provide water tight seal at penetrations.

1.10 WARRANTY

- A. Provide manufacturer's standard limited labor and material warranty.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Provide EIF System accessories from single source manufacturer or approved supplier.
- B. The following are acceptable manufacturers:
 - 1. Dry-vit Systems, Inc.
 - a. Outsulation Plus MD System (basis of design) for all areas. Contact Ben Fredal 734-891-7443, email: bfredal@lwsupply.com
 - 2. Sto Corp.
 - 3. Synergy Wall Systems
 - 4. Pleko Products Inc.
 - 5. Plastic Components, Inc.—Accessories or equal

2.02 AIR/MOISTURE BARRIER

- A. Base Coat: Shall be compatible with the EPS insulation board and reinforcing mesh(es).
 - 1. Cementitious: A liquid polymer-based material, which is field mixed with Portland cement.
 - a. Shall be Primus, Genesis or Genesis FM
 - 2. Noncementitious: A factory-mixed, fully formulated, water-based product.
 - a. Shall be NCB
 - 3. Ready mixed: A dry blend cementitious, copolymer-based product, field mixed with water.
 - a. Shall be Primus DM, Genesis DM, Genesis DMS, Rapidry DM 35-50 or Rapidry DM 50-75.
- B. Reinforcing Mesh: A balanced, open weave, glass fiber fabric treated for compatibility with other system materials.
 - 1. Shall be Panzer 15, Detail and Corner Mesh
 - 2. Shall be colored blue for product identification bearing the Dryvit logo.
- C. Finish: Shall be Ultra-High Impact Resistant Finish. Color and texture as selected by the architect/owner from manufacturer's standard color and texture coating systems.

2.03 JOB MIXED INGREDIENTS

- A. Water--Clean and potable.
- B. Portland cement--Type I in conformance with ASTM C 150.

PART III EXECUTION

3.01 EXAMINATION - New EIFS Finish Over Existing EIFS Materials.

- A. Prior to the installation of the new EIFS finish, the contractor shall notify the Construction Manager and Architect in writing, of all discrepancies.

3.02 PREPARATION

- A. Protect adjoining work and property during Outsulation Plus MD installation.
- B. The substrate shall be prepared as to be free of foreign materials, such as oil, dust, dirt, form-release agents, efflorescence, paint, wax, water repellants, moisture, frost, and any other condition that may inhibit adhesion.

3.03 INSTALLATION

- A. The new finish shall be installed in accordance with the Dryvit Outsulation Plus MD System Application Instructions, DS218.
- B. The overall minimum base coat thickness shall be sufficient to fully embed the mesh. The recommended method is to apply the base coat in two (2) passes.
- C. Sealant shall not be applied directly to textured finishes or base coat surfaces. Dryvit Outsulation Plus MD System surfaces in contact with sealant shall be coated with Demandit or Color Prime.
- D. High impact meshes shall be installed as specified on all surfaces.

3.04 FIELD QUALITY CONTROL

- A. The contractor shall be responsible for the proper application of the Outsulation Plus MD materials.
- B. Dryvit assumes no responsibility for on-site inspections or application of its products.
- C. If required, the contractor shall certify in writing the quality of work performed relative to the substrate system, details, installation procedures, workmanship and as to the specific products used.
- D. If required, the EPS supplier shall certify in writing that the EPS meets Dryvit's specifications.
- E. If required, the sealant contractor shall certify in writing that the sealant application is in accordance with the sealant manufacturer's and Dryvit's recommendations.

3.05 CLEANING

- A. All excess Outsulation Plus MD System materials shall be removed from the job site by the contractor in accordance with contract provisions and as required by applicable law.
- B. All surrounding areas, where the Dryvit Outsulation Plus MD System has been applied, shall be left free of debris and foreign substances resulting from the contractor's work.

3.06 PROTECTION

- A. The Outsulation Plus MD System shall be protected from inclement weather and other sources of damage until dry and permanent protection in the form of flashings, sealants, etc. are installed.

END OF SECTION 09200

SECTION 09250 - GYPSUM DRYWALL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY:

- A. Extent of each type of gypsum drywall construction required is indicated on Drawings.
- B. This Section includes the following types of gypsum board construction:
 - 1. Steel framing members to receive gypsum board.
 - 2. Gypsum board screw-attached to steel framing and furring members.

1.3 DEFINITIONS:

- A. Gypsum Board Construction Terminology: Refer to ASTM C 11 and GA 505 for definitions of terms for gypsum board construction not otherwise defined in this section or other referenced standards.

1.4 SUBMITTALS:

- A. Product data from manufacturers for each type of product specified.

1.5 QUALITY ASSURANCE:

- A. Fire-Resistance Ratings: Where indicated, provide materials and construction which are identical to those of assemblies whose fire resistance rating has been determined per ASTM E 119 by a testing and inspecting organization acceptable to authorities having jurisdiction.
 - 1. Provide fire-resistance-rated assemblies identical to those indicated by reference to GA File No's. in GA-600 "Fire Resistance Design Manual" or to design designations in U.L. "Fire Resistance Directory" or in listing of other testing and agencies acceptable to authorities having jurisdiction.

- B. Single Source Responsibility: Obtain each type of gypsum board and related joint treatment materials from a single manufacturer.
- C. All gypsum board drywall and associated materials shall be manufactured domestically in the United States, by a United States Company and shall conform to ASTM Standards listed herein. Gypsum board drywall and associated materials shall not be imported, rebranded or distributed from another country.

1.6 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver materials in original packages, containers or bundles bearing brand name and identification of manufacturer or supplier.
- B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic and other causes. Neatly stack gypsum boards flat to prevent sagging.
- C. Handle gypsum boards to prevent damage to edges, ends, and surfaces. Do not bend or otherwise damage metal corner beads and trim.

1.7 PROJECT CONDITIONS:

- A. Environmental Conditions, General: Establish and maintain environmental conditions for application and finishing gypsum board to comply with ASTM C 840 and with gypsum board manufacturer's recommendations.
- B. Minimum Room Temperatures: For nonadhesive attachment of gypsum board to framing, maintain not less than 40 deg F (4 deg C). For adhesive attachment and finishing of gypsum board maintain not less than 50 deg F (10 deg C) for 48 hours prior to application and continuously thereafter until drying is complete.
- C. Ventilate building spaces to remove water not required for drying joint treatment materials. Avoid drafts during dry, hot weather to prevent materials from drying too rapidly.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Manufacturer: Subject to compliance with requirements, provide products of one of the following:
 - 1. Steel Framing and Furring:
 - a. Clark Steel Framing.
 - b. Dietrich Industries, Inc.
 - c. Marino/Ware, Division of Ware Industries
 - d. Dale/Incor (Dale Industries)
 - 2. Gypsum Boards and Related Products:
 - a. Georgia-Pacific Corp.
 - b. Gold Bond Building Products Div., National Gypsum Co.
 - c. United States Gypsum Co.

2.2 STEEL FRAMING COMPONENTS FOR SUSPENDED AND FURRED CEILINGS:

- A. General: Provide components which comply with ASTM C 754 for materials and sizes, unless otherwise indicated.
- B. Concrete Inserts: Inserts designed for attachment to concrete forms and for embedment in concrete, fabricated from corrosion-resistant materials, with holes or loops for attachment of hanger wires and capability to sustain, without failure, a load equal to 3 times that imposed by ceiling construction, as determined from testing per ASTM E 488, conducted by an independent testing laboratory.
- C. Wire for Hangers and Ties: ASTM A 641, Class 1 zinc coating, soft temper.
- D. Channels: Cold-rolled steel, 0.0598 inch minimum thickness of base (uncoated) metal and 7/16 inch wide flanges, protected with rust-inhibitive paint, and as follows:
 - 1. Carrying Channels: 1-1/2 inch deep, 475 lbs per 1000 ft., unless otherwise indicated.
 - 2. Furring Channels: 3/4 inch deep, 300 lbs per 1000 ft., unless otherwise indicated.

- E. Steel Studs for Furring Channels: ASTM C 645, with flange edges bent back 90 deg and doubled over to form 3/16 inch minimum lip (return), minimum thickness of base (uncoated) metal and minimum depth as follows:
 - 1. Thickness: 0.0329 inch, unless otherwise indicated.
 - 2. Depth: 3-5/8 inches, unless otherwise indicated.

- F. Steel Rigid Furring Channels: ASTM C 645, hat-shaped, depth of 7/8 inches, and minimum thickness of base (uncoated) metal as follows:
 - 1. Thickness: 0.0329 inch, unless otherwise indicated.

- G. Steel Resilient Furring Channels: Manufacturer's standard product designed to reduce sound transmission, complying with ASTM C 645 for material, finish and widths of face and fastening flange, fabricated to form 1/2 inch deep channel of the following configuration:
 - 1. Single-Leg Configuration: Assymetric-shaped channel with face connected to a single flange by a single slotted leg (web).

- H. Grid Suspension System: ASTM C 645, manufacturer's standard grid suspension system composed of main beams and cross furring members which interlock to form a modular supporting network.

2.3 STEEL FRAMING FOR WALLS AND PARTITIONS:

- A. Steel Studs and Runners: ASTM C 645, with flange edges of studs bent back 90 deg and doubled over to form 3/16" minimum lip (return) and complying with the following requirements for minimum thickness of base (uncoated) metal and for depth:
 - 1. Thickness: 0.0329 inch where indicated.
 - 2. Depth: 3-5/8 inches, unless otherwise indicated.

- B. Steel Rigid Furring Channels: ASTM C 645, hat-shaped, depth and minimum thickness of base (uncoated) metal as follows:
 - 1. Depth: 7/8 inch.
 - 2. Thickness: 0.0329 inch, unless otherwise indicated.

- C. Furring Brackets: Serrated-arm type, adjustable, fabricated from corrosion-resistant steel sheet complying with ASTM C 645, minimum thickness of base (uncoated) metal of 0.0329 inch, designed for screw attachment to steel studs and steel rigid furring channels used for furring.
- D. Steel Resilient Furring Channels: Manufacturer's standard product designed to reduce sound transmission, complying with ASTM C 645 for base metal, finish and widths of face and fastening flange, fabricated to form 1/2 inch deep channel of the following configuration:
 - 1. Single-Leg Configuration: Assymetric-shaped channel with face connected to a single flange by a single slotted leg (web).
- E. Fasteners: Provide fasteners of type, material, size, corrosion resistance, holding power and other properties required to fasten steel framing and furring members securely to substrates involved; complying with the recommendations of gypsum drywall manufacturers for applications indicated.

2.4GYPSUM BOARD:

- A. General: Provide gypsum board of types indicated in maximum lengths available to minimize end-to-end joints.
 - 1. Thickness: Provide gypsum board in thicknesses indicated, or if not otherwise indicated, in either 1/2 inch or 5/8 inch thicknesses to comply with ASTM C 840 for application system and support spacing indicated.
- B. Gypsum Wallboard: ASTM C1396, and as follows:
 - 1. Type: Regular, unless otherwise indicated.
 - 2. Type: Foil-backed where indicated.
 - 3. Type: Type X for fire-resistance-rated assemblies.
 - 4. Edges: Tapered.
 - 5. Thickness: 1/2 inch, unless otherwise indicated.
 - 6. Thickness: 5/8 inch where indicated.

7. Products: Subject to compliance with requirements, provide one of the following products where Type X gypsum wallboard is indicated:
 - a. "Gyprock Fireguard 'C' Gypsum Board"; Domtar Gypsum Co.
 - b. "Fire-Shield G"; Gold Bond Building Products Div., National Gypsum Co.
 - c. "SHEETROCK Brand FIRECODE 'C' Gypsum Panels"; United States Gypsum Co.

- C. Gypsum Backing Board for Multi-Layer Applications: ASTM C1396 or, where backing board is not available from manufacturer, gypsum wallboard, ASTM C1396, and as follows:
 1. Type: Regular, unless otherwise indicated.
 2. Type: Foil-backed where indicated.
 3. Type: Type X for fire-resistance-rated assemblies.
 4. Edges: Manufacturer's standard.
 5. Thickness: 5/8 inch, unless otherwise indicated.
 6. Thickness: 1/2 inch where indicated.

- D. Water-Resistant Gypsum Backing Board: ASTM C1396, and as follows:
 1. Type: Regular, unless otherwise indicated.
 2. Type: Type X for fire-resistance-rated assemblies.
 3. Thickness: 5/8 inch, unless otherwise indicated.

- E. Exterior Gypsum Soffit Board: ASTM C1396, with manufacturer's standard edges, of type and thickness indicated below:
 1. Type: Regular, unless otherwise indicated.
 2. Type: Type X for fire-resistance rated assemblies.
 3. Thickness: 5/8 inch, unless otherwise indicated.

- F. Vandal Resistant Gypsum Board: ASTM C1629 (Noted as hi-

impact gypsum board on wall types) Provide assembly consisting of 5/8'' Hi-Impact brand XP gypsum wallboard as manufactured by National Gypsum with tapered edges with reinforced taped joints (profoam joint tape) and concealed with profoam ready mix or setting compounds and epoxy paint on finished surface, or equal as determined by Architect.

1. Install from finish floor to 8'-0'' A.F.F. min.
- G. Exterior Sheathing for EFIS Applications: ASTM C1177, C79 and C1396.
1. Type regular 1/2'' thick, unless otherwise indicated.
 2. Type: Type x, 5/8'' for fire rated applications.
 3. Provide glass-mat faced gypsum sheathing - DENSGLASS Gold or as manufactured by Georgia-Pacific Gypsum or Securock as manufactured by USG or equal as approved by Architect.

2.5 TRIM ACCESSORIES:

- A. Cornerbead and Edge Trim for Interior Installation:
Provide corner beads, edge trim and control joints which comply with ASTM C 1047 and requirements indicated below:
1. Material: Formed metal, plastic or metal combined with paper, with metal complying with the following requirement:
 - a. Sheet steel zinc-coated by hot-dip process.
 2. Edge trim shapes indicated below by reference to designations of Fig. 1 in ASTM C 1047:
 - a. "LC" Bead, unless otherwise indicated.
 - b. "L" Bead where indicated.
 - c. "U" Bead where indicated.
 3. One-Piece Control Joint: Formed with vee-shaped slot per Fig. 1 in ASTM C 1047, with slot opening covered with removable strip.
- B. Metal Cornerbead and Edge Trim for Exterior Ceilings:
Comply with the following requirements:
1. Edge trim complying with ASTM C 1047, formed from rolled zinc, shape "LC" Bead per Fig. 1, unless otherwise indicated.

2.6 GYPSUM BOARD JOINT TREATMENT MATERIALS:

- A. General: Provide materials complying with ASTM C 475, ASTM C 840, and recommendations of manufacturer of both gypsum board and joint treatment materials for the application indicated.
- B. Joint Tape: Paper reinforcing tape, unless otherwise indicated.
 - 1. Use pressure sensitive or staple-attached open-weave glass fiber reinforcing tape with compatible joint compound where recommended by manufacturer of gypsum board and joint treatment materials for application indicated.
- C. Setting-Type Joint Compounds: Factory-prepackaged, job-mixed, chemical-hardening powder products formulated for uses indicated.
 - 1. Where setting-type joint compounds are indicated for use as taping and topping compounds, use formulation for each which develops greatest bond strength and crack resistance and is compatible with other joint compounds applied over it.
 - 2. For prefilling gypsum board joints, use formulation recommended by gypsum board manufacturer for this purpose.
 - 3. For filling joints and treating fasteners of water-resistant gypsum backing board behind base for ceramic tile, use formulation recommended by gypsum board manufacturer for this purpose.
- D. Drying-Type Joint Compounds: Factory-prepackaged vinyl-based products complying with the following requirements for formulation and intended use.
 - 1. Ready-Mix Formulation: Factory-premixed product.
 - 2. All-purpose compound formulated for use as both taping and topping compound.

2.7 MISCELLANEOUS MATERIALS:

- A. General: Provide auxiliary materials for gypsum drywall construction which comply with referenced standards and the recommendations of the manufacturer of the gypsum board.
- B. Laminating Adhesive: Special adhesive or joint compound recommended for laminating gypsum boards.
- C. Spot Grout: ASTM C 475, setting-type joint compound of type recommended for spot grouting hollow metal door frames.
- D. Fastening Adhesive for Wood: ASTM C 557.
- E. Fastening Adhesive for Metal: Special adhesive recommended for laminating gypsum boards to steel framing.
- F. Gypsum Board Screws: ASTM C 1002.
- G. Gypsum Board Nails: ASTM C 514.
- H. Concealed Acoustical Sealant: Nondrying, nonhardening, nonskinning, nonstaining, nonbleeding, gunnable sealant complying with requirement specified in Division-7 section "Joint Sealers."
- I. Sound Attenuation Blankets: Unfaced mineral fiber blanket insulation produced by combining mineral fibers of type described below with thermosetting resins to comply with ASTM C 665 for Type I (blankets without membrane facing); and as follows:
 - 1. Mineral Fiber Type: Fibers manufactured from glass.
 - 2. Use in all partitions, full height to deck above.

PART 3 - EXECUTION

3.1 EXAMINATION:

- A. Examine substrates to which drywall construction attaches or abuts, preset hollow metal frames, cast-in-anchors, and structural framing, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of drywall construction. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION:

- A. Ceiling Anchorages: Coordinate installation of ceiling suspension system with installation of overhead structural systems to ensure that inserts and other structural anchorage provisions have been installed to receive ceiling anchors in a manner that will develop their full strength and at spacing required to support ceiling.

3.3 INSTALLATION OF STEEL FRAMING, GENERAL:

- A. Steel Framing Installation Standard: Install steel framing to comply with ASTM C 754 and with ASTM C 840 requirements that apply to framing installation.
- B. Install supplementary framing, blocking and bracing at terminations in the work and for support of fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, and similar construction to comply with details indicated and with recommendations of gypsum board manufacturer, or if none available, with "Gypsum Construction Handbook" published by United States Gypsum Co.
- C. Isolate steel framing from building structure to prevent transfer of loading imposed by structural movement, at locations indicated below to comply with details shown on Drawings:
 - 1. Where edges of suspended ceilings abut building structure horizontally at ceiling perimeters or penetration of structural elements.
 - 2. Where partition and wall framing abuts overhead structure.
 - a. Provide slip or cushioned type joints as detailed to attain lateral support and avoid axial loading.
- D. Do not bridge building expansion and control joints with steel framing or furring members; independently frame both sides of joints with framing or furring members or as indicated.

3.4 INSTALLATION OF STEEL FRAMING FOR SUSPENDED AND FURRED

CEILINGS:

- A. Secure hangers to structural support by connecting directly to structure where possible, otherwise connect to cast-in concrete inserts or other anchorage devices or fasteners as indicated.
 - 1. Do not attach hangers to metal deck tabs (where present).
 - 2. Do not attach hangers to metal roof deck (where present).
- B. Do not connect or suspend steel framing from ducts, pipes or conduit.
- C. Keep hangers and braces 2 inches clear of ducts, pipes and conduits.
- D. Sway-brace suspended steel framing with hangers used for support.
- E. Install suspended steel framing components in sizes and at spacings indicated but not less than that required by referenced steel framing installation standard.
 - 1. Wire Hangers: 0.1620 inch diameter (8 gage), 4 ft. on center.
 - 2. Carrying Channels (Main Runners): 1-1/2 inch, 4 ft. on center.
 - 3. Rigid Furring Channels (Furring Members): 16 inches on center.
 - 4. Rigid Furring Channels (Furring Members): 24 inches on center.
- F. Installation Tolerances: Install steel framing components for suspended ceilings so that cross furring members or grid suspension members are level to within 1/8 inch in 12 ft. as measured both lengthwise on each member and transversely between parallel members.
- G. Wire-tie or clip furring members to main runners and to other structural supports as indicated.
- H. For exterior soffits provide cross-bracing and additional framing indicated or required to resist wind uplift.

3.5 INSTALLATION OF STEEL FRAMING FOR WALLS AND PARTITIONS:

- A. Install runners (tracks) at floors, ceilings and structural walls and columns where gypsum drywall stud system abuts other construction.
 - 1. Where studs are installed directly against exterior walls, install asphalt felt strips between studs and wall.
- B. Installation Tolerances: Install each steel framing and furring member so that fastening surface do not vary more than 1/8 inch from plane of faces of adjacent framing.
- C. Extend partition framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.
- D. Terminate partition framing at suspended ceilings where indicated.
- E. Install steel studs and furring in sizes and at spacings indicated but not less than that required by referenced steel framing installation standard.
 - 1. For single layer construction: 16 inches on center.
- F. Install steel studs so that flanges point in the same direction and gypsum boards can be installed in the direction opposite to that of the flange.
- G. Frame door openings to comply with details indicated, with GA-219 and with applicable published recommendations of gypsum board manufacturer. Attach vertical studs at jambs with screws either directly to frames or to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
 - 1. Extend vertical jamb studs through suspended ceilings and attach to underside of floor or roof structure above.
- H. Frame openings other than door openings to comply with

details indicated, or if none indicated, in same manner as required for door openings; and install framing below sills of openings to match framing required above door heads.

3.6APPLICATION AND FINISHING OF GYPSUM BOARD, GENERAL:

- A. Gypsum Board Application and Finishing Standard: Install and finish gypsum board to comply with ASTM C 840.
- B. Install sound attenuation blankets in all partitions/shaft walls whether indicated or not and other locations where indicated, prior to gypsum board unless readily installed after board has been installed.
- C. Locate exposed end-butt joints as far from center of walls and ceilings as possible, and stagger not less than 24 inches in alternate courses of board.
- D. Install ceiling boards across framing in the manner which minimizes the number of end-butt joints, and which avoids end joints in the central area of each ceiling. Stagger end joints at least 24 inches.
- E. Install wall/partition boards in manner which minimizes the number of end-butt joints or avoids them entirely where possible. At stairwells and similar high walls, install boards horizontally with end joints staggered over studs.
- F. Install exposed gypsum board with face side out. Do not install imperfect, damaged or damp boards. Butt boards together for a light contact at edges and ends with not more than 1/16 inch open space between boards. Do not force into place.
- G. Locate either edge or end joints over supports, except in horizontal applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Position boards so that like edges abut, tapered edges against tapered edges and mill-cut or field-cut ends against mill-cut or field-cut ends. Do not place tapered edges against cut edges or ends. Stagger vertical joints over different studs on opposite sides of partitions.
- H. Attach gypsum board to steel studs so that leading edge or end of each board is attached to open (unsupported) edge of stud flange first.
- I. Attach gypsum board to supplementary framing and blocking

provided for additional support at openings and cutouts.

- J. Spot grout hollow metal door frames for solid core wood doors, hollow metal doors and doors over 32 inches wide. Apply spot grout at each jamb anchor clip just before inserting board into frame.
- K. Form control joints and expansion joints at locations indicated, with space between edges of boards, prepared to receive trim accessories.
- L. Cover both faces of steel stud partition framing with gypsum board in concealed spaces (above ceilings, etc.), except in chase walls which are braced internally.
 - 1. Except where concealed application is indicated or required for sound, fire, air or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. area, and may be limited to not less than 75 percent of full coverage.
 - 2. Fit gypsum board around ducts, pipes, and conduits.
- M. Isolate perimeter of non-load-bearing drywall partitions at structural abutments. Provide 1/4 inch to 1/2 inch space and trim edge with "U" bead edge trim. Seal joints with acoustical sealant.
- N. At all drywall partitions, seal construction at perimeters, control and expansion joints, openings and penetrations with a continuous bead of acoustical sealant including a bead at both faces of partitions. Comply with ASTM C 919 and manufacturer's recommendations for location of edge trim, and close off sound-flanking paths around or through construction, including sealing of partitions above acoustical ceilings.
- O. Space fasteners in gypsum boards in accordance with referenced gypsum board application and finishing standard and manufacturer's recommendations.

3.7METHODS OF GYPSUM BOARD APPLICATION:

- A. Single-Layer Application: Install gypsum wallboard as follows:
 - 1. On ceilings apply gypsum board prior to wall/partition board application to the greatest extent possible.
 - 2. On partitions/walls apply gypsum board vertically

(parallel to framing), unless otherwise indicated, and provide sheet lengths which will minimize end joints.

3. On partitions/walls 8'-1" or less in height apply gypsum board horizontally (perpendicular to framing); use maximum length sheets possible to minimize end joints.
- B. Wall Tile Base: Where drywall is base for thin-set ceramic tile and similar rigid applied wall finishes, install gypsum backing board.
1. In "dry" areas install gypsum backing board or wallboard with tapered edges taped and finished to produce a flat surface.
 2. At showers, tubs and similar "wet" areas, install water-resistant gypsum backing board to comply with ASTM C 840 and recommendations of gypsum board manufacturer.
- C. Double-Layer Application: Install gypsum backing board for base layer and gypsum wallboard for face layer.
1. On ceilings apply base layer prior to application of base layer on walls/partitions; apply face layers in same sequence. Offset joints between layers at least 10 inches. Apply base layers at right angles to supports unless otherwise indicated.
 2. On partitions/walls apply base layer and face layers vertically (parallel to framing) with joints of base layer over supports and face layer joints offset at least 10 inches with base layer joints.
- D. Acoustical Tile Base: Where drywall is base for adhesively applied acoustical tile, install gypsum backing board.
1. Provide either V-joint type backing board or tape and finish joints to produce a flat surface.
- E. Single-Layer Fastening Methods: Apply gypsum boards to supports as follows:
1. Fasten with screws.
- F. Double-Layer Fastening Methods: Apply base layer of

gypsum board and face layer to base layer as follows:

1. Fasten both base layers and face layers separately to supports with screws.
- G. Direct-Bonding to Substrate: Where gypsum board is indicated to be directly adhered to a substrate (other than studs, joists, furring members or base layer of gypsum board), comply with gypsum board manufacturer's recommendations, and temporarily brace or fasten gypsum board until fastening adhesive has set.
- H. Exterior Soffits and Ceilings: Apply exterior gypsum soffit board perpendicular to supports, with end joints staggered over supports. Install with 1/4 inch open space where boards abut other construction.
1. Fasten with cadmium-plated screws, or with galvanized or aluminum nails where supports are available.

3.8 INSTALLATION OF DRYWALL TRIM ACCESSORIES:

- A. General: Where feasible, use the same fasteners to anchor trim accessory flanges as required to fasten gypsum board to the supports. Otherwise, fasten flanges to comply with manufacturer's recommendations.
- B. Install corner beads at external corners.
- C. Install metal edge trim whenever edge of gypsum board would otherwise be exposed or semi-exposed, and except where plastic trim is indicated. Provide type with face flange to receive joint compound except where "U" bead (semi-finishing type) is indicated.
1. Install "LC" bead where drywall construction is tightly abutted to other construction and back flange can be attached to framing or supporting substrate.
 2. Install "L" bead where edge trim can only be installed after gypsum board is installed.
 3. Install U-type trim where edge is exposed, revealed, gasketed, or sealant-filled (including expansion joints).
- D. Install plastic edge trim where indicated on wall panels at juncture with ceilings.
- E. Install control joints at locations indicated, or if not

indicated, at spacings and locations required by referenced gypsum board application and finish standard, and approved by the Architect for visual effect.

3.9 FINISHING OF DRYWALL:

- A. General: Apply joint treatment at gypsum board joints (both directions); flanges of corner bead, edge trim, and control joints; penetrations; fastener heads, surface defects and elsewhere as required to prepare work for decoration.
- B. Prefill open joints and rounded or beveled edges, if any, using setting-type joint compound.
- C. Apply joint tape at joints between gypsum boards, except where trim accessories are indicated.
- D. Finish interior gypsum wallboard by applying the following joint compounds in 3 coats (not including prefill of openings in base), and sand between coats and after last coat:
 - 1. Embedding and First Coat: Setting-Type Joint Compound.
 - 2. Fill (Second) Coat: Setting-type joint compound.
 - 3. Finish (Third) Coat: Ready-mix drying-type all-purpose or topping compound.
- E. Finish exterior gypsum soffit board by using setting-type joint compounds to prefill joints, embed tape, and to apply first, fill (second) and finish (third) coats; smooth each coat before joint compound hardens to minimize need for sanding; sand between coats and after finish coat.
 - 1. Painting of exterior gypsum soffit board after finish coat has dried is specified in Division-9 Section "Painting."
- F. Water-Resistant Backing Board Base for Ceramic Tile: Finish joints between water-resistant backing board with tape and setting-type joint compound to comply with gypsum board manufacturer's recommendations and installation standards referenced in Division-9 Section "Tile"
- G. Base for Acoustical Tile: Where gypsum board is indicated

as a base for adhesively-applied acoustical tile, install tape and 2- coat compound treatment, without sanding.

- H. Partial Finishing: Omit third coat and sanding on concealed drywall construction which is indicated for drywall finishing or which requires finishing to achieve fire-resistance rating, sound rating or to act as air or smoke barrier.

3.10 PROTECTION:

- A. Provide final protection and maintain conditions, in a manner suitable to Installer, which ensures gypsum drywall construction being without damage or deterioration at time of Substantial Completion.

END OF SECTION 09250

SECTION 09300 - TILE WORK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Attention is directed to Division 0, Bidding and Contract Requirements, and to Division 1, General Requirements, which are hereby made a part of this Section.

1.02 DESCRIPTION OF WORK:

- A. The extent of tile work is shown on drawings and in schedules.

1.03 QUALITY ASSURANCE:

- A. Qualifications of Installers:

- 1. For installation of ceramic tile, use only thoroughly trained and experienced personnel completely familiar with specified products, manufacturer's recommended methods of installation and requirements established for this work.

- B. Codes and Standards:

- 1. Comply with recommendations of "Handbook for Ceramic Tile Installation" published by Tile Council of America.
- 2. Comply with ANSI and ASTM Standards listed within this Section.

- C. Proprietary Materials: Handle, store, mix and apply proprietary setting and grouting materials in compliance with manufacturer's instructions.

1.04 SUBMITTALS:

- A. Product Data:

- 1. For information only, submit two (2) copies of manufacturer's technical information and install instructions for all materials required, except bulk materials. Include certifications and other data as may be required to show compliance with these specifications. Transmit a copy of each instruction to the Installer.

2. Accompany materials list with two (2) copies of manufacturer's current recommended method of installation for each item. These recommendations, after review by Contractor and Architect/Engineer, shall form basis for acceptance or rejection of installed work.

B. Samples:

1. Submit three (3) samples of each type and color of tile required, not less than 12" square on plywood or hardboard backing and grouted. Submit samples of trim and 6" long sample of marble threshold. Review will be for color, pattern and texture only. Compliance with all other requirements is the exclusive responsibility of the Contractor.

1.05 DELIVERY AND STORAGE:

- A. Deliver packaged materials and store in original containers with seals unbroken and labels in tact until time of use, in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Tile: Subject to compliance with requirements, provide products as follows:
 1. CT1: (Floor Tile)
Virginia Tile
Crossville, Cross-Colors Mingles; finish: cross-sheen unpolished
Tile Thickness: 5/16"
Size: 6" x 6"
Recommended Grout Joint: Between 3/16" and 1/4"
Color: Architect shall select one (1) color from manufacturer's full line.
 2. CT1-Base: (Wall Base)
Virginia Tile
Crossville, Cross-Colors Mingles; finish: cross-sheen unpolished
Tile Thickness: 5/16"
Size: 4" x 8" Surface Bullnose
Color: Architect shall select one (1) color from manufacturer's full line.
Manufacturer's Representative: Kathleen Somervell
248-467-4362.
 3. CT2: (Wall Tile)

Daltile
Natural Hues
Tile Thickness: 5/16''
Recommended Grout Joint: ¼''
Size: 6'' x 6''
Installation: Stacked
Color: Architect shall select two (2) colors from
manufacturer's full line. Manufacturer's
Representative: Erin Leszczynski 586-612-6838.

- B. ANSI Standard for Ceramic Tile: Comply with ANSI A137.1
"American National Standard Specifications for Ceramic
Tile" for types, compositions, and grades of tile
indicated.
 - 1. Furnish tile complying with "Standard Grade"
requirements unless otherwise indicated.
- C. ANSI Standard for Tile Installation Materials: Comply with
ANSI standard referenced with products and materials
indicated for setting and grouting.
- D. Marble Thresholds: Marble thresholds shall be 1/2" inch
high with chamfered edges of a uniform, fine to medium
grained white stone with gray veining and conform to ASTM
C503 with a minimum abrasion resistance of ten (10) per
ASTM C1353 or ASTM C241 and with a honed finish.

2.02 SETTING MATERIALS

- A. MEDIUM SET MORTAR - for wall and floor tile installation
in lobby and toilet rooms:
 - 1. Description: Factory prepared mortar and latex
additive; complying with ANSI A118.4 and ISO standards
C2TES1P1. Medium bed thickness; 3/8 to 3/4 inch thick
floor installation.
 - 2. Color: Gray
 - 3. Acceptable Products:
 - i. MAPEI UltraFlex LFT, complies with ANSI A118.4
 - ii. Custom Building Products, MegaLite.
 - iii. Laticrete, 4XLT.

- B. Latex-Portland Cement Mortar: ANSI A118.4, composed as follows:
1. Mixture of Dry-Mortar Mix and Latex Additive: Mixture the prepackaged dry-mortar mix and liquid-latex additive complying with the following requirements:
 - a. Latex Additive: Acrylic resin.
 2. Provide one of the following products:
 - a. Mapei, Elk Grove Village, IL; Kerabond/Keralastic
 - b. Custom Building Products, Custom Blend/Custom Flex
 - c. Laticrete, Bethany, CT; Laticrete 272/333
 - d. TEC, Palatine, IL; Full set plus/Xtra Flex Additive
- C. Waterproofing and Crack Isolation Membrane: Provide materials complying with ANSI A118.10 and ANSI A118.12 and as specified below. Note: All tile in toilet rooms (walls & floors) and kitchen to be installed on crack isolation membrane.:
1. Mapelastic AquaDefense as manufactured by MAPEI Corp.
 2. Custom building products RedGard waterproofing and crack prevention membrane.
 3. Hydroment ultra-set advanced as manufactured by Bostik, Inc.
 4. Hydro-Ban waterproofing/anti-fracture membrane as manufactured by Laticrete International, Inc., Bethany, CT.
 5. Hydraflex as manufactured by TEC. Ready to use, flexible, mold and mildew resistant waterproofing and crack isolation membrane for interior and exterior applications.
- D. Crack Isolation Membrane in Lobby area: Provide materials complying with ANSI A118.12 and as specified below:
1. Mapeguard 2, as manufactured by MAPEI Corp.

2.03 GROUTING MATERIALS

- A. Pre-mixed grout complying with ANSI A118.3 for stain resistance.
1. Provide one of the following manufacturers:
 - a. Mapei, FlexColor CQ Grout.
 - b. TEC, InColor Advanced Performance Grout.
 - c. Bostik, TruColor Pre-mixed Urethane Grout
 - d. Laticrete, Plasma Pre-mixed Urethane Grout.
- B. Color: As selected by Architect.
- ## 2.04 MISCELLANEOUS MATERIAL

- A. Latex Underlayment: Quick set type, as recommended by membrane manufacturer, as required to provide positive drainage to floor drains.
- B. Sealer for Quarry Tile: Shall be a penetrating sealer as manufactured by Aqua Mix Inc., Santa Fe Springs, California, Miracle Sealants Penetrating Sealer, Arcadia, California, or Architect approved equivalent. (Seal prior to grouting)
- C. Sealants for control joints in floors and walls, use one part fungicidal silicone rubber to match grout, Dow Corning 784, meeting Fed. Spec. TT-S-001543, Class A or B.
- D. Metal trim on outside vertical wall corners and above top course of wall tile: Schluter Rondec, Satin anodized aluminum, 5/16'' (RO 80AE) with factory made corners.

PART 3 - EXECUTION

3.01 INSPECTION:

- A. Installer must examine the areas and conditions under which tile work is to be installed and notify the Contractor, in writing, of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 PREPARATION:

- A. Prepare substrate to receive setting bed and tile recommended both by the manufacturer of the tile and of the setting bed materials.
 - 1. Fill cracks, holes and depressions with trowelable leveling and patching compound according to tile setting material manufacturer's written instructions.
 - 2. Remove protrusions, bumps and ridges by sanding or grinding.
 - 3. Provide concrete substrates for tile floors that comply with flatness tolerances specified in ANSI A108.
 - 4. Apply skim coat full height to all walls to receive wall tile.
 - 5. Apply self leveling agent to entire floor to receive floor tile.
- B. Clean substrate as required and recommended to achieve bond using cleaners, detergents, etc.

C. Neutralize and seal substrates as recommended.

3.03 INSTALLATION:

A. Tile Installation - General:

1. Provide installation of ceramic tile in accordance with Tile Council of America's "Handbook for Ceramic Tile Installation."
2. Fit tile carefully against trim and around pipes, electrical boxes and other built-up fixtures so that escutcheons, plates and collars will completely overlap cut edges.
3. Smooth exposed edges and clean tile before installation.
4. Install ceramic tile with a nominal 1/8" joint (unless noted otherwise).
5. Joint designs shall be symmetrical within room or area; border tile be not less than 1/2 normal width. Floor tile shall be set in straight line design, with wall joints in alignment with floor tile where possible.
6. At junction of base tile and wall tile, at projections through tile and at junctions of tile to shower receptors, urinals, corner guards and similar equipment, leave joint ungrouted for sealing.
7. When using tile sheets, minimize tearing sheets apart.

3.04 SETTING METHODS

- A. Method and typical detailing for tile work shall be in accordance with the following TCA alphanumeric method, listing from the "Handbook for Ceramic Tile Installation", latest edition, by the Tile Council of America.

B. Concrete Subfloors

1. Slabs on Grade at Kitchen areas (Thin-set Method): TCA Setting Method F131-03 (provide with waterproof and crack isolation membrane) Thin Set Mortar and Epoxy Grout complying with Tile Installation Specification ANSI A108.6. Install crack isolation membrane per manufacturer's specs.
2. Slabs on grade and 2nd concrete floor slabs (thin-set method): TCA setting method F115-03 (provide with waterproof and crack isolation membrane) thin set Portland Cement mortar, epoxy grout complying with tile installation specification ANSI A108.5 and epoxy grout installation specification ANSI A108.6.

C. Walls

1. Masonry (Cement Mortar Bond Method): TCA Setting Method W202-03 latex-Portland Cement mortar, install per Tile Installation Specification ANSI A108.5. Install crack isolation membrane per manufacturer's specs.

3.05 GROUTING

- A. Grouting shall be installed in accordance with ANSI A108.10 and the manufacturer's recommended procedures and precautions during application and cleaning.
- B. Rinse tilework thoroughly with clean water before and after using chemical cleaners.
- C. Base Installation:
 1. Over concrete and masonry, install base using dry-set portland cement mortar in accord with ANSI A108.5. Grout using same grout specified for related tile floor.
 2. Over gypsum wall board, install base using organic adhesive in accord with ANSI A108. Grout using same grout specified for related tile floor.
- D. Jointing Pattern: Lay tile in pattern indicated. Layout tile work and enter tile fields both directions in such space or on each wall area. Adjust to minimize tile cutting. Provide uniform joint width, unless otherwise shown.
- E. Expansion and Control Joints: Provide as indicated on drawings and as recommended by TCA and by tile and setting

bed and grouting material manufacturer and as follows:

1. Control Joints Locations: Comply with the Tile Council of America. (TCA) and where indicated.

a. Interior Locations (horizontal and vertical):

1. Over any expansion joint, control joint, cold joint or seismic joint in the building structure.
2. Expansion joints - 24 feet to 36 feet in each direction.
3. Expansion joints - 8 feet to 12 feet where tile work located in direct sunlight or moisture locations.
4. Where tile abuts restraining surfaces such as perimeter walls, dissimilar floors, curbs, columns, pipes, ceiling and where changes occur in backing materials.
5. Coordinate joint locations with the Architect and for other areas indicated or required.
6. Joint width shall be 3/8 inch, unless otherwise indicated.
7. Provide under-layment systems.
8. Install compatible sealant and color approved by the Architect.

b. Exterior Locations (horizontal and vertical)

1. Expansion joints - 8 feet to 12 feet in each direction.
2. Coordinate joint locations with Architect and for other areas indicated or required.
3. Joint width shall be 3/8 inch to 5/8 inch maximum to suit expansion areas.
4. Provide under-layment systems.
5. Install compatible sealant and of color approved by the Architect.

F. Grout all tile using commercial epoxy grout as specified.

1. Temporarily protect tile as required to prevent staining.

3.04 ADJUST AND CLEAN:

A. Cleaning:

1. Clean grout and setting materials from face of tile while materials are workable. Leave tile face clean and free of all foreign matter.
2. Tile may be cleaned with acid solutions only when permitted by the tile and grout manufacturer's printed instructions, but not sooner than 14 days after installation. Protect metal surfaces, cast iron, and vitreous plumbing fixtures from effects of acid cleaning. Flush the surface with clean water before and after cleaning.

B. Finished Tile Work:

1. Leave finished installation clean and free of cracked, chipped, broken, unbonded, or otherwise defective tile work.

C. Protection:

1. Apply a protective coat of neutral protective cleaner to completed tile work.
2. Protect installed tile work with Kraft paper or other heavy covering during the construction period to prevent damage and wear.
3. Prohibit all foot and wheel traffic from using tiled floors for at least 3 days, preferably 7 days.
4. Before final inspection, remove protective coverings and rinse neutral cleaner from all tile surfaces.

END OF SECTION 09300

SECTION 09510 - ACOUSTICAL CEILINGS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Attention is directed to Division 0, Bidding and Contract Requirements, and to Division 1, General Requirements, which are hereby made a part of this Section.

1.02 DESCRIPTION OF WORK:

- A. The extent of acoustical panel ceiling is shown on the drawings and in schedules.

1.03 QUALITY ASSURANCE:

- A. The installation of acoustical panel ceilings is to be by an experienced installation firm which is acceptable to the manufacturer of the acoustical units, as shown by current written statement from the manufacturer.
- B. Standard for Terminology and Performance: Applicable publications by the Acoustical and Insulating Materials Association (AIMA), including "Performance Data, Architectural Acoustical Materials."
- C. Fire Hazard Classification: UL tested, listed and labeled as Class 0.25.

1.04 SUBMITTALS:

- A. Product Data:
 - 1. For information only, submit 2 copies of manufacturer's product specifications and installation instructions for each acoustical panel ceiling material required, and for suspension system, including certified laboratory test reports and other data as required to show compliance with these specifications. Distribute one additional copy of each installation instruction to the Installer.
 - a. Include manufacturer's recommendations for cleaning and refinishing acoustical panel, including precautions against materials and methods which may be detrimental to finishes and acoustical performance.

1.05 SAMPLES

1. Submit 3 sets of 12" square Samples for each acoustical panel required. In each set of samples show the full range of exposed color and texture to be expected in the completed work. Sample submittal and Architect's review will be for color and texture only. Compliance with other requirements is the exclusive responsibility of the Installer.
2. Submit 3, 12" long samples of exposed runner and molding. Architect's review will be for color and texture only. Compliance with other requirements is the exclusive responsibility of the Installer.

C. Maintenance Stock:

1. At the time of completing the installation, deliver stock of maintenance materials to the Owner. Furnish full size units matching the units installed, packaged with protective covering for storage and identified with appropriate labels. Furnish an amount equal to 5.0% of the amount installed.

1.06 JOB CONDITIONS:

- A. Space Enclosures: Do not install until interior acoustical panel ceilings unit space has been enclosed and is weather-tight, and until wet work in the space has been completed and is nominally dry and until work above ceilings has been completed, and until ambient conditions of temperature and humidity will be continuously maintained at values near those indicated for final occupancy.

PART 2 - PRODUCTS

2.01 CEILING UNITS:

- A. Acoustical Panels: (AT-1). (Use at all locations unless noted otherwise)
 1. Provide 24" x 48" wet-formed mineral fiber units, not less than $\frac{3}{4}$ " thick with single score. NRC min. 0.60, CAC 35, light reflectance min. 0.82, Reveal edge.

2. Acceptable Products:
 - a. Armstrong Item No. 1761, fine-fissured-Second look.
 - b. Certainteed: Item No. FFCL-224 Bioshield, fine fissured.
 - c. USG: Item No. 2842-Radar-ClimaPlus Illusion.
 3. Install in 15/16" exposed tee grid.
- B. Acoustical Panels: (AT-2) (Use in Kitchens)
1. Provide 24" x 48" wet-formed mineral fiber units not less than 3/4" thick with single score. NRC 0.55, CAC 35, light reflectance 0.79, Square edge.
 2. Basis of Design: Item #1715 Clean Room Mylar (field units) and #1720 Clean Room mylar border units (for use where panels must be cut on the jobsite), by Armstrong.
 3. Install in 15/16" exposed tee grid.
- C. Wood Fiber Acoustical Panels: (AT-3) (Use in Rooms indicated as TEC in Finish Schedule)
1. Acoustical panels shall be nominal 24" x 24" x 1" cementitious wood fiber lay-in panels with square edges, factory applied white paint finish "Tectum Acousti-Tough" as manufactured by Tectum, Inc.
 2. Provide complete system with hold down clips.
 3. Use in 24" x 24" exposed grid system.
- 2.02 CEILING SUSPENSION MATERIALS:
- A. General: Comply with ASTM C 635, as applicable to an intermediate duty suspension system. Coordinate with other work supported by or penetrating through the ceilings, including light fixtures and HVAC equipment.
- B. Attachment Devices: Size for 5 times the design load indicated in ASTM C 635, Table 1, Direct Hung.
1. Hanger Wires: Galvanized carbon steel, ASTM A 641, soft temper, prestretched, yield-stress load of at least 3 times design load but not less than 12 USWG.

- C. Exposed Suspension System: Exposed systems compatible with tiles specified and as follows:
 - 1. Armstrong - 15/16" Prelude XL exposed tee grid.
 - 2. CertainTeed - 15/16" Classic Aluminum Capped Stab System.
 - 3. Donn - DX24 System; USG Interiors
 - 4. Chicago Metallic Corp: 1200 System.

- D. Edge Moldings: Manufacturer's standard channel molding for grid type used for edges and penetrations of ceiling, with a single flange of molding exposed, finish to match grid.

2.03 MISCELLANEOUS MATERIALS:

- A. Acoustical Sealant: A heavy-bodied, non-shrinking, non-drying, non-sag grade mastic compound intended for interior sealing of concealed construction joints.

- B. Tile Cement: As recommended by tile manufacturer.

PART 3 - EXECUTION

3.01 INSPECTION AND PREPARATION WORK:

- A. Installer must examine the conditions under which the acoustical ceiling work is to be performed and notify the Construction Manager, in writing, of unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

- B. Measure each ceiling area and establish layout of acoustical units to balance border widths at opposite edges of each ceiling. Avoid the use of less-than-half widths units at borders, and comply with reflected ceiling plans wherever possible.

3.02 INSTALLATION:

- A. General: Install material in accordance with manufacturer's printed instructions and comply with governing regulations as indicated, and industry standards applicable to the work.

- B. Install suspension systems to comply with ASTM C 636 with hangers supported only from building structural members as indicated. Locate hangers near each end and spaced 4' - 0' along direct-hung runners, unless

otherwise indicated.

1. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eye-screws, or other devices which are secure and appropriate for the substrate, and which will not deteriorate or fail with age or elevated temperatures.
- C. Install edge moldings at edges of each acoustical ceiling area and at locations where edge of units would otherwise be exposed after completion of the work, except where adhesively applied.
1. Sealant Bed: Apply continuous ribbon of acoustical sealant, concealed pm back of vertical leg before fastening to vertical surface.
 2. Secure moldings to building construction by fastening with screw-anchors into the substrate through holes drilled in not more than 16" o.c. along each molding.
 3. Level moldings with ceiling suspension system to level tolerance of 1/8" in 12' - 0".
 4. Miter corners of moldings accurately to provide hair-line joints, securely connected to prevent dislocation.
- D. Cope exposed flanges of intersection suspension system members so that flange faces will be flush (cope flange of member supported by other member) except as otherwise indicated.
- E. Install acoustical panels in coordination with suspension system, with edges concealed by support of suspension members. Scribe and cut panels to fit accurately at penetrations.
- F. Install edge trim moldings where indicated and elsewhere as needed to conceal edges of acoustical units which would otherwise be exposed to view after completion of the work. Anchor with fasteners, or if not possible, secure in place with permanent adhesive.

3.03 CLEANING AND PROTECTION:

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension members; comply with manufacturer's instructions for cleaning and touch-up of minor finish damage. Remove and replace work which cannot be successfully cleaned and required to permanently eliminate evidence of damage.

- B. The Installer shall advise the Construction Manger of required protection for the acoustical panel ceilings, including temperature and humidity limitations and dust control, so that the work will be without damage and deterioration at the time of acceptance by the Owner.

END OF SECTION 09510

SECTION 09540 - SPECIAL SURFACES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Work described in this section:
 - 1. Window Sills (indicated as synthetic sill material on drawings).
- B. Related work specified elsewhere:
 - 1. Section 06100 - Carpentry
 - 2. Section 09250 - Gypsum Drywall

1.02 REFERENCES

- A. Applicable Standards: Standards of the following, as referenced herein:
 - 1. American National Standards Institute (ANSI)
 - 2. American Society for Testing and Materials (ASTM)
 - 3. National Electrical Manufacturers Association (NEMA)
 - 4. Federal Specifications (FS)

1.03 SUBMITTALS

- A. Shop drawings: Indicate dimensions, component sizes, fabrication details, attachment provisions and coordination requirements with adjacent work.
- B. Samples: Submit minimum 2" x 2" (50mm x 50mm) samples. Indicate full range of color and pattern variation. Approved samples will be retained as standards for work.
- C. Product data: Indicate product description, fabrication information and compliance with specified performance requirements.
- D. Maintenance data: Submit manufacturer's care and maintenance data, including repair and cleaning instructions. Include in project close-out documents.

1.04 QUALITY ASSURANCE

- A. Allowable tolerances:
 - 1. Variation in component size: $\pm 1/8"$ (3 mm).
 - 2. Location of openings: $\pm 1/8"$ (3 mm) from indicated location.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver no components to project site until areas are ready for installation. Store components indoors prior to installation.
- B. Handle materials to prevent damage to finished surfaces. Provide protective coverings to prevent physical damage or staining following installation for duration of project.

1.06 WARRANTY

- A. Provide manufacturer's 10 year warranty against defects in materials. Warranty shall provide material and labor to repair or replace defective materials. Damage caused by physical or chemical abuse or damage from excessive heat will not be warranted.

PART 2 - PRODUCTS

2.01 SOLID POLYMER FABRICATIONS

- A. Material: Homogeneous filled acrylic; not coated, laminated or of composite construction; meeting ANSI Z124.3 & .6, Type Six, and Fed. Spec. WW-P-541E/GEN.
 - 1. Material shall have minimum physical and performance properties specified in the following Section U.
 - 2. Superficial damage to a depth of 0.010" (.25mm) shall be repairable by sanding and polishing.

- B. Manufacturer:
 - 1. Corian (Basis of Design)
 - 2. Newmar
 - 3. Gibraltar
 - 4. Avonite
 - 5. Prism as manufactured by InPro Corp.

- C. Windowsills (pre-finished sills): ½" thick solid polymer, as shown on drawings, adhesively joined with inconspicuous seams; edge details as indicated on the Architects drawings. Color to be selected by Architect from manufacturer's standard and/or custom colors from all price groups.

2.02 ACCESSORY PRODUCTS

- A. Joint adhesive: Manufacturer's standard two-part adhesive kit to create inconspicuous, non-porous joints, with a chemical bond.

- B. Sealant: Manufacturer's standard mildew-resistant, FDA/UL recognized silicone sealant in color matching or clear formulations.

2.03 FABRICATION

- A. Fabricate components in shop to greatest extent practical to sizes and shapes indicated, in accordance with approved shop drawings and manufacturer's requirements.

- B. Form joints between components using manufacturer's standard joint adhesive. Joints shall be inconspicuous in appearance and without voids. Attach 2" (50 mm) wide reinforcing strip of solid surface under each joint.

- C. Rout and finish component edges to a smooth, uniform finish. Rout all cutouts, then sand all edges smooth. Repair or reject defective or inaccurate work.

- D. Finish: All surfaces shall have uniform finish.
 - 1. Matte, with a gloss rating of 5-20.
- E. Thermoforming: Comply with forming data from manufacturer.
 - 1. Construct matching molds of plywood to form component shape.
 - 2. Form pieces to shape prior to seaming and joining.
 - 3. Cut pieces larger than finished dimensions. Sand edges. Remove all nicks and scratches.
 - 4. Heat entire component uniformly between 275°F-325°F during forming.
 - 5. Prevent blistering, whitening and cracking of solid surface during forming.

PART 3 - EXECUTION

3.01 JOB MOCK-UP

- A. Prior to final approval of shop drawings, erect one full size mock-up of each component at project site for Architect review.
- B. Should mock-up not be approved, rework or remake until approval is secured. Remove rejected units from project site.
- C. Approved mock-ups shall remain as part of finished work.

3.02 INSTALLATION

- A. Install components plumb and level, in accordance with approved shop drawings and product installation details.
- B. Form field joints using manufacturer's recommended adhesive, with joints inconspicuous in finished work. Keep components and hands clean when making joints.

- C. Keep components and hands clean during installation. Remove adhesives, sealants and other stains. Components shall be clean on Date of Substantial Completion.
- D. Protect surfaces from damage until Date of Substantial Completion. Repair or replace damaged work that cannot be repaired to Architect's satisfaction.
- E. Fabricator/Installer is to provide manufacturers recommended manuals, and review maintenance procedures and the manufacturer's warranty with the head of Maintenance upon completion of the project.

END OF SECTION 09540

SECTION 09550 - WOOD FLOORING REFINISHING

PART 1. GENERAL

1.01 RELATED DOCUMENTS

- A. Attention is directed to Division 0, Bidding and Contract Requirements, and Division 1, General Requirements, which are hereby made a part of this specification.

1.02 SECTION INCLUDES

- A. Work included in this Section consists of furnishing all labor, materials, equipment and incidentals required for complete finishing of wood flooring, adhesives and all associated accessories mentioned or scheduled on the drawings and/or herein.

1.03 SUBMITTALS

- A. Manufacturer's Data: Submit three copies of manufacturer's specifications and installation instructions for each type of wood refinishing material. Indicate by transmittal that a copy of each installation instruction has been distributed to the Installer.
- B. Maintenance Instructions: Wood flooring, submit two (2) copies of manufacturer's written instructions for recommended maintenance practices for each type of wood flooring finish.

1.04 QUALITY CONTROL

- A. Guarantee: Furnish a manufacturer's written warranty stating all materials supplied shall be free from defects for a period of one year.
- B. All work shall be performed per WSFI Recommendations and Standards.

PART 2. PRODUCTS

2.01 MATERIALS

- A. Perimeter Base: Existing metal vented base to remain.

- B. Transition Trim: Remove and reinstall existing aluminum transitions/thresholds.
- C. Finishing Material:
 - 1. Manufacturer: BonaKemi.
- D. Expansion Joint: Remove existing material and install new cork material for expansion joint.

PART 3. EXECUTION

3.01 EXAMINATION AND PREPARATION

- A. Flooring contractor shall inspect the conditions under which floor re-finishing is to be performed. Fill wide joints in excess of 1/16". Set nails that are in plane to be sanded. Ensure that sanding operations will not reduce wear surface of floor exposing tongue and groove.
- B. Remove and reinstall recessed electrical covers, etc. as required to refinish floor.

3.02 MATERIAL SAFETY DATA SHEETS

- A. MSDS sheets covering all products being used shall be kept on site during course of the work.

3.03 MIOSHA

- A. All applicable MIOSHA shall be strictly adhered to during the course of the work including supplying workers with respirators if requested.

3.04 INSTALLATION - GYM FLOORING

- A. Stripping.
 - 1. Strip existing floor by sanding down to the bare wood. Do not use chemical strippers, heat, or other methods without prior approval by Architect.
 - 2. Sand flooring with drum sander, edger, buffer and hand scraper. All sanding shall be in accordance with floor manufacturer's instructions. Vacuum and tack floor before first coat of finish. When complete, floor shall be free of drum stop marks, gouges, streaks or shiners.
 - 3. Ensure adequate ventilation throughout entire

stripping and refinishing.

B. Finishing procedure:

1. Apply initial coat of Bona Sport Sealer, then one coat (BonaKemi All-Court) followed by 2 finish coats (BonaKemi Sport Poly) Abrade with steel wool between coats.
2. Post signs at appropriate locations making unwanted individuals aware of wet floor conditions.
3. Clean up all materials, trash etc.
4. Paint game lines as identical to the existing court layout, colors and sizes, between second seal coat and first coat of finish.
5. Game line paint shall be compatible with finish manufacturer. Colors shall be selected from manufacturers standard color range.
6. Paint custom 3-color logo at center court to fill 12' diameter circle. Camera ready artwork logo to be provided by Owner to Contractor for installation.

3.05 PROTECTION

A. Cure Time

1. No traffic or other trades shall be allowed on the surface for a period of one week following completion to allow for complete and proper cure of the finish.

B. Other Trades

1. Protect the surface from damage by other trades before acceptance by the owner or the owner's authorized agent.

C. Safety

1. No smoking, open flames or sparks from electrical equipment or any other source shall be permitted during the installation process, or in areas where materials are stored.

END OF SECTION

SECTION 09614 - ADA REPLACEABLE CAST IN PLACE DETECTABLE WARNING SURFACES

PART 1. GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Special Conditions and Division 1 Specifications Section, apply to this Section.

1.02 DESCRIPTION

- A. This Section specifies furnishing and installing Replaceable Cast In Place Detectable/Tactile Warning Surface Tiles where indicated. Not recommended for asphalt applications.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's literature describing products, installation procedures and routine maintenance.
- B. Samples for Verification Purposes: Submit two (2) tile samples minimum 6'' x 6'' of the kind proposed for use.
- C. Shop Drawings are required for products specified showing fabrication details, composite structural system, tile surface profile, fastener and anchor locations, plans of tile placement including joints, and material to be used as well as outlining installation materials and procedure.
- D. Material Test Reports: Submit complete test reports from qualified accredited independent testing laboratories to qualify that materials proposed for use are in compliance with requirements and meet or exceed the properties indicated on the specifications. All tests shall be conducted on a Replaceable Cast In Place Detectable Tactile Warning Surface Tile system as certified by a qualified independent testing laboratory and be current within a 24 month period.
- E. Maintenance Instructions: Submit copies of manufacturer's specified installation and maintenance practices for each type of Detectable Warning Surface Tile and accessory as required.

1.04 QUALITY ASSURANCE

- A. Provide Replaceable Cast In Place Detectable/Tactile Warning Surface Tiles and accessories as produced by a single manufacturer with a minimum of three (3) years experience in the manufacturing of Cast In Place Detectable/Tactile Warning Surface Tiles.
- B. Installer's Qualifications: Engage an experienced installer certified in writing by Replaceable Cast In Place Detectable/Tactile Warning Surface Tile manufacturer as qualified for installation, who has successfully completed installation similar in material, design, and extent to that indicated for Project.
- C. Americans with Disabilities Act (ADA): Provide Replaceable Cast In Place Detectable/Tactile Warning Surface Tiles which comply with the detectable warnings on walking surfaces section of the Americans with Disabilities Act (Title III Regulations, 28 CFR Part 36 ADA STANDARDS FOR ACCESSIBLE DESIGN, Appendix A Section 4.29.2 DETECTABLE WARNINGS ON WALKING SURFACES).
- D. California Code of Regulations (CCR): Provide only approved DSAAC detectable warning products as provided in the California Code of Regulations (CCR) Title 24, Section 1112A.9 and 1127B.5 for "Curb Ramps" and Section 1133B.8.5 for "Detectable Warnings at Hazardous Vehicular Areas".
- E. Vitrified Polymer Composite (VPC) Replaceable Cast In Place Detectable/Tactile Warning Surface Tiles shall be an epoxy polymer composition with an ultra violet stabilization coating employing aluminum oxide particles in the truncated domes. The tile shall incorporate an in-line pattern of truncated domes measuring nominal 0.2" height, 0.9" base diameter, and 0.45" top diameter, spaced center-to-center 3.4" as measured on a diagonal and 2.35" as measured side by side. For wheelchair safety the field area shall consist of a non-slip surface with a minimum of 40 - 90° raised points 0.045" high, per square inch; "Armor-Tile" as manufactured by Engineered Plastics Inc., Tel: 800-682-2525, or approved equal.
 1. Dimensions: Replaceable Cast In Place Detectable/Tactile Warning Surface Tiles shall be held within the following dimensions and tolerances:
 - Length and width: 24" x 48" nominal or as indicated on drawings.
 - Depth: .50 (1/2") (+/-) 5% max.
 - Face Thickness: 0.1875 (3/16") (+/-) 5% max.

- Warpage of Edge: 0.5% max.
Fasteners/Anchors: 11 min.
2. Water Absorption of Tile when tested by ASTM D 570-98 not to exceed 0.05%.
 3. Slip Resistance of Tile when tested by ASTM C1028-96 the combined Wet and Dry Static Co-Efficient of Friction not to be less than 0.80 on top of domes and field area.
 4. Compressive Strength of Tile when tested by ASTM D 695-02a not to be less than 28,000 PSI.
 5. Tensile Strength of tile when tested by ASTM D 638-03 not to be less than 19,000 PSI.
 6. Flexural Strength of Tile when tested by ASTM D 790-03 not to be less than 25,000 PSI.
 7. Chemical Stain Resistance of Tile when tested by ASTM D 543-95 (re approved 2001) to withstand without discoloration or staining - 10% hydrochloric acid, urine, saturated calcium chloride, black stamp pad ink, chewing gum, red aerosol paint, 10% ammonium hydroxide, 1% soap solution, turpentine, Urea 5%, diesel fuel and motor oil.
 8. Abrasive Wear of Tile when tested by BYK - Gardner Tester ASTM D 2486-00 with reciprocating linear motion of $37 \pm$ cycles per minute over a 10'' travel. The abrasive medium, a 40 grit Norton Metallite sand paper, to be fixed and leveled to a holder. The combined mass of the sled, weight and wood block is to be 3.2 lb. Average wear depth shall not exceed 0.060 after 1000 abrasion cycles when measured on the top surface of the dome representing the average of three measurement locations per sample.
 9. Resistance to Wear of Unglazed Ceramic Tile by Taber Abrasion per ASTM C501-84 (re approved 2002) shall not be less than 500.
 10. Fire Resistance of Tile when tested to ASTM E84-05 flame spread shall be less than 15.
 11. Gardner Impact to Geometry ``GE'' of the standard when tested by ASTM D 5420-04 to have a mean failure energy expressed as a function of specimen thickness of not less than 550 in. lb f/in. A failure is noted when a crack is visible on either surface or when any brittle splitting is observed on the bottom plaque in the specimen.
 12. Accelerated Weathering of Tile when tested by ASTM G 155-05a for 3000 hours shall exhibit the following result- $\Delta E < 4.5$, as well as no deterioration, fading or chalking of surface of tile color No. 33538.

13. Accelerated Aging and Freeze Thaw Test of Tile and Adhesive System when tested to ASTM D 1026 shall show no evidence of cracking, delaminating, warpage, checking, blistering, color change, loosening of tiles or other detrimental defects.
14. Salt and Spray Performance of Tile when tested to ASTM B 117-03 not to show any deterioration or other defects after 200 hours of exposure.
15. AASHTO HB-17 single wheel HS20-44 loading ``Standard Specifications for Highways and Bridges``. The Replaceable Cast In Place Tile shall be mounted on a concrete platform with 1/32'' airspace at the underside of the tile top plate then subjected to the specified maximum load of 10,400 lbs., corresponding to an 8000 lb. individual wheel load and a 30% impact factor. The tile shall exhibit no visible damage at the maximum load of 10,400 lbs.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Replaceable Cast In Place Detectable/Tactile Warning Surface Tiles shall be suitably packaged or crated to prevent damage in shipment or handling. Finished surfaces shall be protected by sturdy plastic wrappings to protect tile from concrete residue during installation and tile type shall be identified by part number.
- B. Replaceable Cast In Place Detectable/Tactile Warning Surface Tiles shall be delivered to location at building site for storage prior to installation.

1.06 SITE CONDITIONS

- A. Environmental Conditions and Protection: Maintain minimum temperature of 40°F in spaces to receive Replaceable Cast In Place Detectable/Tactile Warning Surface Tiles for at least 24 hours prior to installation, during installation, and for not less than 24 hours after installation.
- B. The use of water for work, cleaning or dust control, etc. shall be contained and controlled and shall not be allowed to come into contact with the general public. Provide barricades or screens to protect the general public.

1.07 GUARANTEE

- A. Replaceable Cast In Place Detectable/Tactile Warning Surface Tiles shall be guaranteed in writing for a period of five (5) years from date of final completion. The

guarantee includes defective work, breakage, deformation, fading and loosening of tiles.

PART 2. PRODUCTS

2.01 MANUFACTURERS

- A. The Vitrified Polymer Composite (VPC) Replaceable Cast In Place Detectable/Tactile Warning Surface Tiles specified is based on Armor-Tile manufactured by Engineered Plastics Inc. (800-682-2525) existing engineered and field tested products, which have been in successful service for a period of three (3) years are subject to compliance with requirements, may be incorporated in the work and shall meet or exceed the specified test criteria and characteristics.
- B. Color: Color shall be homogeneous throughout the tile. Tiles are available in Yellow conforming to Federal Color No. 33538, Light Grey (Federal Color No. 26280), Dark Grey (Federal Color No. 36118), Onyx Black (Federal Color No. 17038), Pearly White (Federal Color No. 37875), Brick Red (Federal Color No. 22144), Ocean Blue (Federal Color No. 15187), Ochre Yellow (Federal Color No. 23594), and Colonial Red (Federal Color No. 20109). Color to be selected by Architect.

PART 3. EXECUTION

3.01 INSTALLATION

- A. During Replaceable Cast In Place Detectable/Tactile Warning Surface Tile installation procedures, ensure adequate safety guidelines are in place and that they are in accordance with the applicable industry and government standards.
- B. Prior to placement of the Replaceable Cast In Place Detectable/Tactile Warning Surface Tile system, review manufacturer's instructions and contract drawings with the Contractor prior to the construction and refer any and all discrepancies to Project Engineer.
- C. The specifications and related materials shall be in strict accordance with the contract documents and the guidelines set by their respective manufacturers. Not recommended for asphalt applications.
- D. The physical characteristics of the concrete shall be consistent with the contract specifications while maintaining a slump range of 4 - 7 to permit solid placement of the Replaceable Cast In Place

Detectable/Tactile Warning Surface Tile system. An overly wet mix will cause the tile to float. Under these conditions, suitable weights such as sandbags shall be placed on tile.

- E. The concrete pouring and finishing operations require typical mason's tools, however, a 4' long level with electronic slope readout, and 10lb. sandbags are specific to the installation of the Replaceable Cast In Place Detectable/Tactile Warning Surface Tile system.
- F. The factory-installed plastic sheeting must remain in place during the entire installation process to prevent the splashing of concrete onto the finished surface of the tile.
- G. When preparing to set the tile, it is important that no concrete be removed in the area to accept the tile. It is imperative that that installation technique eliminates any air voids under the tile. Gaps in the tile perimeter allow air to escape during the installation process.
- H. The concrete shall be poured and finished true and smooth to the required dimensions and slope prior to the tile placement. Immediately after finishing concrete, the electronic level should be used to check that the required slope is achieved. The tile shall be placed true and square to the curb edge in accordance with the contract drawings. The Replaceable Cast In Place Detectable/Tactile Warning Surface Tiles shall be tamped (or vibrated) into the fresh concrete to ensure that the field level of the tile is flush to the adjacent concrete surface. The embedment process should not be accomplished by stepping on the tile as this may cause uneven setting which can result in air voids under the tile surface. The contract drawings indicate that the tile field level (base of truncated dome) is flush to adjacent surfaces to permit proper water drainage and eliminate tripping hazards between adjacent finishes.
- I. In cold weather climates it is recommended that the Replaceable Cast In Place Detectable/Tactile Warning Surface Tiles be set deeper such that the top of domes are level to the adjacent concrete on the top and sides of ramp. This installation will reduce the possibility of damage due to snow clearing operations. Care should be taken to finish the concrete on the side of the tile with the lower elevation, adding channels to allow water to drain from the field surface of the tile.

- J. Immediately after placement, the tile elevation is to be checked to adjacent concrete. The elevation and slope should be set consistent with contract drawings to permit water drainage to curb as the design dictates. Ensure that the field surface of the tile is flush with the surrounding concrete and back of curb so that no ponding is possible on the tile at the back side of curb.
- K. While concrete is workable, a 1/8'' radius edging tool shall be used to create a finished edge of concrete, then a steel trowel shall be used to finish the concrete around the tile's perimeter, flush to the field level of the tile.
- L. During and after the tile installation and the concrete curing stage, it is imperative that there is no walking, leaning or external force placed on the tile that may rock the tile causing a void between the underside of tile and concrete.
- M. Following tile placement, review installation tolerances to contract drawings and adjust tile before the concrete sets. Suitable weights of 10 to 25 lb. each may be required to be placed on each tile as necessary to ensure solid contact of the underside of tile to concrete.
- N. Following the concrete curing stage, protective plastic wrap is to be removed from the tile surface by cutting the plastic with a sharp knife, tight to the concrete/tile interface. If concrete bled under the plastic, a soft brass wire brush will clean the residue without damage to the tile surface.
- O. Tiles can be cut to custom sizes, or to make a radius, using a continuous rim diamond blade in a circular saw or mini-grinder. Use of a straightedge to guide the cut is advisable where appropriate.

3.02 REPLACING TILES, PROTECTING AND MAINTENANCE

- A. Protect tiles against damage during construction period to comply with Tactile Tile manufacturer's specification.
- B. Protect tiles against damage from rolling loads following installation by covering with plywood or hardwood.
- C. Replace tiles by method specified by Tactile Tile manufacturer.

FARMINGTON PUBLIC SCHOOLS
2017 RENOVATIONS-BID PACK #5
ELEMENTARY SCHOOLS

161664B

NOVEMBER 30, 2016

- D. Comply with manufacturer's maintenance manual for cleaning and maintaining tile surface. It is recommended to perform annual inspections for safety and tile integrity.

END OF SECTION 09614

SECTION 09650 - RESILIENT FLOORING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Attention is directed to Division 0, Bidding and Contract Requirements, and to Division 1, General Requirements, which are hereby made a part of this Section.

1.02 DESCRIPTION OF WORK:

- A. The extent of resilient flooring and accessories is shown on the drawings and in schedule indicated as "LVT" for "Luxury Vinyl Tile Floor".

1.03 QUALITY ASSURANCE:

- A. Wherever possible, provide resilient flooring and accessories produced by a single manufacturer.
- B. Fire Test Performance: Provide resilient flooring which complies with the following fire test performance criteria as determined by an independent testing laboratory acceptable to authorities having jurisdiction.
 - 1. Critical Radiant Flux (CRF): Not less than 0.45 watts per sq. cm. per ASTM E 648.
 - 2. Flame Spread: Not more than 75 per ASTM E 84.
 - 3. Smoke Developed: Not more than 450 per ASTM E 84.
 - 4. Smoke Density: Not more than 450 per ASTM E 662.

1.04 SUBMITTALS:

- A. Product Data:
 - 1. For information only, submit 2 copies of manufacturer's technical data and installation instructions for each type of resilient flooring and accessory. Transmit a copy of each installation instruction to the Installer.

B. Samples:

1. Submit 3 sets of samples of each type, color and finish of resilient flooring and accessory required. Provide full-size tile units and 6" long sample of accessory. Include full range of flooring color and pattern variation. Sample submittals will be reviewed for color, texture and pattern only. Compliance with all other requirements is the exclusive responsibility of the Contractor.

C. Maintenance:

1. Submit 2 copies of manufacturer's written instructions for recommended maintenance practices for each type of resilient flooring and accessories.

1.05 JOB CONDITIONS:

- A. Continuously heat areas to receive flooring to 70 degrees F. for at least 48 hours prior to installation, when project conditions are such that heating is required. Maintain 70 degrees F. temperature continuously during and after installation, as recommended by flooring manufacturer, but for not less than 48 hours.

1.06 EXTRA STOCK

- A. Deliver to the Owner, for his use in future modifications, an extra stock of approximately 10% of each color and pattern in each material installed under this Section, packaging each type of material separately, distinctly marked, and adequately protected against deterioration.

PART 2 - PRODUCTS

2.01 TILE FLOORING: (LVT Flooring)

- A. Tandus Centiva "Event" Series: (Basis of Design)
 1. Sizes: 4" x 36", 6" x 36", 12" x 18", 18" x 18"
 2. Thickness: 0.120"
 3. Finish: Polyurethane reinforced
 4. Edge Treatment: Square
 5. Static Load: ASTM F970-passes
 6. Slip Resistance: ASTM D2047-ADA compliant
 7. 20 year limited commercial wear warranty
 8. Recyclability: 100%
 9. Wear Layer: 30 mil
 10. Contact: Jen Hautamaki 313-330-1629
 11. ASTM F1700 Class III, Type 'B'.

12. Multiple color and patterns will be used throughout building. Refer to finish schedules and floor pattern plans.
13. Selections to be made form ``Event`` Series: Classic Plank; Heritage Plank and Classic Stone Products.

2.02 ACCESSORIES:

A. Resilient Base:

1. Provide vinyl base (Johnsonite vinyl wall base CB) complying with ASTM F-1861, Type TV, Group 1 (solid) in all areas except Admin. Areas and Media Center unless noted otherwise, as follows:
 - a. Height: 4" and 6''- refer to drawings for locations.
 - b. Thickness: 1/8''
 - c. Style: Standard top-set cove or straight type as indicated.
 - d. Provide with preformed inside and outside colors.
 - e. Provide with quarter round .5'' high x .5'' wide QTR-XX-A by Johnsonite at all interior door frames and door sidelight frames.
 - f. Install per manufacturers specs to maintain warranty.
 - g. Color: As selected by Architect. Provide 2 colors per room in pattern TBD.

B. Resilient Stair One Piece Nosing-Tread-Riser and intermediate landing surface. Furnish product consisting of single piece units for width of stair Nosing-Tread-Riser.

1. Provide rubber stair Nosing-Tread-Riser units equal to:
Norament 925 Grano stair treads by Nora Systems. Provide with phosphorescent permalight safety strip according to DIN 67 510 in the horizontal part of the stair nosing.
2. Provide matching intermediate landings component to tread/riser piece.
3. Install per manufacturers specification to maintain warranty.
4. Color as selected by Architect from manufacturer's 12 standard colors.
5. Surface texture shall be hammered.

C. Resilient Moulding/Reducer/Floor Finishing Accessories:

1. Provide vinyl carpet edge guards for glue down applications, nosings for resilient floor covering reducer strip for resilient floor covering, joiner for tile and carpet, or at junction between two dissimilar materials (new/new or new/existing), where shown on drawings and/or required.
 - a. Provide accessories as manufactured by Johnsonite, as follows:
 1. Carpet to sealed concrete: FG-XX-G
 2. PCT to carpet: CCA-XX
 3. VCT to carpet: CTA-XX-D
 4. Carpet to quarry tile: CWA-XX
 - b. Color to be determined by Architect from manufacturer's standard colors.
 - c. Install per manufacturer's standard specifications to maintain warranty.
- D. Adhesives (cements): As recommended by flooring contractor to suit material and substrate conditions.
- E. Concrete Slab Primer: Non-staining type as recommended by flooring manufacturer.

PART 3 - EXECUTION

3.01 INSPECTION:

- A. Installer must examine the areas and conditions under which resilient flooring and accessories are to be installed and notify the Contractor, in writing, of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 PREPARATION:

- A. Prior to laying flooring, broom clean or vacuum surfaces to be covered and inspect subfloor. Start of flooring installation indicates acceptance of subfloor conditions and full responsibility for completed work.
 1. Use leveling compound as recommended by flooring manufacturer for filling small cracks and depressions in subfloors.

2. Perform moisture tests on concrete slabs to determine that concrete surfaces are sufficiently cured and ready to receive flooring.
3. Apply concrete slab primer, if recommended by flooring manufacturer, prior to application of adhesive. Apply in compliance with manufacturer's directions.

3.03 INSTALLATION:

A. General:

1. Install flooring after finishing operations, including painting, have been completed and permanent heating system is operating. Moisture content of concrete slabs, building air temperature, and relative humidity must be within limits recommended by flooring manufacturer.
2. Place flooring with adhesive cement in strict compliance with manufacturer's recommendations. Butt tightly to vertical surfaces, thresholds, nosing and edgings. Scribe around obstructions and produce neat joints, laid tight, even and straight. Extend flooring into toe spaces, door reveals and into closets and similar openings.
3. Maintain reference markers, holes or openings that are in place or plainly marked for future cutting by repeating on finish flooring as marked on subfloor. Use chalk or other non-permanent marking device.
4. Maintain overall continuity of color and pattern with pieces of flooring installed in these covers. Tightly cement edges to perimeter of floor around covers and to covers.
5. Tightly cement flooring to subbase without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks or other surface imperfections.

B. Tile Floors:

1. Lay tile from center marks established with principal walls, discounting minor offsets, so that tile at opposite edges of the room are of equal width. Adjust as necessary to avoid use of cut widths less than 1/2 tile at room perimeters. Lay tile square to room axis, unless otherwise shown.

2. Match tiles for color and pattern by using tile from cartons in same sequence as manufactured and packaged. Cut tile neatly to around all fixtures. Broken, cracked, chipped or deformed tile are not acceptable.

C. Accessories:

1. Apply resilient base to walls, columns, pilasters, casework and other permanent fixtures in rooms or areas where base is required. Install base in as long lengths as practicable, with preformed corner units or fabricated from base materials with mitered or coped inside corners. Tightly bond base to backing throughout the length of each piece, with continuous contact at horizontal and vertical surfaces.
 - a. On masonry surfaces or other similar irregular surfaces, fill voids along top edge of resilient wall base with manufacturer's recommended adhesive filler material.
2. Place resilient edge strips tightly butted to flooring and secure with adhesive. Install edging strips at all unprotected edges of flooring, unless otherwise shown.
3. Apply resilient accessories at stair systems as indicated and in strict conformance to manufacturer's installation instructions.

3.04 CLEANING AND PROTECTION:

- A. Remove any excess adhesive or other surface blemishes, using neutral type cleaners as recommended by flooring manufacturer. Protect installed flooring from damage by covering.
- B. Finishing: After completion of project and just prior to final inspection of work, thoroughly clean floors and accessories.
- C. Apply wax and buff with type of wax, number of coats and buffing procedures, in compliance with flooring manufacturer's instructions.

END OF SECTION 09650

SECTION 09680 - CARPETING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes

1. Carpet Tiles

B. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.02 SUBMITTALS

A. Shop Drawings showing the extent of carpet, and accessories shall be submitted to Architect for approval prior to installation. Should also indicate columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet. Copy of approved shop drawings to be available on job site during installation.

B. Carpet schedule using same room designations indicated on drawings.

C. Product Data: Provide data on specified products, describing physical and performance characteristics, sizes, patterns, colors available, and method of installation.

D. Selection Samples: Submit manufacturer's complete set of color samples for Architect's initial color selection.

E. Verification Samples: Submit two 18" x 18" samples illustrating color and pattern for each carpet material specified.

F. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

G. Maintenance Data: Include maintenance procedures, recommendations for maintenance materials and equipment, and suggested schedule for cleaning.

H. Manufacturer's Carpet Warranty.

- I. Certification of Recycled Content and verification of reclamation and recycling program.
- J. Certifications: Manufacturer to submit copies of the following independent laboratory reports showing compliance with requirements per these methods outlined in Part 2 of this document. Submitted results shall represent average results for production goods of the specified style.
 1. ASTM E-648 Flooring Radiant Panel- Class 1 (mean avg CRF: 0.45w/sq cm or higher
 2. ASTM E-662: Smoke Density
 3. AATCC 134: Electrostatic Propensity - 3.0 kv or lower-permanent conductive fiber
 4. CRI TM-102: Fluorine Analysis - min 500 ppm after two AATCC 171: min. 400 ppm
 5. ASTM D-3936: Delamination

1.03 QUALITY ASSURANCE

- A. Manufacturer Qualifications
 1. Company specializing in manufacturing specified carpet with minimum 10 years documented experience.
 2. Upon request, manufacturer to provide representative to assist in project start-up and to inspect installation while in process and upon completion. Representative will notify designated contact if any installation instructions are not followed.
 3. Single Source Responsibility: Obtain each type of carpet from one source and by a single manufacturer.
- B. Installer Qualifications
 1. Flooring contractor must be certified by the carpet manufacturer prior to bid.
 2. Flooring contractor to be a specialty contractor normally engaged in this type of work and shall have prior experience in the installation of these types of materials.

3. Flooring contractor possessing Contract for the carpet installation shall not sub-contract the labor without written approval of the Project Manager.
4. Flooring contractor will be responsible for proper product installation, including floor testing and preparation as specified by the carpet manufacturer and JOB CONDITIONS herein.
5. Flooring contractor to provide Owner a written installation warranty that guarantees the completed installation to be free from defects in materials and workmanship for a period of one year after job completion.

1.04 DELIVERY, STORAGE, & HANDLING

- A. Deliver materials to the site in manufacturer's original packaging listing manufacturer's name, product name, identification number, and related information.
- B. Store in a dry location, between 60 degrees F and 80 degrees F and a relative humidity below 65%. Protect from damage and soiling. Stack carpet rolls horizontally on a flat surface, stacked no higher than two rolls.
- C. Make stored materials available for inspection by the Owner's representative.
- D. Store materials in area of installation for minimum period of 48 hours prior to installation.

1.05 PROJECT CONDITIONS

- A. Sub-floor preparation is to include all required work to prepare the existing floor for installation of the product as specified in this document and Manufacturer's installation instructions.
- B. The maximum amount of moisture evacuation from the floor is 3.0 pounds per 1,000 square feet in 24 hours. The acceptable pH level of the substrate is between 7.0 and 9.0. Flooring contractor is responsible for floor testing.

- C. All material used in sub-floor preparation and repair shall be recommended by the carpet manufacturer and shall be chemically and physically compatible with the carpet system being bid.
- D. Maintain minimum 65 degrees F ambient temperature and 65% Relative Humidity for 72 hours prior to, during, and 48 hours after installation.
- E. Do not install carpet until space is enclosed and weatherproof, wet-work in space is completed and nominally dry, work above ceilings is complete, and ambient temperature and humidity conditions are and will be continuously maintained at values near those indicated for final occupancy.

PART 2 - PRODUCTS

2.01 PRODUCT RECYCLABILITY

- A. Product must meet FTC guides for recyclability and must be one hundred percent (100%) closed-loop recyclable back into carpet. Products containing both recyclable and non-recyclable components, manufacturer must adequately report which portions of the product are recyclable per FTC guides 16 CFR section 260.7(d). Note: A manufacturer cannot claim that a product or any portion of a product that is incinerated is recyclable, even if incineration is used to produce heat and power (i.e. waste-to-energy) per FTC guides 16 CFR section 260.7 (d) example 3.
- B. Recyclability of product installed must be the same as that claimed by manufacturer and required by Project requirements.

2.02 RECYCLING PROGRAM

- A. Manufacturer must have a collection and recovery system for product and a fully established, currently operational recycling program at time of bid per FTC guides Section 260.7 (d).
- B. Manufacturer must be able to reclaim and recycle 100% of existing carpet of similar composition back into carpet at time of bid.
- C. Manufacturer must have product a take back program and be able to reclaim and recycle 100% of installed product back into carpet at the end of its service life at time of bid. Claiming a

product is recyclable based on future expectation of technology, equipment, process or availability of that product as feed stock is not acceptable. Recycling process must be available for viewing.

- D. Collection and recycling program must be verified by an independent, neutral third-party organization, such as Scientific Certification Systems.
- E. Manufacturer must have written guarantee that 100% of the recovered product will be recycled and that no portion of the product will be landfilled or incinerated (including waste-to-energy).

2.03 MANUFACTURER'S ENVIRONMENTAL COMMITMENT

- A. A manufacturer's environmental commitment will be reflected by its corporate culture and measured by the goals, policies and programs that have been instituted to improve the environmental performance of its operations. Evidence of this commitment must include:
 - 1. All products produced by the manufacturer must meet FTC guides for recyclability and be 100% recyclable in a fully established, currently operational recycling program 16 CFR section 260.7 (d).
 - 2. All products produced by the manufacturer, including recycled content products, must be 100% closed-loop recyclable back into carpet.
 - 3. Manufacturer must show evidence of a positive and continuing improvement in source reduction and the reduction of energy, water, waste and air emissions.
 - 4. Manufacturer must fully comply with FTC Part 260 "Guides for the Use of Environmental Marketing Claims," with respect to advertising, labeling, product inserts, catalogs and sales presentations of all its carpet products submitted and sold. Certification signed by an officer of the manufacturer stating the manufacturer complies with these guides maybe required for submittal upon request.

2.04 INDOOR AIR QUALITY

- A. Product must have low VOC, factory applied, "dry" adhesive.
- B. Product, inclusive of floor covering adhesive, must meet CRI's

IAQ requirements for carpet only. Environmental chamber testing per ASTM D-5116. Emission Rates determined at 24 hours. Product, inclusive of pre-applied adhesive must off gas less than:

0.5 mg/sq. meter per hour of Total Volatile Organic Compound (TVOC);
0.05 mg/sq. meter per hour of formaldehyde;
0.4 mg/sq. meter per hour of styrene; and
0.05 mg/sq. meter per hour of 4-Phenyl Cyclohexene (4-PC)

1. Submit Indoor Air Quality report showing CRI Green label Certification Number for carpet (inclusive of adhesive). [If results for carpet testing are not inclusive of adhesive, submit separate IAQ test reports for carpet and adhesive].
2. Indoor air quality results of the product installed must be same as those specified by the Project requirements.
3. Additionally, product, inclusive of adhesive, must meet the requirements of the State of Washington Indoor Air Quality Specifications for Carpet at 24 hours. Environmental chamber testing per ASTM D-5116. Product must not require the 30-day air out period that the State of Washington protocol allows.

2.05 CARPET WARRANTY

- A. Warranty to be sole source responsibility of the Manufacturer. Second source warranties and warranties that involve parties other than the carpet manufacturer are unacceptable.
- B. If the product fails to perform as warranted when properly installed and maintained, the affected area will be repaired or replaced at the discretion of the Manufacturer.
- C. Chair pads are not required, but are recommended for optimum textural performance. Absent the use of chair pads, more intensive maintenance will be required for areas in direct contact with chair caster traffic, and some degree of appearance change is to be expected.
- D. Warranty shall be for a specifically defined non-prorated period of (25) twenty-five years. Lifetime" warranties are not acceptable. More intensive maintenance will be required for product installed on stairs, and some degree of appearance change is to be expected.

- E. Warranty shall not exclude carpet product installed on stairs provided it is properly installed and maintained.
- F. The non-prorated (25) twenty-five years warranty shall specifically warrant against :
1. Excessive Surface Wear: More than 15% loss of pile fiber weight
 2. Excessive Static Electricity: More than 3.0 kV per AATCC 134
 3. Resiliency Loss of the Backing: More than 10% loss of backing resiliency
 4. Delamination
 5. Edge Ravel
 6. Zippering
- G. Tuft Bind warranty in lieu of edge ravel and zippering is not acceptable.

2.06 FIBER

- A. Nylon Fiber: Solution Dyed, Bulked Continuous Filament (BCF) Nylon Bulked Continuous Filament (BCF) Nylon in a loop pile construction. Cut pile is not acceptable.
- B. Report fiber type (i.e. EPP Certified Invista Antron, SAVANT, etc,)
- C. Report post consumer and post industrial recycled content of the pile face yarn in product based on weight i.e. [(Recycle Content in Pile Face Yarn) / (Total Weight of Pile Face Yarn) x 100]
- D. Fiber to contain carbon-core filament for permanent static control. Topical treatments are not acceptable.
- E. Durable stain inhibitor should be applied to the fiber during product manufacturing to resist fiber staining and soiling.
1. Initial: Minimum 500 ppm Fluorine per CRI TM-102
 2. After two hot water extractions per AATCC 171: Minimum 400 ppm Fluorine per CRI TM-102

2.07 BACKING CHARACTERISTICS

- A. Primary Backing: Synthetic Non-Woven.

- B. Secondary Backing: Powerbond Closed Cell Vinyl Cushion
1. Density (ASTM D-1667): Min. 18.5 lbs/cu ft
 2. Compression Set (ASTM D-1667): Max 10%
 3. Compression Deflection (ASTM D-1667): Min. 7 psi @ 25%; Max. 25 psi @ 25%
 4. Product Size: 6-Foot Width Roll Goods
 5. Impermeable to moisture and airflow
 6. Product's chemically welded seams to be impermeable to moisture and airflow
 7. Fully fused secondary backing system that will not delaminate
- C. Adhesive System: RS
1. Low VOC, factory applied "dry" adhesive applied to backing and cured during manufacturing
 2. Product as installed to be securely attached to the floor in compliance with Americans with Disabilities Act (ADA), Section 4.5.3.
- D. Product to provide asbestos enclosure properties.
Enclosure means an airtight, impermeable, permanent barrier around ACM (Asbestos Containing Material) to prevent the release of asbestos fibers into the air.

2.08 PERFORMANCE CHARACTERISTICS

- A. Test reports for the following performance assurance testing to be submitted upon request.
Submitted results shall represent average results for production goods of the referenced style.
Requirements listed below must be met by all products.
1. Flooring Radiant Panel
ASTM E-648 / NFPA 253: Class 1 (CRF: 0.45 watts/sq cm or greater)
 2. Federal Flammability
CPSC FF 1-70: Passes
 3. Smoke Density
ASTM E-662 / NFPA 258: \leq 450 Flaming Mode
 4. Electrostatic Propensity
AATCC 134 (Step & Scuff): 3.0 kV or less
 5. Static Coefficient of Friction

ASTM C-1028: Passes ADA Requirements for Accessible Routes (minimum 0.60)

6. Delamination of Secondary Backing of Pile Floor Coverings
ASTM D-3936: No Delamination

7. Lightfastness
AATCC 16E: ≥ 4 @ 100 hours

8. Vetterman Drum
ASTM D-5417: Minimum 3 @ 22,000 cycles

9. Moisture Barrier
Moisture Penetration by Impact @ 10 psi: No penetration of backing and seam after 10,000 impacts

10. Air Flow Barrier
Air Permeability of Textile Fabrics: No Air Flow (0.0 cu. ft/min) through backing and seam

2.09 MANUFACTURING SPECIFICATIONS

A. Manufactured by C&A Floorcoverings (or approved equal by Shaw Contract Group)

1. Carpet 1 (All Secure Entry Vestibules and as indicated on drawings as "walk off mat") Carpet shall be based on the following line:

- a. Abrasive Acton II (Style #02578)
 - 1. Construction: Accuweave® Patterned loop
 - 2. Gauge: 1/12
 - 3. Stitches per inch: 8.0
 - 4. Pile Height Average: 0.187 inch
 - 5. Fiber System: TDX nylon with Static Control and Ensure.
 - 6. Dye Method: 100% solution dyed
 - 7. Total Weight: 87.0 oz/sq yd +/- 5%
 - 8. Product width: 6' roll goods

2. Carpet 2 (All other rooms as indicated on drawings as "CPT")

- a. Tandus Centiva, "Link", Style No. 04222
 - 1. Size: 24 x 24" tile (18" x 18" and 36" x 36" also available)
 - 2. Stitches per inch: 10.0

3. Gauge: 1/12
4. Radiant Panel: Class 1
5. Fiber System: Dynex SD Nylon
6. Dye Method: 100% Solution Dyed
7. Construction: Accuweave patterned loop
8. Smoke Generation: Less than 450

b. Shaw Contract Group, "Diffuse" Style No. 59575

1. Size: 24 x 24" tile
2. Stitches per inch: 9.0
3. Gauge: 1/12
4. Radiant Panel: Class 1
5. Fiber System: Eco Solution Q Nylon
6. Dye Method: 100% Solution Dyed
7. Construction: Multi Level Patterned loop
8. Smoke Generation: Less than 450

3. Area Rug:

- a. Manufacturers Product-Basis of Design: The design for each material type is based on the product named. Subject to compliance with the requirements, provide the named product or a comparable product acceptable to the Architect by one of the other manufacturers.
 1. Carpet Tile Manufacturers as indicated on drawings and as listed below:
 - i. Collins and Aikman (C & A)
 - ii. Other as approved by Architect
- b. Carpet Types-Material Information and Selection:
 1. Refer to Room Finish Schedule located in the Architects drawings.
- c. Rugs shall be 12' x 12' in size comprised of (6') six foot roll goods; seam welded and additionally reinforced with 3M tape for Nomad Mats #61-5000-4563-0 adhered with 3M adhesive #61-5000-4187-8 to the back of seam. The material shall have Powerbond cushion dry backing. Contractor shall chemically weld two 6' x 12' pieces per manufacturer's instructions.
- d. Corners cut on area rugs using 15" radius. Outside binding edge to be season UV polypropylene web, 2 inch wide, .045 thick with a 92% UV resistance. The thread and bobbin to be tex #138,420 denier 3 ply nylon.

2.10 ACCESSORIES

- A. Materials recommended by Manufacturer for patching, priming, etc.
- B. Adhesives: Products to be supplied with a low VOC, factory applied, "dry" adhesive for "peel and stick" installation.
- C. Base, Carpet Edge, and Transition Strips: As specified in applicable sections.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

- A. Prepare sub-floor to comply with criteria established in Manufacturer's installation instructions. Use only preparation materials that are acceptable to the Manufacturer.
 - 1. Remove all deleterious substances from substrate(s) that would interfere with or be harmful to the installation (i.e. floor wax).
 - 2. Remove sub-floor ridges and bumps. Fill cracks, joints, holes, and other defects.
- B. Verify that sub-floor is smooth and flat within specified tolerances and ready to receive carpet.
- C. Verify that substrate surface is dust-free and free of substances that would impair bonding of product to the floor.
- D. Verify that concrete surfaces are ready for installation by conducting moisture and pH testing. Results must be within limits recommended by Manufacturer.
- E. There will be no exceptions to the provisions stated in the Manufacturer's installation instructions.

3.02 INSTALLATION - GENERAL

- A. Install product in accordance with Manufacturer's installation instructions.
- B. Verify carpet match before cutting to ensure minimal variation between dye lots.
- C. Layout carpet in accordance with shop drawings.
 - 1. Align run of pile in same direction as anticipated traffic and in same direction on adjacent pieces.
 - 2. Locate change of color or pattern between rooms under door centerline.
 - 3. Provide monolithic color, pattern, and texture match within any one area.
- D. Install carpet tight and flat on sub-floor, well-fastened at edges, with a uniform appearance.
- E. Roll with appropriate roller for complete contact of carpet with mill-applied adhesive to sub-floor.
- F. Trim carpet neatly at walls and around interruptions.
- G. Completed carpet is to be smooth and free of bubbles, puckers, and other defects.

3.03 PROTECTION & CLEANING

- A. Remove excess adhesive from floor and wall surfaces without damage.
- B. All rubbish, wrappings, debris, trimmings, etc. to be removed from site and recycled or disposed of properly.
- C. Clean and vacuum carpet surfaces using a beater brush/bar commercial vacuum.
- D. After each area of carpet is installed, protect from soiling and damage by other trades.

SECTION 09900 - PAINTING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Attention is directed to Division 0, Bidding and Contract Requirements, and to Division 1, General Requirements, which are hereby made a part of this Section.

1.02 DESCRIPTION OF WORK:

- A. The extent of painting work is shown on the drawings and schedules, and as herein specified.
- B. The work includes painting and finishing of interior and exterior exposed items and surfaces throughout the project, except as otherwise indicated.
- C. The work includes field painting of exposed bare and covered pipe and ducts (excluding color coding), and of hangers, exposed steel and iron work, and primed metal surfaces of equipment installed under the mechanical and electrical work, except as otherwise indicated.
- D. Surface preparation, priming and coats of paint specified are in addition to shop-priming and surface treatment specified under other sections of work.
- E. "Paint" as used herein means all coating systems materials, including primers, emulsions, enamels, stains, sealers and fillers and other applied materials, whether used as prime, intermediate or finish coats.
- F. Paint all exposed surfaces in areas designated "paint" in "schedules," except where the natural finish of the material is specifically noted as a surface not to be painted. Where items or surfaces are not specifically mentioned, paint them the same as adjacent similar materials or areas.

1.03 PAINTING NOT INCLUDED:

- A. The following categories of work are not included as part of the field-applied finish work, or are included in other sections of these specifications:
1. Shop Priming: Unless otherwise specified, shop priming of ferrous metal items is included under the various sections for structural steel, miscellaneous metal, hollow metal work, and similar items.
 2. Pre-Finished Items: Unless otherwise indicated, do not include painting when factory-finishing or installer finishing is specified for such items as (but not limited to) metal toilet enclosures, acoustic materials, casework, finished mechanical and electrical equipment including light fixtures, switchgear and distribution cabinets, but not light or power panels where exposed elevator entrance frames, doors and equipment.
 3. Concealed surfaces: Unless otherwise indicated, painting is not required on surfaces such as walls or ceilings in concealed areas and generally inaccessible areas, foundation spaces, furred areas.
 4. Finished Metal Surfaces: Metal surfaces of anodized aluminum, stainless steel, chromium plate, copper, bronze and similar finished materials will not require finish painting, unless otherwise indicated.
 5. Operating Parts and Labels:
 - a. Moving parts of operating units, mechanical and electrical parts such as valve and damper operators, linkages, sinkages, sensing devices, motor and fan shafts will not require finish painting unless otherwise indicated.
 - b. Do not paint over any code-required labels, such as Underwriters', Laboratories and Factory Mutual, or any equipment identification, performance rating, name or nomenclature plates.

1.04 SUBMITTALS:

A. Product Data:

1. For information only, submit 2 copies of manufacturer's technical information including paint label analysis and application instructions for each materials proposed for use. Transmit a copy of each manufacturer's instructions to the paint Applicator.

B. Samples:

1. Submit samples for Architect's review of color and texture only. Compliance with all other requirement is the Exclusive responsibility of the Contractor. Provide a listing of the materials and application for each coat of each finish sample.
 - a. On 12" x 12" hardboard, provide two samples of each color and material with texture to simulate actual conditions. Resubmit each sample as requested until acceptable sheen, color and texture is achieved.
 - b. On actual wood surfaces, provide two 4" x 8" samples of each stained wood finish as required. Label and identify each as to location and application.

1.05 DELIVERY AND STORAGE:

- A. Deliver all materials to the job site in original, new and unopened packages and containers bearing manufacturer's name and label, and the following information:
1. Name or title of material.
 2. Fed. Spec. Number, if applicable.
 3. Manufacturer's stock number and date of manufacturer.
 4. Manufacturer's name.
 5. Contents by volume, for major pigment and vehicle.
 6. Constituents.
 7. Thinning instructions.

8. Application instructions.

9. Color name and number.

1.06 JOB CONDITIONS:

- A. Apply water-base paints only when the temperature of surfaces to be painted and the surrounding air temperatures are between 50 degrees F. and 90 degrees F., unless otherwise permitted by the paint manufacturer's printed instructions.
- B. Apply solvent-thinned paints only when the temperature of surfaces to be painted and the surrounding air temperatures are between 45 degrees F. and 95 degrees F. unless otherwise permitted by the paint manufacturer's printed instructions.
- C. Do not apply paint in snow, rain, fog or mist; or when the relative humidity exceeds 85% or to damp or wet surfaces; unless otherwise permitted by the paint manufacturer's printed instructions.
 - 1. Painting may be continued during inclement weather only if the areas and surfaces to be painted are enclosed and heated within the temperature limits specified by the paint manufacturer during application and drying periods.

PART 2 - PRODUCTS

2.01 COLORS AND FINISHES:

- A. Prior to beginning work, the Architect will furnish color chips for surfaces to be painted. Multiple colors will be used and colors will vary from wall to ceiling and from room to room. Final selection for gloss level will be by Architect and may not necessarily be the same as scheduled.
 - 1. Use representative colors when preparing samples for review.
 - 2. Final acceptance of colors will be from samples applied on the job.
- B. Color Pigments: Pure, non-fading, applicable types to suite the substrates and service indicated.
- C. Paint Coordination: Provide finish coats which are

compatible with prime paints used. Review other sections of these specifications in which prime paints are to be provided to ensure compatibility of total coatings system for various substrates. Upon request from other trades, furnish information on characteristics of finish materials proposed for use, to ensure compatible prime coats are used. Provide barrier coats over incompatible primers or remove and reprime as required. Notify the Architect in writing of any anticipated problems using specified coating systems with substrates primed by others.

2.02 EXTERIOR PAINT SYSTEMS:

- A. Metal-Galvanized and Ferrous (Semi-Gloss):(Acrylic Latex System).
1. Finish Coats: 100 percent acrylic, Waterborne, Semi-Gloss (30-40 units at 60 degrees F.),3.0 mils DFT/coat.
Benjamin Moore: (2) coats DTM acrylic semi-gloss (M29)
- B. Metal-Heat Resistant:(Maximum Temperature 1,000 degrees F.) (VOC 650)
1. Primer: Silicone Alkyd, .75 mils DFT/coat.
Benjamin Moore: (1) coat high heat zinc (M66-77)
 2. Finish Coats: Silicone Alkyd, Aluminum Bright, .75-1.0 mils DFT/coat.
Benjamin Moore: (1) coat high heat zinc (M66-78)
- C. Concrete/Masonry Surfaces (Semi-Gloss)
1. Primer: 100 percent Acrylic Resin Block Filler, .075 - 1.0 DFT/coat.
Benjamin Moore: Waterborne block filler (M31/32)
 2. Finish Coats: Water Based Epoxy, Semi-Gloss (20-30 units at 60 degrees F.) 3 mils DFT/coat.
Benjamin Moore: (2) coats acrylic epoxy (M43/44)
- D. Exterior Siding Panels and Steel Columns:

1. Surface Prep: Thoroughly and uniformly abrade entire surface to provide a minimum 1.0 mil profile. All leading edges should be feathered to meet substrate.
2. Prime Coat: Tnemec Series 66 Hi-Build Epoxoline at 2.0-4.0 mils DFT.
3. Finish Coat: Tnemec Series 1075U Endura-Shield II (semi-gloss) at 2.0-3.0 mils DFT.

2.03 INTERIOR PAINTING SCHEDULE:

A. Concrete/Masonry Surfaces (Semi-Gloss) (Vinyl Acrylic Latex System)

1. Primer: Vinyl Acrylic Block Filler
Benjamin Moore: Moorcraft interior and exterior block filler #173
2. Finish Coats: Vinyl Acrylic Semi-Gloss Enamel (25-35 units at 60 degrees F.), 1.5 DFT/coat.
Benjamin Moore: (2) coats Moorcraft latex semi-gloss enamel #1416

B. Concrete/Masonry Surfaces (Semi-Gloss): (Water Based Epoxy - Normal Exposure) for all Toilet Rooms and Kitchens.

1. Primer: 100 percent Acrylic Resin Block Filler, .075 - 1.0 DFT/coat.
Benjamin Moore: Waterborne block filler (M31/32)
2. Finish Coats: Water Based Epoxy, Semi-Gloss (20-30 units at 60 degrees F.) 3 mils DFT/coat.
Benjamin Moore: (2) coats acrylic epoxy (M43/44)

C. Concrete Floor Surfaces - Epoxy Paint

1. Two component 100% (+/- 1%) solids epoxy color coating.
 - a. Epoxy paint for floor and (where indicated to be painted) base shall be: Norklad 100 two component 100% solids epoxy broadcast coat 16-18 mils DFT with marble chip flakes (color to be selected from manufacturer's standard colors by Architect) over Norklad 200 100% solids epoxy base coat 12-30 mils DFT. Provide with manufacturer's recommended primer and urethane top coat.
 - b. Prepare floor per SSPC SP13 and

- manufacturer's specifications.
- c. Norklad Products - Manufactured by:
Original Color Chips Company, 26200 Groesbeck
Hwy, Warren, MI 48089, 1-800-227-8479 or
1-586-771-6500.
- D. Metal-Ferrous (Semi-Gloss): (Alkyd Enamel System,
Maximum VOC content 450 grams/liter)
1. Primer: Modified Alkyd Resin Primer, 3 mils
DFT/coat
Benjamin Moore: iron clad retardo rust inhibitive
paint, 163
 2. Finish Coats: Alkyd Enamel, Semi-Gloss (40-50
units at 60 degrees F.) 3.0 mils DFT/coat.
Benjamin Moore: (2) coats satin impervo
- E. Metal - Galvanized (Semi-gloss): Code #5.13 (Acrylic
Latex System)
1. Finish Coats: 100 percent Acrylic, Waterborne,
Semi-Gloss (30-40 units at 60 degrees F.) 3.0 mils
DFT/coat.
Benjamin Moore: (2) coats DTM acrylic semi-gloss
(M2a)
- F. Gypsum Board (Eggshell): (Acrylic Latex System)
1. Primer: Vinyl Acrylic Latex, 1.1 mils DFT/coat
Benjamin Moore: Moorcraft undercoater (284)
 2. Finish Coats: Vinyl Acrylic Semi-Gloss (25-35
units at 60 degrees F.), 1.5 mils DFT/coat.
Benjamin Moore: (2) coats Moorcraft latex semi
gloss (276)
- G. Gypsum Board (Eggshell): (Water Based Epoxy System)
1. Primer: Vinyl Acrylic Latex, 1.1 mils DFT/coat
Benjamin Moore: Moorcraft undercoater (284)
 2. Finish Coats: Water Based Catalyzed Epoxy, Semi-
Gloss (20-30 units at 60 degrees F.), 2.5 - 3.0
mils DFT/coat.
Benjamin Moore: (2) coats acrylic epoxy (M43/44)
- H. Painted Woodwork:

- a. 1st Coat-Enamel undercoat (TT-S-543)
 - b. 2nd Coat-Alkyd enamel (TT-E-509)
 - c. 3rd Coat-Alkyd enamel (TT-E-509)
- I. Stained Woodwork:
- a. 1st Coat-Interior oil stain (TT-S-711)
 - b. 2nd Coat-Bleached shellac (TT-S-300)
 - c. 3rd Coat-Rubbing varnish (TT-V-86)
 - d. 4th Coat-Rubbing varnish (TT-V-86)
 - e. Fill open grained wood with filler complying with TT-F-336 and wipe before first varnish coat.
- J. Markerboard Wall Paint:
- a. Sherwin Williams dry erase coating. KB65C2000.
 - b. Prepare substrate per manufacturer's recommendations.
- K. Green Screen Paint:
- a. Pro Cyc's virtual green chroma key paint and grey bonding primer.
 - b. Prepare substrate and apply per manufacturer's instructions.

PART 3 - EXECUTION

3.01 INSPECTION:

- A. Applicator must examine the areas and conditions under which painting work is to be applied and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Applicator.
- B. Starting of painting work will be construed as the Applicator's acceptance of the surfaces and conditions within any particular area.
- C. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions otherwise detrimental to the formation of a durable paint film.

3.02 SURFACE PREPARATION:

A. General:

1. Perform preparation and cleaning procedure in strict accordance with the paint manufacturer's instructions and as herein specified for each particular substrate condition.
2. Remove all hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items in place and not to be finish-painted, or provide surface-applied protection prior to surface preparation and painting operations. Remove, if necessary for the complete painting of the items and adjacent surfaces. Following completion of painting of each space or area, reinstall the removed items by workmen skilled in the trades involved.
3. Clean surfaces to be painted before applying paint or surface treatments. Remove oil and grease prior to mechanical cleaning. Program the cleaning and painting so that contaminants from the cleaning process will not fall onto wet, newly-painted surfaces.

B. Cementitious Materials:

1. Prepare cementitious surfaces to be painted by removing all efflorescence, chalk, dust, grease, oils, and by roughening as required to remove glaze conforming to SSPC SP13.
2. Determine the alkalinity and moisture content of the surfaces to be painted by performing appropriate tests. If the surfaces are found to be sufficiently alkaline to cause blistering and burning of the finish paint, correct this condition before application of paint. Do not paint over surfaces where the moisture content exceeds that permitted by the manufacturer's printed directions.

C. Wood:

1. Clean wood surfaces to be painted of all dirt, oil, or other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sandpaper smooth those finished surfaces exposed to view and dust off. Scrape and clean small, dry, seasoned knots and apply a thin coat of white shellac or other recommended knot sealer before application of the priming coat. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler. Sandpaper smooth when dried.
2. Prime, stain, or seal wood required to be job painted immediately upon delivery to job. Prime edges, ends, faces, undersides, and backsides of such wood, including cabinets, counters, cases, paneling, etc.
3. When transparent finish is required, use spar varnish for backpriming.
4. Seal tops, bottoms, and cut-outs of unprimed wood doors with a heavy coat of varnish or equivalent sealer immediately upon delivery to job.

D. Ferrous Metals:

1. Clean ferrous surfaces, which are not galvanized or shop-coated, of oil, grease, dirt, loose mill scale and other foreign substances by solvent or mechanical cleaning, conforming to SSPC SP-1 and SSPC SP-2, SSPC SP-3 or SSPC - SP7/NACE - No. 4 (brush off blast cleaning)
2. Properly prepare previously painted surfaces per manufacturer's requirements so new paint bonds corrected to previously painted surfaces.

E. Galvanized Surfaces:

1. Clean free of oil and surface contaminants with an acceptable non-petroleum based solvent per SSPC SP-1.

3.03 MATERIALS PREPARATION:

- A. Mix and prepare painting materials in accordance with manufacturer's directions.
- B. Store materials not in actual use in tightly covered

containers. Maintain containers used in storage, mixing and application of paint in a clean condition, free of foreign materials and residue.

- C. Stir materials before application to produce a mixture of uniform density and stir as required during the application of the materials. Do not stir surface film into the material. Remove the film and if necessary, strain the material before using.

3.04 APPLICATION:

A. General:

1. Apply paint in accordance with the manufacturer's directions. Use applicators and techniques best suited for the substrate and type of material being applied.
2. Apply additional coats when undercoats, stains or other conditions show through the final coat of paint, until the paint film is of uniform finish, color and appearance. Give special attention to insure that all surfaces, including edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
3. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Paint surfaces behind permanently-fixed equipment or furniture with prime coat only before final installation of equipment.
4. Paint interior surfaces of ducts where visible through registers or grilles with a flat, non-specular black paint.
5. Paint the back sides of access panels and removable or hinged covers to match the exposed surfaces.
6. Finish exterior doors on tops, bottoms and side edges the same as the exterior faces, unless otherwise indicated.
7. Sand lightly between each succeeding enamel or varnish coat.
8. Omit the first coat (primer) on metal surfaces

which have been shop-primed and touch-up painted,
unless otherwise indicated.

B. Scheduling Painting:

1. Apply the first-coat material to surfaces that have been cleaned, pretreated or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
2. Allow sufficient time between successive coatings to permit proper drying. Do not recoat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure and the application of another coat of paint does not cause lifting or loss of adhesion of the undercoat.

C. Minimum Coating Thickness:

1. Apply each material at not less than the manufacturer's recommended spreading rate to establish a total dry film thickness as indicated or, if not indicated, as recommended by coating manufacturer.

D. Mechanical and Electrical Work:

1. Painting of mechanical and electrical work is limited to those items exposed in occupied spaces and includes all exterior exposed work.

E. Prime Coats:

1. Apply a prime coat of material which is required to be painted or finished, and which has not been prime coated by others.
2. Recoat primed and sealed surfaces where there is evidence of suction spots or unsealed areas in first coat, to assure a finish coat with no burn-through or other defects due to insufficient sealing.

F. Pigmented (Opaque) Finishes:

1. Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness or other surface imperfections will not be acceptable.

G. Transparent (Clear) Finishes:

1. Use multiple coats to produce glass-smooth surface film of each luster. Provide a finish free of laps, cloudiness, color, irregularity, runs, brush marks, orangpeel, nail holes, or other surface imperfections.
2. Provide satin finish for final coats, unless otherwise indicated.

H. Completed Work:

1. Match approved samples for color, texture and coverage. Remove, refinish or repaint work not in compliance with specified requirements.

3.05 CLEAN-UP AND PROTECTION:

A. Clean-up:

1. During the progress of the work, remove from the site all discarded paint materials, rubbish, cans and rags at the end of each work day.
2. Upon completion of painting work, clean window glass and other paint-spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

B. Protection:

1. Protect work of other trades, whether to be painted or not, against damage by painting and finishing work. Correct any damage by cleaning, repairing or replacing and repainting, as acceptable to the Architect.

2. Provide "Wet Paint" signs as required to protect

newly-painted finishes. Remove temporary protective wrappings provided by others for protection of their work, after completion of painting operations.

3. At the completion of work of other trades, touch-up and restore all damaged or defaced painted surfaces.

END OF SECTION 09900

SECTION 10100 - MARKERBOARDS AND TACKBOARDS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Attention is directed to Division 0, Bidding and Contract Requirements, and to Division 1, General Requirements, which are hereby made a part of this Section.

1.02 DESCRIPTION OF WORK:

- A. The extent of markerboards and tackboards is shown on the drawings.
- B. The types of boards required include the following:
 - 1. Vinyl-faced tackboards.
 - 2. Porcelain enamel dry markerboards.
 - 3. Custom lined (music) dry markerboards (black lines and letters (where indicated on drawings)).

1.03 QUALITY ASSURANCE:

- A. Fire Hazard Classification: Provide materials bearing UL label and marking indicating fire hazard classification of marking and tack surfaces, as determined by ASTM E 84, Class A and as follows.
 - 1. Flame spread not more than 25.
 - 2. Fuel contributed not more than 35.
 - 3. Smoke developed not more than 50.
- B. In addition to the requirements of these specifications, comply with manufacturer's instructions and recommendations for all phases of the work, including preparation of substrate, installation of grounds and anchors, and application of materials.
- C. Provide colors of material for marking markerboards and tackboards as selected by the Architect from manufacturer's standard colors.
- D. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication where possible to ensure proper fitting of the work. However, do not delay job progress; allow for trimming and fitting wherever the taking of field measurements before fabrication might delay the work.

1.04 SUBMITTALS:

A. Product Data:

1. For information only, submit 4 copies of manufacturer's technical data and installation instructions for each material and component part. Include methods of installation for each type of substrate to receive units. Transmit copy of each instruction to the Installer.

B. Samples:

1. Submit 4 sets of samples for each color of markerboard and tackboard, trim, and accessories required. Provide 12" square samples of sheet materials and 12" lengths of trim members. Architect's review of samples will be for color, pattern, and texture only. Compliance with all other requirements is the exclusive responsibility of the Contractor.

C. Shop Drawings:

1. Submit shop drawings for markerboard and tackboard units. Include full-scale sections of typical trim members and dimensioned elevations. Show anchors, ground reinforcement, accessories, and installation details.

PART 2 - PRODUCTS

2.01 TACKBOARD:

A. Balanced Laminated Three-ply Construction:

1. Vinyl Fabric: Claridge
 - a. Texture: Fabricork
 - b. Colors as selected by Architect.
2. Backing: Single layer 1/2" thick.
3. Wrap all edges.

B. Manufacturer: Provide tackboard produced by one of the following:

1. Claridge Products and Equipment, Inc.
2. Marsh Industries
3. Newline Products
4. Alliance Wall Corp.
5. Polyvision Corp.

2.02 MARKERBOARD:

- A. LCS Liquid Chalk Porcelain Enamel Writing Surface.
 - 1. Porcelain enamel finish on 24 gauge steel.
 - 2. Core: 3/8'' thick particle board core complying with ANSI A208.1 Grade 1-M-1.
 - 3. Backing Sheet: 0.015'' aluminum sheet.
- B. Manufacturer:
 - 1. Claridge Products & Equipment, Inc.
 - 2. Marsh Industries
 - 3. Newline Products
 - 4. Polyvision
- C. Provide staff lined markerboards in Choir A120 and Band A124.
- D. All markerboards are to be magnetized.

2.03 TRIM AND ACCESSORIES:

- A. General: Fabricate frames and trim of not less than 0.062'' thick aluminum alloy, size as shown to suit type of installation. Provide straight, single-length units wherever possible and keep joints to a minimum. Miter corners to a neat, hairline closure. Furnish exposed aluminum trim, accessories, and fasteners with satin anodized finish AA-M31A31, unless otherwise indicated.
 - 1. Except as otherwise indicated, provide manufacturer's standard "narrow" trim units, approximately 1/2" wide.
 - 2. When structural support accessories are required for markerboards and tackboards in addition to normal trim, provide such additional support or modify trim as required to provide necessary support.
 - a. Provide snap-on trim with no visible screws or exposed joints.
- B. Chalktrough: Furnish continuous aluminum chalktrough for each markerboard unless otherwise indicated as follows:
 - 1. Solid extrusion, manufacturer's standard continuous box type aluminum marker tray with slanted front and cast aluminum end closures for each markerboard.
- C. Delete all top cork rails above marker boards. Provide magnetic flagpole holder and flag (one flagpole holder per room unless noted otherwise).

2.04 FABRICATION:

- A. Provide factory-assembled markerboards and tackboards.
- B. All boards are to be in sizes indicated on plans. Boards are to be wall mounted in a stationary position unless noted otherwise.

PART 3 - EXECUTION

3.01 INSPECTION:

- A. Installer must examine the areas and conditions under which units are to be installed and notify the Construction Manager, in writing, of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 INSTALLATION:

- A. Install boards in locations and mounting heights as shown on the drawings and in accordance with the manufacturer's instructions. Provide all grounds, clips, backing materials, brackets, and anchors for a complete installation.
- B. Deliver factory-built markerboard and tackboard units completely assembled in one piece without joints, whenever possible. Where dimensions exceed panel size, provide 2 or more pieces of equal length, as acceptable to the Architect. When overall dimensions require delivery in separate units, prefit at the factory, disassemble for delivery, and make final joint at the site. Use splines at joints to maintain surface alignment and smooth joints.
- C. Install units with concealed hangers plumb and level, in accordance with the manufacturer's printed instructions.
- D. Coordinate job-assembled units with grounds, trim, and accessories. Join all parts with neat, precision fit.

END OF SECTION 10100

SECTION 10160 - TOILET PARTITIONS

PART 1 - GENERAL

1.01 SUBMITTALS:

- A. Plastic compartment work includes the following, where indicated:
 - 1. Floor mounted overhead-braced compartments.
- B. Furnish all labor and materials necessary for the completion of work in this section as shown on the contract drawings and specified herein.
- C. Work in this section shall include, but is not limited to:
 - 1. Toilet compartments, compartment doors.
 - 2. Hardware for toilet compartments.
 - 3. Shop drawings and working drawings.
 - 4. Manufacturer's guarantee/warranty.
- D. Related work specified elsewhere shall include accessories and anchorage/blocking for attachment of partitions.

1.02 PRODUCT:

- A. Submit six (6) sets of shop drawings and details for Architect's approval.
- B. Colors shall be selected from the manufacturer's full range of colors.
- C. Submit 6'' square color samples of each color and hardware samples for approval by the Architect.

PART 2 - PRODUCTS

2.01 MANUFACTURER:

- A. Provide toilet partitions and screens by one of the following manufacturer's:
 - 1. SCRANTON PRODUCTS (Santana/Comtec/Capitol) Scranton, PA.
 - 2. Legacy Polymer Products, Inc., Poly Series, Dunmore, PA.
 - 3. AMPCO Products, LLC, Solid Plastic Polyethylene, Miami, FL.
 - 4. Bradmar; Bradley Corp.
 - 5. General Partitions.

2.02 MATERIALS:

- A. Doors, panels, pilasters and privacy screens and supports shall be 1'' thick constructed from High-Density Polyethylene (HDPE) resins. Partitions and privacy screens shall be fabricated from polymer resins compounded under high pressure, forming a single component which is waterproof, nonabsorbent and has a self-lubricating surface that resists marks from pens, pencils, markers and other writing instruments. All plastic components shall be covered with a protective plastic masking.

2.03 CONSTRUCTION:

- A. Doors, panels, pilasters and privacy screens shall be 1'' thick with all edges rounded to a ¼'' radius.
- B. Doors and dividing panels shall be 55'' high and mounted at 14'' above the finished floor. Fasten an aluminum heat sinc to the bottom edges.
- C. Pilasters shall be 82'' high (standard) and fastened into a 3'' high pilaster shoe with a stainless steel, torx head sex bolts.

2.04 HARDWARE:

- A. Door hardware shall be as noted:
 - 1. Hinges shall be integral, fabricated from the door and pilaster with no exposed metal parts, adjustable in 30 degree increments to hold door open up to 90 degrees.
 - 2. Door strike/keeper shall be 6'' long and made of heavy-duty extruded aluminum (6436-T5 alloy) of either an anodized finish or a bright dipped anodized finish, with wrap around flanges and secured to the pilasters with stainless steel, torx head sex bolts. Bumper shall be made of extruded black vinyl.
 - 3. Latch and housing shall be made of heavy-duty extruded aluminum (6463-T5 alloy). The latch housing shall have either an anodized finish or a bright dipped anodized finish, and the slide bolt and button shall have a black anodized finish.
 - 4. Each door shall be supplied with one coat bumper/hook and 2 door pulls made of chrome plated zamak. Outswing doors shall be supplied with a door stop made of chrome plated zamak.

- B. Plaster shoes shall be 3'' high (type 304, 20 gauge) stainless steel. Pilaster shoes shall be secured to the pilaster with a stainless steel, torx head sex bolt.
- C. Wall brackets for partitions shall be 1½'' stirrup type made of heavy-duty aluminum (6463-T5 alloy) with either an anodized or a bright dipped anodized finish. Stirrup brackets shall be fastened to pilasters and panels with stainless steel, torx head sex bolts.
- D. Headrail shall be made of heavy-duty extruded aluminum (6463-T5 alloy) with anti-grip design and integrated curtain track. The headrail shall have an anodized finish and shall be fastened to the headrail bracket by a stainless steel, torx head sex bolt, and fastened to the top of the pilasters with stainless steel, tamper resistant torx screws.
- E. Headrail brackets shall be of heavy duty extruded aluminum with an anodized finish or 20 gauge stainless steel with a satin finish, and secured to the wall with #14 stainless steel screws.

PART 3 - EXECUTION

3.01 PREPARATION:

- A. Examine areas to receive toilet partitions/compartments for correct height and spacing of anchorage/bolting and plumbing fixtures that may affect installation of partitions/compartments. Report any discrepancies to the Architect and Construction Manager.
- B. Take complete and accurate measurements of complete toilet compartment locations.
- C. Start of work constitutes acceptance of job.

3.02 INSTALLATION:

- A. Install partitions rigid, straight, plumb, and level, with plastic laid out as shown on shop drawings and manufacturer's installation instructions.
- B. All doors and panels to be mounted at 14'' above finished floor.
- C. Clearances at vertical edges of doors shall be uniform top to bottom and shall not exceed 3/8''.

- D. Clearances at pilasters and panels shall be uniform top to bottom and shall not exceed $\frac{1}{2}$ "
- E. Clearances between panels and walls shall be uniform top to bottom and shall not exceed 1".
- F. No evidence of cutting, drilling, and/or patching shall be visible on the finished work.
- G. Finished surface shall be cleaned after installation and be left free of all imperfections.

3.03 WARRANTY:

- A. Submit manufacturer's standard guarantee for HDPE plastic against breakage, corrosion, and delamination under normal conditions for 15 years from the date of receipt by the customer. If materials are found to be defective during that period for reasons listed above, the materials will be replaced free of charge. (Labor not included in warranty).

END OF SECTION 10160

SECTION 10400 - IDENTIFICATION DEVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. The provisions of the General Conditions, Supplementary Conditions, and the Sections included under Division 1, General Requirements, are included as a part of this Section as though bound herein.

1.02 SUMMARY

- A. Provide labor, materials, and equipment necessary for the complete installation of identifying devices as indicated, including:
 - 1. Interior Signage
 - 2. Interior Pin Mounted Signage
 - 3. Exterior Pin Mounted Signage
 - 4. Exterior Ground Sign Panels

1.03 SUBMITTALS:

- A. Submit product data for each type of sign specified, including details of construction relative to materials, dimensions of individual components, profiles, and finishes.
- B. Submit Shop Drawings showing fabrication and erection of signs. Include plans, elevations, and large scale sections of typical members and other components. Show anchors, grounds, layout, reinforcement, accessories, and installation details.
- C. Signage shall have 2 colors, background and letters. Match sample provided by Architect.
- D. Provide samples for verification of color, pattern, and texture selected and compliance with requirements indicated:
 - 1. Cast Acrylic Sheet: Provide a sample panel not less than 8-1/2 inches by 11 inches for each material, color, texture, and pattern required. On each panel include a representative sample of the graphic image process required, showing graphic style, and colors and finishes of letters, numbers, and other graphic devices.

1.04 QUALITY ASSURANCE:

- A. Reference Codes and Specifications: Standard Building Code.
- B. Signage shall be provided to conform with the Americans with Disabilities Act Accessibility Guidelines (ADAAG) and State and Local Regulations.

PART 2 - PRODUCTS

2.01 MANUFACTURER:

- A. Manufacturers: (Interior Signage) Subject to compliance with requirements, provide signage by one of the following:
 - 1. ASI Sign Systems, Indianapolis, Indiana; Cincinnati, Ohio; Cleveland, Ohio
 - 2. Jacob Design, Grand Rapids, Michigan
 - 3. Diskey Sign Corp. Fort Wayne, Indiana
 - 4. Andco Industries Corp. Greensboro, North Carolina
 - 5. Southwell Company, San Antonio, Texas
 - 6. Roban, Lakemore, Ohio
 - 7. Best Signs, Montrose, Colorado
 - 8. Bayuk Graphic Systems, Inc. (CW Series)
- B. Products of other manufacturers will be considered for acceptance provided they equal or exceed the material requirements and functional qualities of the specified product. Requests for Architect's approval must be accompanied by the "Substitution Request Form" and complete technical data for evaluation. All materials for evaluation must be received by the Project Manager and Specification Department at least 10 days prior to bid due date. Additional approved manufacturers will be issued by Addendum.
 - 1. Refer to Section 00100 - Instructions to Bidders and Section 00121 - Substitution Request Form for additional requirements.

2.02 MATERIALS:

- A. Cast Acrylic Sheet: Provide cast (no extruded or continuous cast) methyl methacrylate monomer plastic sheet, in sizes and thicknesses indicated, with a minimum flexural strength of 16,000 psi when tested according to ASTM D 790, with a minimum allowable continuous service temperature of 176 degrees F and of the following general types:

1. Thickness: 1/8 inch.
2. Colors as specified.
- B. Fasteners: Use concealed fasteners fabricated from metals that are not corrosive to the sign material and mounting surface.
- C. Anchors and Inserts: Use nonferrous metal or hot dipped galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or lead expansion bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete masonry work.
- D. Colored Coatings for Acrylic Plastic Sheet: Use colored coatings, including inks and paints for copy and background color that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and are nonfading for the application intended.

2.03 INTERIOR SIGNAGE:

A. Signage, General:

1. Graphic Process; Raised letters and Braille shall be formed as an integral part of the sign face. Surface applied letters and Braille are not allowed.
2. Letters: Letters and numbers shall have width to height ratio between 3:5 and 1:1 and a stroke width to height ratio between 1:5 and 1:10. Letters and numbers shall be raised 1/32 inch, uppercase, sans serif or simple sans serif type and shall be accompanied with Grade 2 Braille. Raised characters shall be 5/8 inch high minimum and 2 inches high maximum.
3. Ease sign edge and radius corners 3/8 inch.
4. Material
 - a. Acrylic plastic
5. Size: 8" x 8" or match existing sign sizes and profiles in building.

B. Toilet Room Handicapped Signs

1. Provide one sign depicting International Men/Women Symbol along with the words "Men" or "Women" indicated on the sign at each toilet room, equipped with facilities for the handicapped as indicated on the Signage Schedule.

C. Interior Room Name and Number Signs

1. Layout of room names and numbers shall be as indicated on drawings on signage schedule.

2.04 INTERIOR PIN MOUNTED SIGNAGE:

- A. Provide 1-3/4" minimum mounted distance/projection from the wall face (mounting type PMS-3). Provide with all required stainless steel accessories for a complete installation.
- B. Letter size shall be 8"H and style shall be Helvetica font.
- C. Acrylic individual letters in color as selected by Architect.
- D. Provide lettering as follows: Verify exact location in field with Architect.

Wood Creek:

1. Media Center (3)
2. Cafeteria (2)
3. Gymnasium (2)
4. Main Office

Longacre:

1. Media Center (2)
2. Cafeteria (2)
3. Gymnasium (2)
4. Main Office

Hillside:

1. Media Center (2)
2. Cafeteria (2)
3. Gymnasium (2)
4. Main Office

2.05 EXTERIOR PIN MOUNTED SIGNAGE:

- A. Provide 1-3/4" minimum mounted distance/projection from the wall face (mounting type PMS-3). Provide with all required stainless steel accessories for a complete installation.
- B. Letter size = 6", 8" and 12" high as indicated below and/or as shown on elevations. Font style to be helvetica
- C. Color of letters and numerals - TBD.

- E. Provide letters based on Metal Arts Metal Letters - Phone: (1-800-237-8069) or equal.
- F. Provide lettering as follows: Exact locations to be determined.

Wood Creek:
Wood Creek Elementary School (12"h)

Longacre:
MAIN OFFICE (12"h)

2.06 EXTERIOR GROUND SIGN PANELS: For Hillside Elem.

- A. Provide two (2) new ground sign colored transparent polycarbonate panels designed for internal illumination, each panel approximately 7'-4"W x 2'-0" (see details on AS1.0HS)
- B. New transparent panels (2) to be multi-colored (colors TBD) with custom graphics integral in the panel to allow for internal illumination to transmit thru all graphics. Custom graphic artwork design to be supplied by Owner. (see details on AS1.0HS)

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. General: Located sign units and accessories where indicated, using mounting methods of the type described and in compliance with the manufacturer's instructions.
 - 1. Install signs level, plumb, and at the height indicated, with sign surfaces free from distortion or other defects in appearance.
- B. Wall Mounted Panel Signs: Attach panel signs to wall surfaces using the method indicated below:
 - 1. Mount with adhesive as recommended by manufacturer.
 - 2. Mount with nonremovable oval head screws, using plastic plugs where mounted on masonry.
 - 3. For signs mounted to glass panels. Provide an additional solid panel on the back of the glass to conceal fastening methods from view. Panel to

be solid in same color and overall size as the
front facing sign.

3.02 CLEANING AND PROTECTION

- A. After installation, clean soiled sign surfaces according to the manufacturer's instructions. Protect units from damage until acceptance by the Owner.

END OF SECTION 10400

SECTION 10436 - ELECTRONIC MESSAGE BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections apply to this Section.

1.2 SUMMARY

- A. This section includes the following:

- 1. Electronic Message Board Sign.

- B. Related Sections: The following sections contain requirements that relate to this section.

- 1. 03001 - Concrete Work
 - 2. 04100 - Mortar and Grout
 - 3. Unit Masonry Work
 - 4. Cast Stone

1.3 SYSTEM PERFORMANCE REQUIREMENTS

- A. Design Criteria: Design, fabricate and install exterior post and panel-type signs to withstand a wind pressure of 100 mph on the total sign area in all directions.
- B. Digital panel to be fabricated panels with message capability on both sides, to fit between masonry upright construction as indicated on the drawings.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of the Contract and Division 1 Specification Sections.

- B. Product Data: Include manufacturer's construction details relative to materials, dimensions of individual components, profiles and finishes for each type of sign required. Provide manufacturer's recommendations for maintenance and cleaning requirements for exterior sign surfaces.
- C. Shop Drawings: Include plans, elevations and not less than $\frac{3}{4}$ -inch scale sections of typical members and other components. Show anchors, reinforcement, accessories, layout and installation details.
 - 1. Indicate message board capabilities, including for special graphics.
 - a. Describe full-range of letters, numbers and other graphic symbols.
 - b. LED display, including the recommended installation method.
 - c. LED display riser diagram.
 - 2. Indicate required location of connections to electrical service provided as a unit of work under other sections.
 - 3. Provide message list, including not less than half-size details of wording and lettering layout. Include full-size details of special graphics.
 - a. Furnish full-size templates for cutout letters, numbers and other graphic symbols.
 - b. Provide setting drawings, templates and directions for installation of anchor bolts and other anchors to be installed as a unit of Work in other sections.
- D. Wiring diagrams from the manufacturer for internally illuminated signs.
- E. LED display control software operator's manual.

F. Samples: For each sign component provide the following samples showing finishes, colors and surface textures.

1. For verification of color, pattern and texture selected and compliance with requirements indicated.
2. Aluminum: Samples of each finish type and color on 6-inch long sections of extrusions and not less than 4-inch squares of sheet or plate. Where finishes involve normal color and texture variations, include sample sets showing the full range of variations expected.
3. Acrylic, Polycarbonate: Provide a sample panel not less than 8-1/2 inches by 11 inches. Include a panel for each color required.
 - a. In each panel include a representative sample of the graphic image process required showing graphic style and colors and finishes of letters, numbers and other graphic devices.
4. Sign Cabinet and Housing: Samples of each finish type and color, on 6-inch long sections of extrusions and not less than 4-inch squares of sheet or plate. Where finishes involve normal color and texture variations, include sample sets showing the full range of variations expected.
5. Display Screen: Provide a sample panel not less than 8-1/2 inches by 11 inches. Include a panel for each color required.
 - a. In each panel include a representative sample of the graphic image process required showing graphic style and colors and finishes of letters, numbers and other graphic devices.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer who is an authorized representative of the sign manufacturer and has completed installation of exterior post and panel signs similar in material,

design and extent to those indicated for the project and that has resulted in construction with a record of success in service performance.

1. The installer shall be capable of providing replacement message bars within 10 working days of receipt of an order.
- B. UL and NEMA Compliance: Provide internal fluorescent light fixtures and electrical components required as part of illuminated post and panel signs that are listed and labeled by UL and comply with applicable NEMA standards.
- C. Single-Source Responsibility: Obtain each type of electronic message sign and related equipment through single source from a single manufacturer.
- D. LED Display Manufacturer Qualifications:
 1. Shall have been in the business of manufacturing permanently mounted outdoor displays for a minimum period of five (5) years prior to the contract bid date. An "LED" display contains pixels constructed solely of high-intensity discrete lighting components.
 2. Shall have in operation a minimum of twenty (20) large outdoor permanently mounted LED displays as defined above. Each of these LED displays shall have operated successfully for a minimum period of one (1) year prior to the contact bid date. Signage contractor shall provide documentation of existing installations.
 3. Shall have been in business under the same corporation name for a period of no less than five (5) years prior to the contract bid date.
 4. Shall utilize a documented in-house quality management procedure that has been in place for no less than two (2) years prior to the contract bid date.
 5. Shall provide a toll-free help desk number that will be manned during normal business hours.

1.6 DELIVERY AND HANDLING

- A. Delivery: Proved protective covering or crating as recommended by the manufacturer to protect sign components and surfaces against damage during transportation and delivery.
 - 1. Coordinate time of delivery so that pylon signs can be installed within 24 hours of receipt at the project site.

- B. Handle signs carefully to prevent breakage, surface abrasion, denting, soiling and other defects. Comply with the manufacturer's handling instructions for unloading components subject to damage.
 - 1. Inspect sign components for damage upon delivery. Do not install damaged sign components. Repair minor damage to signs provided the finished repair is equal in all respects to the original work and is acceptable to the Architect; otherwise remove and replace damaged sign components.

1.7 WARRANTY

- A. Signs Panel Warranty: Submit a written warranty signed by the manufacturer agreeing to repair signs due to coating or construction degradation.

- 1. Warranty Period: Five (5) years.

Electronic Board Warranty: Submit a written warranty signed by the manufacturer agreeing to service and repair Electronic Board due to Degradation of Malfunction.

- 1. Warranty Period: Five (5) year on-site warranty.
- 2. 24 hour response time.
- 3. Parts and Labor on all components (electronics and LED's): Five (5) years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide the following signage:

1. Electronic Message Board Sign: Daktronics Galaxy Monochrome, AF-3400-48X128-20-A, 20mm pixel pitch, 44" x 107" cabinet dimension, 48 x 128 Led Matrix, Amber color LED Message Center.

2.2 MATERIALS

A. Aluminum Sheet or Plate: Provide alloy and temper recommended by the aluminum producer or finisher for the type of use and finish indicated and with not less than the strength and durability properties in ASTM B 209 for 5005-H15.

B. Aluminum Extrusions: Provide alloy and temper recommended by the aluminum producer or finisher for the type of use and finish indicated and with not less than the strength and durability properties specified in ASTM B 221 for 6063-T5.

C. Cast Acrylic Sheet: Provide cast (not extruded or continuous cast) methyl methacrylate monomer plastic sheet in sizes and thickness indicated with a minimum flexural strength of 16,000 psi when tested in accordance with ASTM D 790, a minimum allowable continuous service temperature of 176 degrees F (80 degrees C) and of the following general types:

1. Translucent Sheet: Provide white translucent acrylic sheet of density required to produce uniform brightness and minimum halation effects where acrylic is indicated as "white."

D. Fasteners: Unless otherwise indicated, use concealed fasteners fabricated from metals that are non-corrosive to either the sign material or the mounting surface.

- E. Anchors and Inserts: Use nonferrous metal or hot-dipped galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or lead expansion bolt devices for drilled-in-place anchors. Furnish inserts as required to be set into concrete.

2.3 COMPONENTS

- A. Panels: Provide smooth, even, level sign panel surfaces constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16 inch measured diagonally from corner to corner.
1. Framed Hollow Box-Type Panels: Provide framed hollow box sign message panels finished to comply with the following requirements:
 2. Finish: Manufacturer's standard semi-gloss finish with ultraviolet inhibitors.
 3. Provide clips welded to the back of panels for installation without visible fasteners.
- B. Frames: Fabricate frames to profile indicated; comply with the following requirements:
1. Frame Material: SignComp Commercial extruded aluminum.
 2. Frame Finish: Match finish of the panel.
 3. Corner Condition: Square corners.
- C. Illuminated Units: Provide internal illumination as indicated using standard lighting components. Provide an accessible concealed internally wired fluorescent strip fixture system to illuminate message panels uniformly with minimum halation and without light leaks. Make provisions for servicing and concealed connection to electric service. Coordinate electrical characteristics with those of the power supply provided.

1. Fluorescent tubes: Provide the number of tubes indicated or required by the sign panel size.
 2. Ballasts: Provide low-temperature, high-power-factor, low-energy, exterior-type fluorescent lamp ballasts that comply with Certified Ballast Manufacturers Association standards and carry the CBM label.
 3. Provide transformers, insulators and other components necessary for operation.
- D. Graphic Content and Style: Provide sign copy to comply with the requirements indicated for sizes, styles, spacing, content, positions, materials, finishes and colors of letters, numbers, symbols and other graphic devices.
1. Cutout Copy: Machine-cut letters, numbers, symbols and other graphic devices through the sign panel to produce precisely formed copy. Use high-speed cutters mechanically linked to master templates in a pantographic system or equivalent process capable of producing characters of the style indicated with sharply formed edges.
 2. Backup: Provide 0.125-inch thick translucent acrylic sheet back-up attached to back side of the panel.
 3. Backup: Provide 0.125-inch thick acrylic sheet back-up with precise-fitting copy cut from 0.250-inch thick transparent acrylic sheet projecting through engraved copy chemically welded to acrylic back-up.

2.4 FABRICATION

- A. General: Provide the manufacturer's standard double post, single-panel-type post and panel signs. The completed sign assembly shall consist of a message panel supported between two posts. Comply with requirements indicated for materials, thicknesses, finishes, colors, designs, shapes, sizes and details of construction.
1. Allow for thermal movement resulting from a maximum ambient temperature change (range) of 100 degrees F (55.5 degrees C). Design, fabricate and install post and panel sign assemblies to prevent buckling, opening up of joints and over-stressing welds and fasteners.
 2. Base design on actual surface temperatures of metals due to both solar heat gain and nighttime sky heat loss.
- B. Welded Connections: Comply with AWS for recommended practices in shop welding. Provide welds behind finished surfaces without distortion or discoloration of the exposed side. Clean exposed welded surfaces of welding flux and dress on all exposed and contact surfaces.
1. Mill joints to a tight, hairline fit. Form joints exposed to the weather to exclude water penetrations.
 2. Conceal fasteners where possible; otherwise locate fasteners where they will be inconspicuous.
- C. Posts: Fabricate posts to lengths required for mounting method indicated.
1. Provide posts to support sign as indicated.

2. Base Plate: Provide posts with base plates, flanges or other fittings of sizes recommended by the manufacturer, welded to bottom of posts. Pre-drill slotted holes in base plate for anchor bolt connection.
 - a. Furnish templates as necessary for accurate setting of anchor bolts in concrete foundations.
 - b. Provide anchor bolts of size required for connection of posts to concrete foundations.

- D. Panels: Form panels to required size and shape. Comply with requirements indicated for design, dimensions, finish, color and details of construction.
 1. Coordinate dimensions and attachment methods to produce message panels with closely fitting joints. Align edges and surfaces with one another in the relationship indicated.
 2. Increase metal thickness or reinforce with concealed stiffeners or backing materials as required to produce surfaces without distortion, buckles, warp or other surface deformations.
 3. Continuously weld joints and seams except where other methods are indicated; grind, fill and dress welds to produce smooth flush exposed surfaces with welds visible after final finishing.

2.5 DISPLAY CAPABILITY

- A. The LED display shall be capable of displaying alphanumeric character fonts measuring a minimum of 5.5 inches tall.
- B. The display shall be able to display messages composed of any combination of alphanumeric text, punctuation symbols and graphic images.

C. Displays shall be legible under the following conditions:

1. 24 hours per day and inmost normally encountered weather conditions.
2. During dawn and dusk hours when sunlight is shining directly on the display face or when the sun is directly behind (silhouetting) the display.

2.6 DISPLAY

A. Display shall operate in a minimum ambient temperature range of -40 to +120 degrees F (-40 to +50 degrees C) and to 100% humidity.

B. Display Components

1. Electrical display components shall be 100% solid-state.
2. The presence of ambient radio signals and magnetic or electromagnetic interference, including those from power lines, transformers and motors shall not impair performance of the display system. The display system shall not radiate electromagnetic signals that adversely affect any other electronic device.
3. The display shall contain a full LED matrix composed of 48 pixel rows high by 128 pixel columns wide. The LED display shall display messages that are continuous, uniform and unbroken in appearance. The following sections detail the necessary components of a high quality LED display.

C. Display Controller

1. The controller shall be able to run independently from the controlling computer allowing the display to operate even when computer is unhooked or turned off.

2. All signal inputs shall be protected by transient protection or optical isolation (with the exception of RS232).
3. Communication protocol shall support other products from the vendor such as other outdoor or indoor displays of varying sizes and/or colors.
4. Shall be able to operate via Ethernet communication.
5. Each controller shall be connected to a light sensor allowing each LED display to automatically adjust a minimum of 32 levels of brightness according to display direction and lighting conditions.
6. The controller shall allow connection to a temperature sensor that provides accurate site temperatures.
7. Controller will have a time of day clock/calendar.
8. Active messages, stored, messages, message schedules, display configuration, time and date shall be stored in non-volatile memory. No external power will be required to maintain this data.
9. Controller can be configured with a unique name for the display.

D. Discrete LEDs

1. Pixels shall be constructed with discrete LEDs, shall conform to the following specifications:
2. LEDs shall be flush mount, ultra-bright, solid-state light emitting diodes constructed of AllnGaP technology.
3. The LED lens diameter shall be 0.2 inches (5 mm). This is sometimes referred to as a T 1-3/4 style LED package.

4. LEDs shall emit amber light that has a peak wavelength of 592 ± 4 nm respectively.
5. LEDs used in all LED displays provided for this contract shall be from the same manufacturer and of the same part number.
6. LED half life shall be a minimum of 100,000 hours.

E. Regulated DC Power Supplies

1. The LED modules shall be powered with regulated switching DC power supplies. Power supplies shall protect the LED pixel, LED display and driver circuitry in the event of power spikes or surges.
2. Regulated DC power supplies shall conform to the following specifications:
 - a. Operating input voltage range: +115 VAC ±10%
 - b. Over current protection: 105%
 - c. Over voltage protection: 115-140%
 - d. UL listed
3. Internal wiring for LED display modules and other internal components shall be installed in the housing in a neat and professional manner. Wiring shall not impede the removal of display modules, power supplies or other display components. Wires shall not make contact with or be bent around sharp metal edges. LED display module power and signal wiring shall be cut to a length and labeled. All wiring shall conform to the National Electric Code.
4. Transient Protection: The display shall be protected from electrical spikes and transients.

2.7 CONTROL AND COMMUNICATIONS

- A. Each display shall be controlled by its own display controller. The display controller shall be a stand-alone processor, which does not require continuous communication with control software in order to perform all functions.

B. The display controller shall be able to receive instructions from and provide information to a computer containing control software using the following communication modes:

1. Ethernet - Via 10base-T or 100base-T Ethernet connection. Media converters to be included.

C. Control Software

1. The control software for the displays shall be windows based. It shall provide simple, user-friendly features for creating, editing, scheduling, running and deleting messages.
2. The software shall include profanity protection.
3. Messaging:
 - a. The display shall have the ability to store a minimum of 100 messages.
 - b. Each frame shall have the ability to contain a minimum of 50 frames.
 - c. Hold times for each frame must be variable in 0.1 second increments with a minimum of 0 seconds and a maximum of 1 hour.
 - d. Each message shall be stored in a single file.
 - e. Messages shall run in a looping queue.
 - f. The software must have the ability to schedule the messages.
 - g. A single frame shall encompass the entire face of the display.
 - h. The contents of a text window shall be capable of being left, center or right justified horizontally.
 - i. Messages may be retrieved from the display for editing.
 - j. Messages shall consist of a series of frames with each frame containing a set of windows.
 - k. Each frame may have a bitmap in the background with the ability to overlay text in windows.
 - l. Windows may be placed free form at any location within the frame.
 - m. Windows may be overlapped.

- n. Text windows may be assigned foreground and background colors.
 - o. Text windows have a transparent background.
 - p. The software shall have the ability to copy and paste text from most windows applications.
4. Time, Date and Temperature Fields
- a. The software shall have the ability to display time and date in widely used formats within a message. The software shall be programmable to automatically adjust time zone offsets.
 - b. The software shall have the ability to accurately display local temperature in both Fahrenheit and Celsius. A feature will be included to calibrate the temperature sensor up or down in the range +/- 9 degrees F.
5. Display of Graphic Images
- a. The display and control software provided for this contract shall have the capability of using "graphic frames." The display shall be able to show messages containing graphic images of any size that will fit on the LED matrix.

2.8 HOUSING

- A. In order to provide structural integrity of the display housing and long life of the entire display, the housing frame shall be constructed of aluminum. To meet the anti-corrosive, degradation and oxidation requirements, the display housing aluminum sheet quality shall be no less than the properties of alloy 5052-H34.
- B. The display housing shall provide access to all LED display modules, electronics, power supplies, photo sensor assemblies, wiring and other internal display components.

- C. Internal display component hardware (nuts, bolts, screws, standoffs, rivets, fasteners, etc.) shall be fabricated from stainless steel, aluminum, nylon or other durable corrosion-resistant materials suitable for the signage application.
- D. Display housing shall be constructed to have a neat, professional appearance.
- E. Housing shall protect internal components from the outdoor elements.
- F. Serviceability: The display housing shall provide safe and convenient front service access for all modular assemblies, components, wiring and other materials located within the housing. All internal components shall be removable and replaceable by a single technician with basic hand tools. Displays shall be designed with service features that minimize potential bodily harm.
 - 1. Service access shall be easily obtained by removing individual LED modules. Internal components shall be accessed by removing the associated module as specified in the component layout diagram.

2.9 ELECTRICAL

- A. Display shall operate from the following power source:
 - 1. 120/240 VAC, 50/60 Hz single-phase, including neutral and earth ground.
- B. Earth Grounding: The manufacturer shall provide an earth ground lug in the display. The installation contractor shall provide the balance of materials and services needed to properly earth ground the display.

2.10 DIAGNOSTICS AND STATUS INFORMATION

- A. The software shall be capable of displaying operational status of each display. This shall minimally include the following information:

1. Display Name: Name of the display as entered by the operator.
2. Address: An identification number associated with the specific sign by which the software locates the sign to establish communications.
3. Communications Status - Pictorially represented as "Normal" or "Failed."
4. Current Message - As {name of message being displayed} or "Blank."
5. Time and Date - As running on the display.
6. Last Reset - Date and time of last communications with sign.
7. Available Memory - Pictorially and numerically represented memory available in the LED controller.
8. Brightness - The intensity control of the LEDs at which the display is currently operating, set as "Automatic" or "Manual."
9. Firmware Version - Current firmware version of the LED controller.
10. Schedule Status - Indicates if a schedule is active at the display.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrate, areas and conditions with installer present for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Verify that items, including anchor inserts and electrical power are sized and located to accommodate signs.

- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Furnish templates, anchor bolts, internal reinforcing and other items required to be set in concrete post foundations at proper time for setting.

3.3 INSTALLATION

- A. General: Locate sign units and accessories where indicated, using mounting methods of the type described and in compliance with the manufacturer's instructions.
- B. Excavation: Excavate for sign foundation to elevations and dimensions indicated. Reconstruct subgrade that is not firm, undisturbed or compacted soil or that is damaged by freezing temperatures, frost, rain, accumulated water or construction activities by excavating a further 12 inches (300 mm), back-filling with satisfactory soil and compacting to original subgrade elevation.
- C. Set anchor bolts and other embedded items required for installation of signs. Use templates furnished by suppliers of items to be attached.
 - 1. Protect portion of pylons above ground from concrete splatter.
- D. Mechanical Fasteners: Attach signs with fasteners and anchors suitable for secure attachment to substrate as recommended in writing by sign manufacturer.
- E. Install signs level, plumb and at the height indicated with sign surfaces free from distortion or other defects in appearance.

3.4 CLEANING

- A. At completion of the installation, clean soiled surfaces of sign units in accordance with the manufacturer's instructions.

3.5 PROTECTION

- A. Protect installed sign units from damage until acceptance by the Owner.

END OF SECTION 10436

SECTION 10500 - METAL LOCKERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Attention is directed to Division 0, Bidding and Contract Requirements, and to Division 1, General Requirements, which are hereby made a part of this Section.

1.02 DESCRIPTION OF WORK:

- A. The extent of metal lockers is shown on the drawings and is generally as follows:
 - 1. 15"w x 12"d x 60"h 'Single Tier' heavy duty corridor lockers (952 frames) with solid panel door.
 - a. Wood Creek Elementary = 268 lockers
 - b. Longacre Elementary = 244 lockers
 - c. Longacre Elementary = 44 lockers
(set into existing 12' deep wall recess-see plans)
 - d. Lanigan Elementary = 28 lockers
(part of the Alt Bid with addition)
 - e. Hillside Elementary = provide and install
772 new stainless steel locker bottoms

1.03 QUALITY ASSURANCE:

- A. Provide metal lockers as a complete unit produced by a single manufacturer, including necessary mounting accessories, fittings, and fastenings.
- B. Manufacturer: Provide metal lockers as manufactured by Republic Steel Corporation, Lyon, General Partitions or other as approved by Owner.

1.04 SUBMITTALS:

- A. Manufacturer's Data:
 - 1. For information only, submit two (2) copies of manufacturer's technical data and installation instructions for the metal locker units. Transmit a copy of each instruction to installer.
- B. Samples:
 - 1. Submit three (3) samples, on metal, of each color and finish that are required for lockers. Review will be

for color and texture only. Compliance with all other requirements is the exclusive responsibility of the Contractor.

C. Shop Drawings:

1. Submit shop drawings for metal lockers, verifying dimensions affecting locker installations. Show lockers in detail, method of installation, fillers, trim, base and accessories. Include locker numbering sequence information.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Do not deliver metal lockers until building is ready for their installation. Protect from damage during delivery, handling, storage and installation.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Sheet Steel: Cold-rolled steel for doors and door frames. Cold-rolled steel or annealed, specially treated steel for other parts. All steel free from buckle, scale and surface imperfections.
- B. Fasteners: Cadmium, zinc or nickel plated steel. Exposed bolt heads, slotless type. Provide self-locking nuts or lock washers for nuts on moving parts, or otherwise prevent loosening of nuts. Do not expose bolts or rivet heads on fronts of lockers or frames.
- C. Equipment: Furnish of zinc-plated steel, formed with ballpoints and attached with two bolts or rivets.

2.02 LOCKERS:

- A. Door Frames: Shall be 16 gauge formed into deep, 1'' face channel shapes with a continuous vertical door strike integral with the frame on both sides of the door opening. Double, triple or four tier locker cross frame members shall be 16 gauge channel shaped securely welded to vertical framing members to ensure a square and rigid assembly.

B. Body:

1. The body of the locker shall consist of 24 gauge

upright sheets, backs, tops and shelves. Tops and shelves shall be flanged on all four sides; backs are flanged on two sides. Uprights shall be offset at the front and flanged at the rear to provide a double lapped rear corner.

2. Locker bottoms shall be made of 16ga. stainless steel construction.
- C. Handles: A non-protruding 14 gauge lifting trigger and slide plate shall transfer the lifting force for actuating the lock bar when opening the door. The exposed portion of the lifting trigger shall be encased in a molded ABS thermoplastic cover that provides isolation from metal-to-metal contact and be contained in a formed 20 gauge stainless steel recessed pocket. This stainless steel pocket shall contain a recessed area for a padlock and a mounting area for the number plate. (Padlocks to be supplied by Owner).
- D. Pre-Locking Device: All "tiered" lockers shall be equipped with a positive automatic pre-locking type, whereby the locker may be locked while door is open and then closed without unlocking and without damaging locking mechanism.
- E. Doors: Doors shall be 14 gauge. Doors shall be formed with a full channel shape on lock side to fully conceal the lock bar, channel formation on the hinge side and right angle formation across the top and bottom.
1. Doors on corridor lockers shall be of flush design without louvers or perforations. The top and bottom flanges of all doors shall be perforated for ventilation with Republic's Verti-Vent System.
- F. Hinges: Hinges shall be 2'' high, 5-knuckle, full loop, tight pin style, securely welded to frame and double riveted to the inside of the door flange. Doors over 42'' high shall have three hinges.
- G. Latching: Latching shall be one-piece, pre-lubricated, spring steel latch completely contained within the lock bar under tension to provide rattle-free operation. The lock bar shall be of precoated, double-channel steel construction. The lock bar shall be securely contained in the door channel by self-lubricating polyethylene guides that isolate the lock bar from metal-to-metal contact with the door. There shall be three latching points for lockers over 42" in height. The lock bar travel is limited by contacting resilient elastomeric cushioning

devices located inside the lock bar. Frame hooks to accept latching shall be of heavy gauge steel, set close in and welded to the frame. Continuous vertical door strike shall protect frame hooks from door slam damage. The impact caused by the door closing shall be absorbed by a soft rubber silencer which is to be securely installed on each frame hook. Provide a latch guard steel plate welded on each frame hook on tier athletic lockers.

2.03 LOCKER ACCESSORIES:

A. Locking:

1. Owner to provide padlocks.

B. Interior Equipment:

1. Single tier lockers shall have two (2) hat/book shelves. All single lockers shall have one double prong back hook and two single prong wall hooks in each compartment. All hooks shall be made of steel, formed with ball points, zinc-plated and attached with two bolts or rivets.

C. Number Plates: Each locker shall have a polished aluminum number plate with black numerals not less than 1/2'' high. Plates shall be attached with rivets to the lower surface within the recessed handle pocket. Number sequence will differ between the schools and will be determined at a later date.

D. Tops: Provide heavy duty continuous sloped top on all lockers in corridors.

E. Base: Existing concrete or masonry base with wood blocking (provided by others).

F. Trim: Provide fillers at sides and top as shown or required in corridors along walls, at the ends of rows, etc.

G. End Panels: Provide boxed finished end panels on all exposed ends in corridors along walls, at the ends of rows, etc.

H. Construction: Fabricate lockers square, rigid and without warp with metal faces flat and free of dents or distortion. Make all exposed metal edges safe to the touch. Weld frames together. Weld, bolt, or rivet other

joints and connections as standard with manufacturer.
Grind exposed welds flush.

- I. Finishing: Chemically pretreat metal with degreasing and phosphatizing process. Apply baked-on enamel finish to all surfaces, exposed and concealed, except plates and non-ferrous metal. Architect will select from manufacturer's standard colors.

PART 3 - EXECUTION

3.01 INSPECTION:

- A. Installer must examine the areas and conditions under which metal lockers are to be installed and notify the Construction Manager in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the installer.

3.02 INSTALLATION:

- A. Install metal lockers at the locations shown in accordance with the manufacturer's instructions for a plumb, level, rigid, and flush installation.
- B. Space fastenings about 48" O.C. and apply through back-up reinforcing plates where necessary to prevent metal distortion. Conceal all fasteners wherever possible.
- C. Install trim, metal zee base, and sloping top units where indicated to provide a flush, hairline joint against adjacent surfaces. Install with concealed fasteners.
- D. Touch-up marred finishes, or replace if not acceptable to the Architect. Use only materials and finishes as recommended or furnished by the locker manufacturer.
- E. Adjust doors and latches to operate easily without bind. Verify satisfactory operation of integral locking devices.
- F. Where required, provide metal filler panels for closure to adjacent surfaces, factory-finishes to metal lockers.

FARMINGTON PUBLIC SCHOOLS
2017 RENOVATIONS-BID PACK #5
ELEMENTARY SCHOOLS

161664B

NOVEMBER 30, 2016

END OF SECTION 10500

SECTION 10800 - TOILET ACCESSORIES

PART I - GENERAL

1.01 RELATED DOCUMENTS:

- A. Attention is directed to Division 0, Bidding and Contract Requirements, and to Division 1, General Requirements, which are hereby made a part of this Section.

1.02 DESCRIPTION:

- A. The extent of each type of toilet accessory is shown on the drawings.
- B. The type of toilet accessories required, provided and installed by the Contractor, include the following:
 - 1. Wall mounted soap dispenser (by Owner)
 - 2. Sanitary napkin disposal
 - 3. Toilet tissue dispensers (by Owner)
 - 4. Paper towel dispensers/disposals (by Owner)
 - 5. Mirrors
 - 6. Grab bars
 - 7. Misc. Accessories
 - 8. ADA Shower Seat
 - 9. Towel Hooks
 - 10. Recessed Soap Dish
 - 11. Shower/Privacy Curtains & Track
 - 12. Shower Grab Bar

1.03 QUALITY ASSURANCE:

- A. Inserts and Anchorages:
 - 1. Furnish inserts and anchoring devices which must be built into walls for the installation of toilet accessories. Coordinate delivery with other work to avoid delay.

B. Products:

1. Provide products of the same manufacturer for units exposed in the same areas, unless otherwise acceptable to the Architect.
2. Stamped names or labels on exposed faces of units will not be permitted, except where otherwise indicated.
3. Provide locks where indicated, with the same keying for each type of accessory units in the project wherever possible. Furnish two keys for each lock.

C. The specifications indicated specific products of one manufacturer to communicate design intent. Other manufacturers offering products to comply with the requirements for toilet accessories include the following:

1. American Specialties, Inc.
2. Accessory Specialties.
3. Bradley Corporation
4. Bobrick

1.04 SUBMITTALS:

A. Product Data:

1. For information only, submit four (4) copies of manufacturer's technical data and installation instructions for each toilet accessory. Transmit copies of installation instructions to the Installer.

B. Samples:

1. When requested, submit full-size samples of units to Architect for review of design and operation. Acceptable samples will be returned and may be used in the work. Compliance with all other requirements is the exclusive responsibility of the Contractor.

C. Setting Drawings:

1. Provide setting drawings, templates, instructions and directions for installation of anchorage devices in other work.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Stainless Steel: AISI, Type 302/304 with polished No. 4 finish, 0.034 inch (22 gauge) minimum thickness.
- B. Brass: Unleaded , flat products, ASTM B19; rods, shapes, forgings, and flat products with finished edges, ASTM B16; castings, ASTM B30.
- C. Sheet Steel: Cold rolled, commercial quality, ASTM A336, 0.04 inch (20 gauge) minimum. Surface preparation and metal pretreatment as required for applied finish.
- D. Galvanized Steel Sheet: ASTM A527, G60.
- E. Chromium Plating: Nickel and chromium electro-deposited on base metal, ASTM B456, Type SC2.
- F. Mirror Glass: Nominal 6.0mm (0.23 inch) thick, conforming to ASTM C1036, Type I, Class 1, Quality q2, and with silvering electro-plated copper coating, and protective organic coating.
 - 1. Provide tempered glass, unless indicated otherwise.
- G. Galvanized Steel Mounting Devices: ASTM A153, hot-dip galvanized after fabrication.
- H. Fasteners: Screws, bolts, and other devices of same material as accessory unit, or of galvanized steel where concealed.

2.02 MIRRORS

- A. Stainless Steel Framed Mirror: Mirror shall have a one piece, Type 304 stainless steel angle frame, 3/4 inch by 3/4 inch with continuous integral stiffener on all sides and beveled front to hold frame tightly against mirror; corners shall be heliarc welded, ground and polished smooth; all exposed surfaces shall have satin finish with vertical grain. Tempered glass mirror shall be guaranteed for 15 years against silver spoilage. All edges shall be protected by plastic filler strips and the back shall be protected by full size, shock absorbing, water resistant, nonabrasive, 1/8 inch thick polyethylene padding. Galvanized steel back shall have integral hanging brackets for mounting on concealed rectangular wall hanger(s). Mirror shall be secured to hanger(s) with concealed phillips head jocking screws located in bottom of frame.
 - 1. Manufacturers: Subject to compliance with

requirements, provide mirror unit by one of the following:

- a. Bobrick: B-290. Provide with tempered glass.
2. Mount mirrors at 40'' AFF to bottom edge of glass.
3. Provide sizes and locations as indicated on plans.

2.03 GRAB BARS

- A. Stainless Steel Type: Provide grab bars with wall thickness not less than 0.05 inch and as follows:
 1. Mounting: Concealed, manufacturer's standard flanges and anchorages.
 2. Clearance: 1-1/2 inch clearance between wall surface and inside face of bar. Mount at locations and heights indicated on drawings.
 3. Gripping Surfaces
 - a. Satin finish with peened gripping surface, unless noted otherwise.
 4. Heavy Duty Size: Outside diameter of 1-1/2 inches minimum.
- B. Grab bar shall be constructed of Type 304 stainless steel with satin finish. Concealed mounting flanges shall be 1/8 inch thick stainless steel plate, 3-1/8 inch diameter, and each shall have 2 screw holes for attachment to wall. Flange covers shall be 22 gauge, 3-1/4 inch diameter by 1/2 inch deep, and shall snap over mounting flange to conceal mounting screws. Ends of grab bars shall pass through concealed mounting flanges and be heliarc welded to form one structural unit. Grab bars shall comply with ADA Accessibility Guidelines for structural strength. Provide concealed anchor device or backing as specified or required in accordance with local building codes before wall is finished.
 1. Manufacturers: Subject to compliance with requirements, provide grab bars by one of the following:
 - a. Bobrick: B-6806.99 Series
 1. Horizontal: B-6806.99 by 36''
 2. Horizontal: B-6806.99 by 42''
 3. Vertical: B-6806.99 by 18''
 2. Provide sizes and locations as indicated on plans.

2.04 SANITARY NAPKIN DISPOSAL

- A. Provide where indicated on plans. Mount in each stall at 24'' AFF to top of unit.
- B. Bobrick B-270

2.05 ADA SHOWER SEAT

- A. Reversible folding shower seat shall have a frame constructed of type 304, satin finish stainless steel, 16 gauge (1.6mm), 1¼'' (32mm) square tubing, and 18 gauge (1.2mm), 1'' (25mm) diameter seamless tubing. Seat shall be constructed of one piece, ½'' (13mm) thick, solid phenolic with matte finish, ivory-colored, melamine surfaces, and black phenolic resin core. Seat shall be reversible for left or right hand.
 - 1. Bobrick Model B5181 install seat in RH or LH configuration as indicated on drawings.

2.06 TOWEL HOOK

- A. Surface mounted vandal resistant clothes/towel hook (secured from front) shall be constructed of type 304 stainless steel with satin finish and have square 7/8'' (22mm) deep black plate. Face plate shall be 14 gauge (2mm) with drawn, one piece seamless construction. Hook shall snap down for safety if excessively loaded. Furnish with tamper resistant mounting screws.
 - 1. Bobrick B-983

2.07 SOAP DISH

- A. Recessed heavy-duty stainless steel soap dish shall be constructed of type 304 stainless steel with satin finish. Soap dish and flange shall be drawn and beveled, with one-piece, seamless construction. Unit shall be equipped with 20 gauge (0.9mm) galvanized steel mounting clamp for installation in dry or stud wall construction.
 - 1. Bobrick B4380 altered for masonry wall installation.

2.08 SHOWER/PRIVACY CURTAIN

- A. Shower Curtains: Curtains as manufactured by Imperial Fastener Company, Pompano Beach, Florida 1-954-782-7130. Mount IFC-69 jiffy curtain track to gypsum ceiling. Space safety tabs at 4'' o.c. Provide sure-chek shower curtain with mesh top and clear bottom. Color as selected by Architect from manufacturer's standard colors. Provide track with aperture.

2.09 MISCELLANEOUS ACCESSORIES

- A. Mop and Broom Holders (MH): Surface mounted mop and broom holder shall be Type 304 stainless steel with satin finish. Unit shall be 36 inches long with 4 spring loaded, rubber cam holders. Manufacturers: Subject to compliance with requirements, provide accessories by one of the following:

- a. Bobrick: B-223-36
- b. Provide 1 per each Janitor Closet indicated on plans.

- B. Trapwrap

- 1. Provide trapwrap at all exposed piping below wall mounted lavatories (1 @ each sink). Verify quantities in field (9 required).
- 2. Trapwrap to be as manufactured by Brocar Products Inc. or TrueBro.

- C. Fasteners and Anchors

- 1. Provide mounting kits with stainless steel screws for accessories requiring same.
- 2. Mounting kits shall include toggle nuts for hollow walls and expansion shields for solid walls. Provide 2 fasteners at each mounting plate.
- 3. Provide 12 gauge, 3 inches wide, steel concealed anchor plates with tapped holes for installation of grab bars on walls constructed with metal studs.
- 4. Provide concealed anchors for installation of grab bars on solid walls. Anchor assembly shall consist of tapped 12 gauge anchor plate, 10 gauge back plate, and 3/8 inch diameter thru-wall bolt.

2.10 SHOWER GRAB BAR

- A. Stainless Steel type, wall mounted inside shower unit.
 - 1. Bobrick: B-6861

PART 3 - EXECUTION

3.01 INSPECTION:

- A. Installer must examine the areas and conditions under which toilet accessories are to be installed and notify the Construction Manager in writing, of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 INSTALLATION:

- A. Use concealed fastenings wherever possible.
- B. Provide anchors, bolts and other necessary anchorages and attach accessories securely to walls and partitions in locations as shown or directed.
- C. Install concealed mounting devices and fasteners fabricated of the same materials as the accessories, or of galvanized steel, as recommended by manufacturer.
- D. Install exposed mounting devices and fasteners finished to match the accessories.
- E. Provide theft-resistant fasteners for all accessory mountings.
- F. Secure toilet room accessories in accordance with the manufacturer's instructions for each item and each type of substrate construction.

END OF SECTION 10800

SECTION 10999 - MISCELLANEOUS SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Attention is directed to Division 0, Bidding and Contract Requirements, and to Division 1, General Requirements, which are hereby made a part of this Section, and Division 16 (wiring of fluorescent lighting).

1.02 DESCRIPTION OF WORK:

- A. The extent of miscellaneous specialties is as shown on the drawings or schedules and includes the following:
 - 1. Solar Tube Skylight
 - 2. Metal Soffit Panels
 - 3. Metal Column Enclosure

1.03 SUBMITTALS:

- A. Product Data:
 - 1. Submit two (2) copies of manufacturer's specifications and installation instructions for each type of specialty required. Indicate by transmittal that copy of each instruction has been distributed to the Installer.
- B. Samples:
 - 1. Submit three (3) samples of each color and finish of exposed materials and accessories required for each specialty. Architect's review of samples will be for color and texture only. Compliance with all other requirements is the exclusive responsibility of the Contractor.
- C. Shop Drawings:
 - 1. Submit shop drawings for fabrication and erection of specialties, including plans, elevations and large scale details, shop anchorages and accessory items. Provide location template drawings for items supported or anchored to permanent construction.

PART 2 - PRODUCTS

2.01 PREFABRICATED PRODUCTS:

A. Solar Tube Skylight

1. Provide 21" dia. Solar tube skylight, SolaTube, SolaMaster Series 330DS for open and closed ceiling applications, (Solatube International, Vista, CA. 888-765-2882)
2. Provide 8" high pre-fab roof curb and all necessary roof flashings for watertight installation.
3. Refer to details for structural steel reinforcing required for new roof openings.
4. For open ceiling applications, provide 21" dia. SolaTube, SolaMaster Series 330DS with 21" round OptiView diffuser at end with white trim. Extend tube down 12" below roof deck ht. See plans for locations and quantities.
5. For closed ceiling applications, provide 21" dia. SolaTube, SolaMaster Series 330DS with 24"x24" OptiView diffuser installed into existing/modified lay-in ceiling grid as required. Verify conditions if field. Line up new roof opening with ceiling grid for straight down tube installation per details on drawings. See plans for locations and quantities.

B. Metal Soffit Panels (Wood Creek Elem.)

1. Provide 22 ga., FW-12, SMOOTH face, prefinished metal soffit panels as manufactured by Berridge manuf. Co. (800-669-0009.
2. Provide panels with concealed fasteners, Seam-Lock feature, in compliance with ASTM E-1592.
3. Color to be selected from manufacturers standard color range.

C. Metal Column Enclosure (Wood Creek Elem.)

1. Provide .080 Aluminum, Series 2000-Single Skin, pre-finished Circular Column Cover, as manufactured by Centria. 800-759-7474.
2. Provide panels with 5/8" wide reveal, with 1 1/2" depth and in equal vertical ht. sections (max 15")
3. Install all panels in strict accordance with manufacturers installation details. Provide all required 16GA. internal column cover support framing inside the column cover secured to the steel column as required by the column cover manufacturer.
4. Color to be selected from manufacturers standard color range.

PART 3 - EXECUTION

3.01 INSPECTION:

- A. Installer must examine the substrates and conditions under which the specialties are to be installed, and notify the Construction Manager and Architect in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 INSTALLATION:

- A. In addition to the requirements of these specifications, comply with manufacturer's instructions and recommendations for preparation of substrate, installation of anchors, and application of specialties. Coordinate with work of other trades for application of inserts of other integral equipment items.
- B. Install at the locations shown or scheduled, securely mounted with concealed fasteners, unless otherwise shown. Attach to substrates in accordance with the manufacturer's instructions, unless otherwise shown.
- C. Install level, plumb and at the proper height. Cooperate with other trades for installation in finish surface. Repair or replace damaged units as directed by the Architect.

END OF SECTION 10999

SPEC SECTION 11063 – STAGE CURTAINS

SCOPE:

- A. Intent:** This specification covers the fabrication, furnishing, delivery and installation of all state equipment and associated hardware. All equipment used in performance of this contract shall be of the best known to the industry and shall be manufactured by a long established, thoroughly experienced responsible Stage Equipment manufacturer with their own installation department and Curtain manufacturing facility. The form of contract, general conditions and the project drawings are considered to be part of these specifications.
- B. Complete System:** The Stage Equipment Contractor shall provide all items necessary for a complete, safe, fully functional system as described herein, including all tools, scaffolding, labor and supervision, even though they may not be specifically enumerated. Any errors, omissions or ambiguities do not relieve the Contractor of this responsibility, but shall be brought to the attention of the Owner for clarification. All additional support steel or spanner steel found necessary for this installation shall be supplied and installed by the Stage Equipment Contractor. All welding completed on site shall be performed by certified welders.
- C. Work Include:** The work of this section shall include, but not necessarily be limited to the following
- 1. Demolition of front Stage Curtains and Tracks**
 - 2. New Front Stage Curtain**
 - 3. New Front Stage Curtain Track Assemblies**

GENERAL REQUIREMENTS

- A. Field Conditions: All bidders shall fully inform themselves of the conditions under which the work is to be performed. All Curtains and equipment sizes listed within shall be field verified prior to submission of bid. No additional compensation shall be allowed for any labor or item the bidder could have been full informed of prior to the bid date.**

Stage Equipment Contractor to provide protective tarps to cover entire stage floor for the duration of this respective work.

ALL WORK SHALL BE COMPLETED IN PHASES.

Phase 1). At the beginning of construction the Stage Equipment Contractor shall complete the full demolition of all Stage Equipment. All materials shall be removed from site and disposed of properly.

Phase 2). After all work has been completed within this space the Stage Equipment Contractor shall return to complete the installation of all New Stage Equipment as specified.

- B. Safety: The systems shall conform to all applicable code requirements and shall be in conformance with industry standards of operation and practices. All materials, arrangements and procedures shall comply with applicable code requirements and shall be in conformance with industry standards of operation and practices. All materials, arrangements and procedures shall comply with applicable code requirements, allowing the users to arrange and operate a safe assembly and working environment for audience and user personnel.**
- C. Insurance: I the absence of more stringent requirements, the Stage Equipment Contractor shall maintain injury and property liability insurance coverage throughout the project's scheduled timetable, including workmen's compensation coverage for Contractor's employees**

COMPETENCY OF BIDDER

- A. Stage equipment Contractor shall have been engaged in the installation and manufacturing of stage equipment for a minimum of ten (10) years. Contractor must have completed ten (10) projects of equal or greater scope within the last twelve (12) months. Contractor may be asked to supply proof of the above qualification if desired by the owner.**
- B. This work requires total adherence to all bid specifications and procedures. Variation from this specification shall be indicated by the submission of detailed and complete specifications showing exactly what substitution the bidder proposes to make. Any intent to substitute shall be clearly called to the attention to the Owner before the proposal is submitted to facilitate comparison with the original specifications. If proposed substitute is accepted by the Owner all parties known to be bidding this project shall be notified through addendum. Substitutions not specifically noted before time of bidding will not be accepted.**

- C. Requirements: The Rigging Contractor shall be an approved rigging manufacturer or an authorized representative or dealer of an approved manufacturer of stage and theatrical rigging hardware and show a satisfactory record of successful in-service performance. If at any time in the past, Stage Equipment Contractor has substituted specified products without prior written approval, or has failed to complete a project as specified, to the Owners, Architects or Theatre Consultants satisfaction, they shall be ineligible to bid on this project. Stage Equipment Contractor must maintain and operate their own sewing production shop located within their place of business and must have sufficient production capacity to produce required units without causing delay. Stage Equipment Contractor shall have their own in-house full-time installation crews complete with their own production tool shop and warehouse located within their place of business. There shall be no subletting of Curtain manufacturing or installation work. A qualified and experienced supervisor of the Rigging Contractor of which is employed by the contractor on a full time basis must be at the site during the entire installation period and shall actively direct and supervise the work.**
- D. All bidders are required to make a full inspection of the auditorium facility so that they are fully aware of all special job conditions and product requirements.**
- E. The Stage Equipment Contractor shall install all items in accordance with the;**
- 1) Curtain fabricators written instructions,**
 - 2) the Curtain Track and hardware manufacturers written instructions and**
- F. Pre-approved Contractors:**
- 1) Secoa, Inc., Champlain, MN - V(763)506-8800, Fx (763)506-8844**
 - 2) J.R. Clancy, Inc., Syracuse, NY - V(315)451-3440, Fx-(315)451-1766**
 - 3) Syracuse Scenery, Inc., Liverpool, NY - V(315)453-8096, Fx-(315)453-7897**
 - 4) North Coast Studios, Inc., Clinton Twp., MI - V(586)359-6630, Fx-(586)359-6638**

G. Requirements for Approval: Other Contactors seeking acceptance must submit the following information at least two (2) weeks prior to the bid opening date. Approval of Contractors will be by addenda. Failure to submit any of the required information will automatically disqualify the Contractor from consideration of approval.

- 1. A listing of ten (10) equivalent installations within the past twelve (12) months**
 - a. Name, address and telephone number of Owner;**
 - b. Name, address and telephone number of Architect;**
 - c. Scope of work.**
- 2. A brief written description of the Contractors operation including facilities, financial capabilities, and experience of key personnel.**
- 3. A statement from a bonding company agreeing to provide the required bonds in the amount required for the project.**

WARRANTY

- A. The Contractor shall provide a two (2) year written guarantee against defects in materials workmanship starting from the date of acceptance of equipment by the Owner's representative. The guarantee shall not cover damage due to normal wear and tear, acts of God, neglect, or improper use of equipment.**

Any required maintenance or replacement shall be provided by the Rigging Contractor within thirty days of notification by the Owner except for safety related items, which shall be corrected within 48 hours of notification. Subsequent to the expiration of the guarantee period the Rigging Contractor agrees to furnish repair and maintenance service, at the Owner's expense, within thirty days of request for such service.

MANUFACTURER

A. Rigging Manufacturers:

**J.R. Clancy, 7041 Interstate Island Road, Syracuse, NY 13209
H & H Specialties, PO Box 9327, South El Monte, CA 91733**

B. Fabric Sources:

**KM Mills, Greenville SC
Rose Brand Fabrics, New York, NY
J.B. Martin, Quebec Canada
Milliken Company, New York, NY**

C. Track and Equipment:

**Automatic Devices Company, Allentown, PA
J.R. Clancy, Inc., Syracuse, NY
H & H Specialties, South El Monte, CA**

D. Products of other manufacturers will be considered for acceptance provided they equal, or exceed requirements and functional qualities of the specified project. Request for Owner's approval with complete supporting technical data for evaluation must be received at least ten (10) days prior to bid due date. Additional approved manufacturers will be issued by Addendum.

CURTAIN SCHEDULE

FRONT SETTING CURTAINS

One (1) Grand Traveler two (2) sections finish 22'0" x 88'0"

Fabric: 24 oz. I.F.R. Charisma Velour, color to be selected as manufactured by KM Fabrics, Inc., -or equal

Lining: I.F.R. RB Cloth, color Black as manufactured by Rose Brand Fabrics, New York, NY -or equal

The above Curtains shall be box pleated with approximately 60% fullness on a heavy 3-1/2" BMF jute webbing with four (4) rows of reinforced stitching and provided with grommets and "S" hooks or 36" long #4 cotton tie line, color Black centered on each pleat and two (2) 3-1/2" apart on all leading and side edges. All four side edges of the Grand Traveler shall have not less than 12" of face fabric turned back. All side edges of the Grand Valance shall have no less than 3" of face fabric turned back. All bottom hems shall be a full 5". All salvages shall be snipped on approximately 18" centers prior to fabricating and all pleats shall be arranged to conceal vertical seams. 24/4 thread in a color to match fabric shall be used throughout and all sewing shall be completed with a heavy duty industrial straight stitch, power operated machine. Blind stitching any portions is unacceptable. All Curtains shall be lined. Lining shall finish 2" above bottom hem of face fabric. Lining shall be connected to all vertical sides by means of adjustable Velcro straps and horizontally by means of adjustable frog legs sewn across bottom hem at each seam with one (1) intermediate position between each seam as found necessary. Lining shall be sewn inside of the bottom hem line of face fabric and fold down to finish 2" above bottom hem of face fabric. Lining shall be connected at all vertical sides by means of adjustable Velcro straps. Sewn to the backside offstage edge of each Curtain Panel shall be a 12: x 12@ loose piece of fabric from the same dye lot for future field flame test purposes of each fabric used within constructions.

FLAMEPROOFING

All fabrics to be flame retardant by the emersion method or inherently flame retardant.

All fabrics shall be flame retardant to pass all City and State fire codes and comply with NFPA-701.

Certification of Flameproofing must be permanently stitched into the Curtain hem.

Contractor shall supply to Owner a notarized affidavit signed by manufacturer of Stage Curtains certifying that products furnished comply with the above requirements.

HARDWARE SCHEDULE

CURTAIN TRACK ASSEMBLIES

Grand Traveler

Curtain track Model #5000 shall be of 7 gauge extruded aluminum I-beam construction consisting of a center rib and top, intermediate and bottom flanges. Each curtain carrier Model #5001 shall be spaced on 12" centers and shall be of steel construction to include two (2) nylon-tiered ball-bearing wheels rolling on two (2) separate parallel treads. Each curtain carrier shall consist of a free-moving plated swivel to accommodate curtain nap hook. Live-End Model #5003 and Dead-End Model #5004 pulley blocks shall be equipped with 5" diameter ball-bearing wheels adequately guarded. Nylon cable guides Model #5058 shall be furnished for the purpose of guiding operating cable along the contour of the factory-formed curved track. Operating cable Model #5029 shall be of 3/16" diameter extruded nylon wire-center. 1-1/4" I.D. stiffening pipe or equivalent shall be used to support both straight and curved areas of all suspended curved tracks. The manufacturer shall furnish two (2) end stops Model #5009 for placement at track ends. Model #500 as manufactured by Automatic Devices Company of Allentown, PA - or equal

INSTALLATION

EQUIPMENT SCHEDULE

Set #01 - Grand Traveler - Dead Hung

A. Coordination:

- 1. Take all measurements required at the job site and verify the location of all items to which attachment must be made, or which may cause any restriction in the total operation of the rigging.**
- 2. Provide connecting members needed for proper installation and securing to masonry, joists, wall, structural members or other parts of the construction as may be suited.**

B. Relocation:

- 1. Owner reserves the right to notify this Contractor of any desired change in spacing without causing a change in bid price.**
- 2. Such notification must be made before the installation of any piece of equipment for that set has begun.**
- 3. This Contractor, while carefully following the detailed schedule of sets, may make such minor adjustments as deemed necessary to clear possible obstacles.**
- 4. Notification must be made to the Owner's representative on the job.**
- 5. Relocation of a major nature must be proposed in writing to the Owner.**

CLEAN UP

A. The Contractor shall be responsible for cleanup, including removal of packing materials etc. and the protection surfaces or equipment provided by the other Contractors. All existing Curtain and hardware shall be removed from site and properly disposed of.

INSPECTION AND TESTING

A. Inspection: During the installation of equipment the Rigging Contractor shall arrange for access as necessary for inspection of equipment by the Owner's representatives.

B. Completion Testing: Upon completing the installation of all equipment specified under this section, the Contractor shall notify the Architect, who will schedule an inspection. At the time of the inspection, the Rigging Contractor shall furnish sufficient workers to operate all equipment and to perform such adjustments and test as may be required by the Owner's representative. Any equipment which fails to meet with approval shall be repaired or replaced with suitable equipment and the inspection shall be re-scheduled under the same conditions as previously specified. At the time of these inspections, no other work shall be performed in the auditorium and stage areas. All temporary bracing, scaffolding, etc. shall be withheld until all systems have been thoroughly tested and found to be in first class operating condition in every particular.

C. Instructional Period: After final approval of completed work Contractor shall schedule an instructional day with Owners staff to demonstrate proper working procedures and maintenance of all equipment. Contractor to have necessary lifts on site and full stage rigging crew for this presentation. One full eight (8) hour day shall be set aside for this presentation.

END OF SPECIFICATION

SPEC SECTION 11063 – STAGE CURTAINS & RIGGING
FARMINGTON HIGH SCHOOL: RE-BID

SCOPE:

- A. Intent:** This specification covers the fabrication, furnishing, delivery and installation of all state equipment and associated hardware. All equipment used in performance of this contract shall be of the best known to the industry and shall be manufactured by a long established, thoroughly experienced responsible Stage Equipment manufacturer with their own installation department and Curtain manufacturing facility. The form of contract, general conditions and the project drawings are considered to be part of these specifications.
- B. Complete System:** The Stage Equipment Contractor shall provide all items necessary for a complete, safe, fully functional system as described herein, including all tools, scaffolding, labor and supervision, even though they may not be specifically enumerated. Any errors, omissions or ambiguities do not relieve the Contractor of this responsibility, but shall be brought to the attention of the Owner for clarification. All additional support steel or spanner steel found necessary for this installation shall be supplied and installed by the Stage Equipment Contractor. All welding completed on site shall be performed by certified welders.
- C. Work Include:** The work of this section shall include, but not necessarily be limited to the following
- 1. Demolition of all Stage Curtains, Tracks and Rigging**
 - 2. Stage Curtain**
 - 3. Stage Curtain Track Assemblies**
 - 4. All Associated Rigging Hardware**

D. Related Work: Related work which is not included in this section:

- 1. Gridiron, head and loft block beams, and all other structural steel and miscellaneous metals not specifically called out as part of this sections**
- 2. Galleries, ladders and catwalks**
- 3. Stage flooring**
- 4. Stage lighting**
- 5. Electrical connections, conduit, boxes and wiring of any type**

GENERAL REQUIREMENTS

- A. Field Conditions: All bidders shall fully inform themselves of the conditions under which the work is to be performed. All Curtains and equipment sizes listed within shall be field verified prior to submission of bid. No additional compensation shall be allowed for any labor or item the bidder could have been full informed of prior to the bid date.**

Stage Equipment Contractor to provide protective tarps to cover entire stage floor for the duration of this respective work.

ALL WORK SHALL BE COMPLETED IN PHASES.

Phase 1). At the beginning of construction the Stage Equipment Contractor shall complete the full demolition of all Stage Equipment. All materials shall be removed from site and disposed of properly.

Phase 2). After all work has been completed within this space the Stage Equipment Contractor shall return to complete the installation of all New Stage Equipment as specified.

- B. Safety: The systems shall conform to all applicable code requirements and shall be in conformance with industry standards of operation and practices. All materials, arrangements and procedures shall comply with applicable code requirements and shall be in conformance with industry standards of operation and practices. All materials, arrangements and procedures shall comply with applicable code requirements, allowing the users to arrange and operate a safe assembly and working environment for audience and user personnel.**
- C. Insurance: I the absence of more stringent requirements, the Stage Equipment Contractor shall maintain injury and property liability insurance coverage throughout the project's scheduled timetable, including workmen's compensation coverage for Contractor's employees**

COMPETENCY OF BIDDER

- A. Stage equipment Contractor shall have been engaged in the installation and manufacturing of stage equipment for a minimum of ten (10) years. Contractor must have completed ten (10) projects of equal or greater scope within the last twelve (12) months. Contractor may be asked to supply proof of the above qualification if desired by the owner.**
- B. This work requires total adherence to all bid specifications and procedures. Variation from this specification shall be indicated by the submission of detailed and complete specifications showing exactly what substitution the bidder proposes to make. Any intent to substitute shall be clearly called to the attention to the Owner before the proposal is submitted to facilitate comparison with the original specifications. If proposed substitute is accepted by the Owner all parties known to be bidding this project shall be notified through addendum. Substitutions not specifically noted before time of bidding will not be accepted.**

- C. Requirements: The Rigging Contractor shall be an approved rigging manufacturer or an authorized representative or dealer of an approved manufacturer of stage and theatrical rigging hardware and show a satisfactory record of successful in-service performance. If at any time in the past, Stage Equipment Contractor has substituted specified products without prior written approval, or has failed to complete a project as specified, to the Owners, Architects or Theatre Consultants satisfaction, they shall be ineligible to bid on this project. Stage Equipment Contractor must maintain and operate their own sewing production shop located within their place of business and must have sufficient production capacity to produce required units without causing delay. Stage Equipment Contractor shall have their own in-house full-time installation crews complete with their own production tool shop and warehouse located within their place of business. There shall be no subletting of Curtain manufacturing or installation work. A qualified and experienced supervisor of the Rigging Contractor of which is employed by the contractor on a full time basis must be at the site during the entire installation period and shall actively direct and supervise the work.**
- D. All bidders are required to make a full inspection of the auditorium facility so that they are fully aware of all special job conditions and product requirements.**
- E. The Stage Equipment Contractor shall install all items in accordance with the;**
- 1) Curtain fabricators written instructions,**
 - 2) the Curtain Tract and hardware manufacturers written instructions and**
 - 3) the Rigging equipment manufacturers written instructions.**
- F. All Rigging equipment used on this project shall meet ANSI/ESTA Standard E1.4-2009.**

G. Pre-approved Contractors:

- 1) Secoa, Inc., Champlain, MN - V(763)506-8800, Fx (763)506-8844
- 2) J.R. Clancy, Inc., Syracuse, NY - V(315)451-3440, Fx-(315)451-1766
- 3) Syracuse Scenery, Inc., Liverpool, NY - V(315)453-8096, Fx-(315)453-7897
- 4) North Coast Studios, Inc., Clinton Twp., MI - V(586)359-6630, Fx-(586)359-6638

H. Requirements for Approval: Other Contactors seeking acceptance must submit the following information at least two (2) weeks prior to the bid opening date. Approval of Contractors will be by addenda. Failure to submit any of the required information will automatically disqualify the Contractor from consideration of approval.

1. A listing of ten (10) equivalent installations within the past twelve (12) months
 - a. Name, address and telephone number of Owner;
 - b. Name, address and telephone number of Architect;
 - c. Scope of work.
2. A brief written description of the Contractors operation including facilities, financial capabilities, and experience of key personnel.
3. A statement from a bonding company agreeing to provide the required bonds in the amount required for the project.

WARRANTY

- A. The Rigging Contractor shall provide a two (2) year written guarantee against defects in materials workmanship starting from the date of acceptance of equipment by the Owner's representative. The guarantee shall not cover damage due to normal wear and tear, acts of God, neglect, or improper use of equipment.

Any required maintenance or replacement shall be provided by the Rigging Contractor within thirty days of notification by the Owner except for safety related items, which shall be corrected within 48 hours of notification. Subsequent to the expiration of the guarantee period the Rigging Contractor agrees to furnish repair and maintenance service, at the Owner's expense, within thirty days of request for such service.

MANUFACTURER

A. Rigging Manufacturers:

**J.R. Clancy, 7041 Interstate Island Road, Syracuse, NY 13209
H & H Specialties, PO Box 9327, South El Monte, CA 91733**

B. Fabric Sources:

**KM Mills, Greenville SC
Rose Brand Fabrics, New York, NY
J.B. Martin, Quebec Canada
Milliken Company, New York, NY**

C. Track and Equipment:

**Automatic Devices Company, Allentown, PA
J.R. Clancy, Inc., Syracuse, NY
H & H Specialties, South El Monte, CA**

D. Products of other manufacturers will be considered for acceptance provided they equal, or exceed requirements and functional qualities of the specified project. Request for Owner's approval with complete supporting technical data for evaluation must be received at least ten (10) days prior to bid due date. Additional approved manufacturers will be issued by Addendum.

CURTAIN SCHEDULE

FRONT SETTING CURTAINS

One (1) Grand Traveler two (2) sections finish 22'0" x 88'0"

Fabric: 24 oz. I.F.R. Charisma Velour, color to be selected as manufactured by KM Fabrics, Inc., -or equal

Lining: I.F.R. RB Cloth, color Black as manufactured by Rose Brand Fabrics, New York, NY -or equal

The above Curtains shall be box pleated with approximately 60% fullness on a heavy 3-1/2" BMF jute webbing with four (4) rows of reinforced stitching and provided with grommets and "S" hooks or 36" long #4 cotton tie line, color Black centered on each pleat and two (2) 3-1/2" apart on all leading and side edges. All four side edges of the Grand Traveler shall have not less than 12" of face fabric turned back. All side edges of the Grand Valance shall have no less than 3" of face fabric turned back. All bottom hems shall be a full 5". All salvages shall be snipped on approximately 18" centers prior to fabricating and all pleats shall be arranged to conceal vertical seams. 24/4 thread in a color to match fabric shall be used throughout and all sewing shall be completed with a heavy duty industrial straight stitch, power operated machine. Blind stitching any portions is unacceptable. All Curtains shall be lined. Lining shall finish 2" above bottom hem of face fabric. Lining shall be connected to all vertical sides by means of adjustable Velcro straps and horizontally by means of adjustable frog legs sewn across bottom hem at each seam with one (1) intermediate position between each seam as found necessary. Lining shall be sewn inside of the bottom hem line of face fabric and fold down to finish 2" above bottom hem of face fabric. Lining shall be connected at all vertical sides by means of adjustable Velcro straps. Sewn to the backside offstage edge of each Curtain Panel shall be a 12: x 12@ loose piece of fabric from the same dye lot for future field flame test purposes of each fabric used within constructions.

INTERMEDIATE SETTING CURTAINS

Three (3) Masking Borders each finish 10'0" x 74'0"

Two (2) Mid Stage Travelers each 2-sections each finish 22'0" x 76'0"

One (1) Rear Traveler two (2) sections finish 22'0" x 76'0"

Two (2) Side Masking Curtains each four (4) sections each finish 22'0" x 24'0"

Fabric: 22 oz. Encore I.F.R. color Black as manufactured by Milliken Company, New York, NY -or equal

The above Curtains shall be box pleated with approximately 60% fullness on a heavy 3-1/2" BMF jute webbing with four (4) rows of reinforced stitching and provided with grommets and "S" hooks or 36" long #4 cotton tie line, color Black centered on each pleat and two (2) 3-1/2" apart on all leading and side edges. All four (4) side edges of Rear Traveler Curtains shall have no less than 16" of face fabric turned back. All side edges to the Masking Borders shall have not less than 3" of the face fabric turned back. All bottom hems shall be a full 5" and all Curtains shall have a heavy weight #8 zinc plated jack chain encased in a separate canvas pocket. This chain weight shall be inserted, so that it rides approximately 2" up from bottom hem of Curtain and shall be hand tacked into each seam to prevent bunching, as found necessary. All salvages shall be snipped on approximately 18" centers prior to fabricating and all pleats shall be arranged to conceal vertical seams. 24/4 thread in a color to match fabric shall be used throughout and all sewing shall be completed with a heavy duty industrial straight stitch, power operated machine. Blind stitching of any portion is unacceptable. Sewn to the backside offstage edge of each Curtain Panel shall be a 12" x 12" loose piece of fabric from the same dye lot for future field flame test purposes of each fabric used within construction.

***All Black Curtains shall have black anodized grommets - no exceptions.**

Back Drop's

One (1) Bounce Drop one (1) section finish 22'6" x 7'0"

Fabric: Heavyweight seamless Muslin F.R. color Bleach White as manufactured by Frankel Associates, Bayshore, NY -or equal

One (1) Scrim Drop One (1) section finish 22'6" x 74'0"

Fabric: Heavyweight seamless Sharkstooth scrim F.R. Color Black as manufactured by Frankel Associates, Bayshore, NY - or equal

The above drop shall be sewn flat (no fullness) on a heavy 3-1/2" BMF jute webbing with four (4) rows of reinforced stitching. Grommets shall be placed no more than 12 apart center to center with end grommets 1-1/2" in from each off stage edge. Each grommet shall be provided with #4 glazed cotton tie end no less than 36" long. A grommet shall be positioned at center line of Drop and the center line shall be identified by the use of one color white #4 glazed cotton tie line no less than 36" long. Both side hems shall have no less than 3" of face fabric turned back. Bottom hem shall be a full 5" and shall contain a heavy weight #8 zinc plated jack chain encased in a separate canvas pocket. This chain weight shall be inserted, so that it rides approximately 2" up from the bottom hem of Drop. Sewn to the top back side of bottom hem shall be a tensioning pipe pocket. This pipe pocket shall be constructed using heavy weight F.R. Canvas Duck in color Natural. Pockets shall be made 3" in height and in 10'10" lengths. The 10' length shall be centered to the center line of Drop and shall have a 2" gap between the next 10' sections for ease of connecting the tensioning pipe batten. 24/4 thread in a color to match fabric shall be used throughout and all sewing shall be completed with a heavy duty industrial straight stitch, power operated machining. Blind stitching of any portion is unacceptable. Sewn to the backside offstage edge of each Curtain Panel shall be a 12" x 12" loose piece of fabric from the same dye for future field flame test purposes of each fabric used within construction. Drop's to have a heavyweight reinforcement sewn within each side hem and provided with grommets and tie lines on no more than 18" centers. Tie line color to correspond with color of drop.

FLAMEROOFING

All fabrics to be flame retardant by the emersion method or inherently flame retardant.

All fabrics shall be flame retardant to pass all City and State fire codes and comply with NFPA-701.

Certification of Flameproofing must be permanently stitched into the Curtain hem.

Contractor shall supply to Owner a notarized affidavit signed by manufacturer of Stage Curtains certifying that products furnished comply with the above requirements.

HARDWARE SCHEDULE

CURTAIN TRACK ASSEMBLIES

Grand Traveler

Curtain track Model #5000 shall be of 7 gauge extruded aluminum I-beam construction consisting of a center rib and top, intermediate and bottom flanges. Each curtain carrier Model #5001 shall be spaced on 12" centers and shall be of steel construction to include two (2) nylon-tiered ball-bearing wheels rolling on two (2) separate parallel treads. Each curtain carrier shall consist of a free-moving plated swivel to accommodate curtain nap hook. Live-End Model #5003 and Dead-End Model #5004 pulley blocks shall be equipped with 5" diameter ball-bearing wheels adequately guarded. Nylon cable guides Model #5058 shall be furnished for the purpose of guiding operating cable along the contour of the factory-formed curved track. Operating cable Model #5029 shall be of 3/16" diameter extruded nylon wire-center. 1-1/4" I.D. stiffening pipe or equivalent shall be used to support both straight and curved areas of all suspended curved tracks. The manufacturer shall furnish two (2) end stops Model #5009 for placement at track ends. Model #500 as manufactured by Automatic Devices Company of Allentown, PA - or equal

Motor Control Operator for Grand Traveler

One (1) Model #466VS-1 Draw Curtain Machine complete with Curtain Machine Enclosure, one (1) #482VS Control Station with Keyed Lock-out and two (2) #481 Remote Control Stations. Motor Control to be mounted to a steel base at an elevation of 6'0" A.F.F..

Mid-Stage and Rear Traveler's

Curtain tracks Model #2800 shall be of 14 gauge galvanized steel construction entirely enclosed except for slot in bottom, each half to be in one continuous piece except where splicing clamps are required. Each curtain carrier Model #2851 shall be spaced on 12" centers and shall be of steel construction with two (2) nylon tired ball-bearing wheels held to steel body by rustproof nickel plated rivet, such wheel rolling on two (2) separate parallel threads. Each curtain carrier shall consist of a free-moving plated swivel and sufficient trim chain to accommodate curtain snap hook. Live-End pulley Model #2863 and Dead-End pulleys Model #2864 shall be adjustable and shall be equipped with 5" diameter sleeve-bearing wheels adequately guarded. A rubber bumper shall be attached to each curtain carrier to function as noise reducer. The manufacturer shall furnish two (2) End Stops for placement at track ends and a tension Floor Pulley Model #2866 for increasing cord tension. Stretch-resistant operating cord Model #2828 for hand operation shall have synthetic center and shall be of 3/8" diameter. Model #282 as manufactured by Automatic Devices Company of Allentown, PA -or equal

Scenery, Backdrop's and Side Masking's

Curtain tracks Model #2800 shall be of 14 gauge galvanized steel construction entirely enclosed except for slot in bottom, each half to be in one continuous piece except where splicing clamps are required. Each curtain carrier Model #2801 shall be spaced on 12" centers and shall be of nylon construction supported from a ball-bearing by two (2) polyethylene wheels held to ball-bearing by rustproof nickel plated rivet, such wheel rolling on two (2) separate parallel treads. Each curtain carrier shall consist of a free-moving plated swivel and sufficient trim chain to accommodate curtain snap hook. A rubber washer shall be attached to each curtain carrier to function as noise reducer. The manufacturer shall furnish four (4) End Stops Model #2809 for placement at each track end. This model track system is for walk-along operation only and does not include pulleys or other operating hardware. Model #284 as manufactured by Automatic Devices Company of Allentown, PA -or equal

Masking Borders, Track Backbone's and Spare Battens

1 ½" Nominal Diameter Sch 40 steel pipe with cut threaded ends. Sections to be 21' long. If sections need to be cut down the smallest section would be positioned at the center of the pipe. This piece can be not less than 10'0" long. All pipe sections shall be joined together using 18" long sleeves with 9" extending into each pipe and held by two (2) 3/8" GR 5 hex head bolts and Nylok nuts on each side at the joint. Pipe Batten to be shop painted Black.

All existing suspension beam clamps, cable, chain and connectors shall be removed and discarded. All new suspension points shall consist of new steel formed and adjustable width beam clamps, zinc plated safety suspension chain and zinc plated or galvanized chain connectors and anchor shackles. All products shall be sized accordingly to safety carry applied loads, friction of system and common or uncommon usage of equipment.

- ❖ Suspension points shall not exceed the following:**
- ❖ Traveler Track assemblies, maximum 7'0" centers.**
- ❖ Walk draw Tracks, maximum 5'0" centers.**
- ❖ Pipe battens, maximum 10'0" centers.**

All necessary spanner steel for equipment suspension shall be supplied and installed by the Stage Equipment Contractor.

Bridled suspension points will not be acceptable.

***The bottom end of all suspension chains shall have a minimum of 1' extra length for future adjustment. Free end of chain shall be securely connected to standing end with a connector that can be easily opened for future adjustment.**

*** All threaded fasteners shall be SAE Grade 5 or greater.**

***All turnbuckles shall be forged, proper sized for the load and equipped with jam nuts or through wired.**

INSTALLATION

EQUIPMENT SCHEDULE

Set #01 - Grand Traveler - Dead Hung

Set #02 - #1 Masking Border - Counterweight

Set #03 - #1 Electric - Counterweight

Set #04 - Projection Screen - Dead Hung

Set #05 - #2 Electric - Counterweight

Set #06 - #2 Masking Border - Counterweight

Set #07 - #1 Mid-Stage Traveler - Dead Hung

Set #08 - Scenery Track w/Black Scrim - Dead Hung

Set #09 - Spare Batten - Counterweight

Set #10 - #3 Electric - Counterweight

Set #11 - Scenery Track - Dead Hung

Set #12 - #3 Masking Border - Counterweight

Set #13 - #2 Mid-Stage Traveler - Dead Hung

Set #14 - #4 Electric - Counterweight

Set #15 - Rear Traveler - Dead Hung

Set #16 - Scenery Track - Dead Hung

Set #17 - Scenery Track - Bounce Drop - Dead Hung

Set #18 - Side Masking Curtains - Dead Hung

PROJECTION SCREEN

One (1) Senior Electrol Projection Screen

Size: 20'0" x 20'0" w/additional 4' Top Black Drop

Fabric: Matte White

Control switch to have a Key Locking Cover Plate. Above as manufactured by Da-Lite Screen Company -or equal.

Eight (8) Guide Wire Counterweight sets each to have

One (1) - 12" - 8 line Underhung Head Block

Eight (8) - 8" - 1 Loft Block with Idlers

A/N - 12" - 8 Line Mule Blocks

One (+)- 8" Guide Wire combination Floor Block with Rope Lock

One (1) - 6' Wire Guide, Single Purchase Counterweight Arbor

A/M - 3/4" Multiline II Purchase Line

76' - 1-1/2" SCH 40 Internally Sleeved Pipe Batten 8Finished with primer and one coat enamel paint - Flat Black

Two (2) Yellow Batten End Caps

Eight (8) 36" - 1/4" Proof Coil Trim Chain

A/N - 1/4" 7 x 19 Galvanized Utility Cable

A/N - 1/4" - Screw Pin Forged Anchor Shackle and Safety Tie

A/N - ¼" - H.D. Galvanized Cable Thimble

A/N - ¼" - Copper Oval Sleeves

625lbs. - 4" wide Steel Counterweight - 75% 2" thick 25% 1" thick

**INDEX LIGHT FOR EACH ARBOR AREA. Index lights supported from Dead Hung 1-1/2" SCH
40 Black Pipe Batten**

- ❖ **All curved sets to have one (1) mule block positioned next to each Loft Block to guide all cables with the same arch of the Pipe Batten**
- ❖ **All curved sets to have no less than three (3) cable slack Multi-Sheave Blocks positioned between Mule Block and Head Block**
- ❖ **All Loft Blocks, Mule Blocks, Multi-Sheave Blocks, Mule Blocks etc. must be shimmed accordingly for rake of Rigging Steel.**
- ❖ **All misc. Clips, Anchors and other associated items for a complete installation.**

A. Coordination:

- 1. Take all measurements required at the job site and verify the location of all items to which attachment must be made, or which may cause any restriction in the total operation of the rigging.**
- 2. Provide connecting members needed for proper installation and securing to masonry, joists, wall, structural members or other parts of the construction as may be suited.**

B. Relocation:

- 1. Owner reserves the right to notify this Contractor of any desired change in spacing without causing a change in bid price.**
- 2. Such notification must be made before the installation of any piece of equipment for that set has begun.**
- 3. This Contractor, while carefully following the detailed schedule of sets, may make such minor adjustments as deemed necessary to clear possible obstacles.**
- 4. Notification must be made to the Owner's representative on the job.**
- 5. Relocation of a major nature must be proposed in writing to the Owner.**

CLEAN UP

A. The Contractor shall be responsible for cleanup, including removal of packing materials etc. and the protection surfaces or equipment provided by the other Contractors. All existing Curtain and hardware shall be removed from site and properly disposed of.

INSPECTION AND TESTING

A. Inspection: During the installation of equipment the Rigging Contractor shall arrange for access as necessary for inspection of equipment by the Owner's representatives.

B. Completion Testing: Upon completing the installation of all equipment specified under this section, the Contractor shall notify the Architect, who will schedule an inspection. At the time of the inspection, the Rigging Contractor shall furnish sufficient workers to operate all equipment and to perform such adjustments and test as may be required by the Owner's representative. Any equipment which fails to meet with approval shall be repaired or replaced with suitable equipment and the inspection shall be re-scheduled under the same conditions as previously specified. At the time of these inspections, no other work shall be performed in the auditorium and stage areas. All temporary bracing, scaffolding, etc. shall be withheld until all systems have been thoroughly tested and found to be in first class operating condition in every particular.

C. Instructional Period: After final approval of completed work Contractor shall schedule an instructional day with Owners staff to demonstrate proper working procedures and maintenance of all equipment. Contractor to have necessary lifts on site and full stage rigging crew for this presentation. One full eight (8) hour day shall be set aside for this presentation.

END OF SPECIFICATION

SECTION 11400 - FOOD SERVICE EQUIPMENT

GENERAL REQUIREMENTS

RELATED DOCUMENTS

The general provisions of the Contract, including instructions to bidders, General Conditions, Supplementary Conditions, General Requirements, apply to the work specified in this section.

1. DESCRIPTION

The fabrication requirements attached are a governing part of this specification and shall be consulted for all matters pertaining to the work. When references are made to FSEC, the same shall be construed to designate the Food Service Equipment Contractor.

The FSEC is to provide all items, articles, materials, transportation, operations, and methods listed, mentioned, or scheduled on the drawings and specifications, including all labor, materials, equipment, and incidentals necessary and as required for their completion.

2. QUALITY ASSURANCE

Brands and Names

The manufacturer's catalog designations used in the following specifications are intended to illustrate and represent the standards which will be required by the Owner. Bidders are to list, by item number, manufacturer's name and quantities on itemized proposal form attached to the specifications for approval by the Owner. When not attached, the FSEC shall make up his own itemized list and submit same attached with his bid. NOTE! Base Bid must be on fixtures specified for fair comparison of all bids.

Substitutions

Substitutions by any bidder wishing to supply alternate equipment other than that specified may submit a separate itemized proposal on similar articles of other manufacturers of the same standard performance, capacity, size, durability and appearance but must accompany their alternate proposal with complete descriptive literature of the item quoted.

Owner and Architect reserve the right to accept or reject such proposed substitutions. Bidders recommending such substitutions are cautioned to examine the mechanical plans that may have already been approved and conditions at the building site to determine if such substitutions require changes in mechanical connections already planned or installed.

If the proposed substitutions require such changes, the Bidder shall include the cost of same in his bid and call it to the attention of the Architect and Owner by including a descriptive notation in his bid.

Discrepancies

Where model numbers, quantities, sizes or gauges of material differ on plans and specifications, it shall be understood that the FSEC shall figure the larger quantities, longest size and heavier gauge unless advised otherwise in writing.

Where an accessory or piece of equipment is shown on elevation or plan, it shall be deemed part of the Food Service Contract, even if it is not listed in the Item Specifications.

Where an item is listed in Item Specifications and not shown on plan or elevations, the item shall be deemed part of the Food Service Equipment Contract.

Measurements

All dimensions given on bidding documents are approximate and are as accurate as can be determined at the time. The Equipment Contractor shall check all measurements at the building prior to fabrication of equipment and shall bring any deviation from the

dimensions shown or required by building conditions to the Consultant's attention. All equipment must conform to the finished building conditions. Where obstructions occur, equipment must be neatly scribed fitting to and around same resulting in a sanitary fixture.

Prior to fabrication, the Consultant or the Owner reserves the right to require the Contractor to make reasonable modifications in the routing of the work and relocation of the equipment. This specifically refers to conditions where interference occurs or where materials cannot be installed because of structural or mechanical conditions encountered. The Contractor will receive no additional compensation for such work.

Ordinances

Work and materials shall be in full accord with the latest rules of U.S. Public Health Service, National Board of Fire Underwriters, O.S.H.A., local and state ordinances, State Accident Commissions Safety Ordinances, regulations of the Bureau of Fire Services and with prevailing ordinances.

Ordinances including building codes, gas codes, steam codes, and other codes applying to this contract shall be followed.

All applicable items shall conform to latest Standards Revisions established by the National Sanitation Foundations, (N.S.F.), Ann Arbor, Michigan.

Electric operated and/or heated equipment, fabricated or otherwise shall conform to the latest standards of National Electric Manufacturer's Association, Underwriters Laboratories, Inc., National Electric Code or local standards such as to be acceptable to authorities having jurisdiction.

Standard steam heated equipment shall be manufactured in accordance with A.S.M.E. code requirements and carry the A.S.M.E. stamp.

Burners for gas heated equipment shall be equipped with automatic lighters. Oven burners and other concealed burners

shall have automatic safety pilots and conform to A.G.A. standards. All gas equipment is to be furnished with appliance pressure regulators.

The drawings and specifications shall govern whenever they require longer sizes or higher standards than are required by the ordinances.

The Ordinances shall govern whenever drawings and specifications require something which will violate the ordinances.

No extra change will be paid for furnishing items required by local and state ordinances not specified or shown on drawings. Rulings and interpretations of the enforcing agencies shall be considered as part of the ordinances.

Should any change in the drawings and specifications be required to conform to the above, the Architect shall be notified when bid is submitted.

After entering into contract, all necessary work shall be done to meet above laws, ordinances, Bureau of Fire Services requirements, etc., without additional expense to the Owner.

Samples

Samples of all hardware, locks, feet, brackets, and other materials that may be requested shall be submitted for approval before use.

Scheduling of Work

The work shall be scheduled so there will be no interference with work of other trades and so that it will cause no delay. A time schedule will be worked out for the entire building and this work shall keep pace with the set schedule, working nights, Sundays and holidays, if necessary, to complete the work within the time limit.

3. SUBMITTALS

All submittals to be reviewed, stamped and dated by FSEC prior to sending them to the Contractor, Architect and Consultant. Submittals not bearing the FSEC's stamp will be rejected.

FSEC shall submit required number of drawings, brochures and portfolios of all equipment, apparatus, materials, etc., which are applicable to this contract together with detailed specifications. Each piece of equipment, apparatus, and accessory to be checked by the FSEC to insure compliance with requirements of Architect's drawings and specifications and also brochures or any other item of information to be clearly marked for identification with respect to their application and installation locations. This specification page shall appear on every shop drawing.

Approval and/or review of shop drawings, details, and equipment by the Consultant is for design and concept only and does not relieve the FSEC of responsibility for compliance with design drawings, details and specifications, verification of all dimensions of equipment and building conditions and reasonable adjustments due to deviations.

While the Architect's drawings and specifications propose to be complete in all respects as to layout, type of equipment and materials, they are not intended to serve as detailed sleeve or insert drawings, and preparation of such drawings, required or necessary for this purpose, or to set equipment accurately, are to be the responsibility of the FSEC.

FSEC shall submit drawings of all custom fabricated equipment within thirty (30) days after notification of contract award. Drawings to be accurately laid out and correlated with other contractors work and latest architectural final construction plans. Equipment elevation shop drawings must be on 3/4" scale (3/4" = 1'-0").

Drawings to show detailed construction for each piece of equipment. Before submitting detail drawings for review, they must be checked by the FSEC with the specifications and shall show exactly how item will be fabricated. Construction of equipment shall not deviate from approved shop drawings without

written approval from the Architect and/or Food Service Consultant.

FSEC shall submit rough-in drawings for approval at a scale of 1/4" = 1'-0", locating accurately all utility connections for each item of equipment requiring the same. Rough-in plan to be drawn up using final architectural building drawings. NOTE! All rough-in connections to conform with normal acceptable standards. Rough-in requirements for present or future food service equipment shall be included on all drawings.

FSEC 1/4" scale rough-in drawings are to be dimensioned from ends of finished walls. Shop drawings with dimensions from centerline of columns will not be accepted, unless approval has been given by Architect, Consultant or the General Contractor.

Drawings showing all dimensions of bases or platforms and depressions to be submitted on a scale of 1/4" = 1'-0".

Rough in connection notes are not to be listed under numbered rough in schedule, except for general purpose outlets or where drawing space is limited.

Equipment rough in plans are to be furnished complete with layout plan and item schedule similar to food service consultants drawings. Plumbing, electrical, ventilation & depression plan, and base detail when required.

Plumbing and electrical plans are to be on separate sheets when drawings are prepared at 1/4" scale. NOTE! Food Service Consultants documents are not to be traced.

Manufacturers to strictly adhere to approved and reviewed drawings, except where field conditions require changes and in that event the Architect must be notified in writing.

Manufacturing of any equipment fitting between walls or between columns and walls to be withheld until actual field dimensions are set and approved by the General Contractor. All other items which do not require field dimensions are to be manufactured upon receipt of reviewed shop drawings.

Upon completion of contract, the contractor is to deliver to the Owner two (2) complete sets of final working drawings and two (2) portfolios of purchased equipment bound in a binder. A time schedule will be worked out for the entire building and this work shall keep pace with set schedule, working nights, Sundays, and holidays, if necessary, to complete the work within the time limit.

4. JOB CONDITIONS

Job Meetings

It shall be the responsibility of the FSEC to have a qualified representative at all monthly or special job meetings to help the Architect and other contractors on the job to correlate work or answer questions so that the job can progress without any obstructions.

Examination of Premises

FSEC to check the Architectural Contract Plans and visit the premises at a suitable time to determine maximum size of equipment he can safely get into the building in one piece. Field joints to be held to a minimum. Should door openings not be large enough, FSEC shall provide field joints in equipment as required and re-weld inside of building.

Utilities Services

Rough-in cold water, hot water, waste and vent piping, duct work and electrical wiring to be installed by Plumbing and Electrical Trades. Such items are to be brought away from surface of floors, walls and/or ceilings by these Trades and capped prior to installation of food service equipment.

5. GUARANTEE

FSEC is to furnish one (1) year written guarantee for equipment starting from date of acceptance by the Owner or the Owner's duly authorized representative. Guarantee to be in accordance with Architect's General Conditions.

Refrigeration - Self-contained

All self-contained refrigeration compressors for milk coolers, ice cream cabinets, cold food counters, reach in refrigerators or freezers, etc., shall be furnished with a five (5) year compressor warranty and one (1) year refrigeration service starting from date of final acceptance.

6. PRODUCTS

Fabrication Requirements - See following page for details

All food service equipment is to be constructed in strict compliance with the latest standards of the National Sanitation Foundation and to meet all requirements of the local and State Health Regulations. All equipment to bear the N.S.F. seal of approval.

Welding

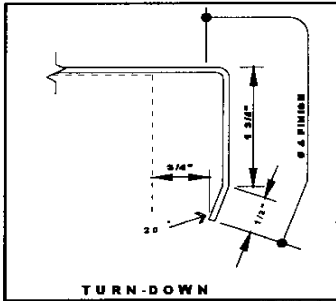
The words "weld", "welded", or "welding" as used in the item specifications, mean a metal joint continuously welded then all exposed parts ground smooth and polished to match adjoining surfaces.

All welding to be done in a thorough manner with welding rod of same composition as sheets or parts welded. Welds to be strong, ductile with excess metal and discoloration ground off and joint finished smooth to match adjoining surfaces.

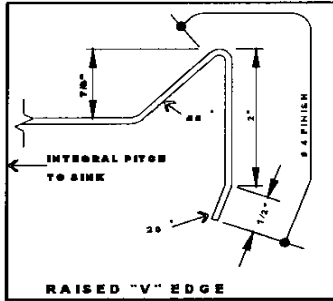
Welds to be free of imperfections such as pits, runs, splatters, cracks, warping or discoloration. All welded joints to be homogeneous with parent metal itself. All fabricated equipment items where metal to metal butt joints occur to be joined and properly welded then ground and polished smooth.

Grinding, Polishing and Finishing

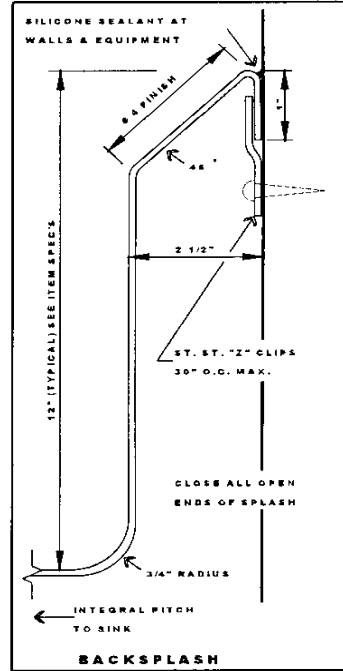
All exposed welded joints to be ground flush with adjoining material and neatly finished to harmonies therewith.



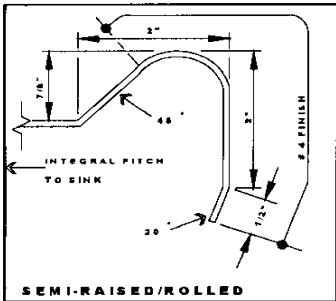
TYPE "A" EDGE



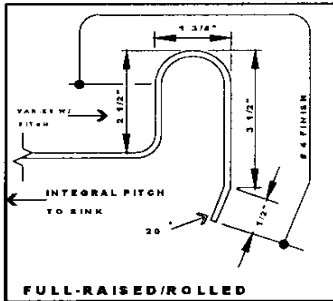
TYPE "B" EDGE



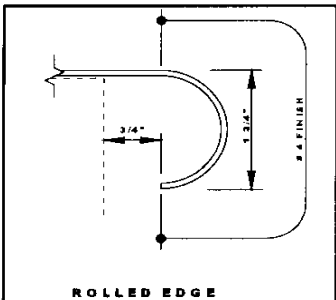
TYPE "G" EDGE



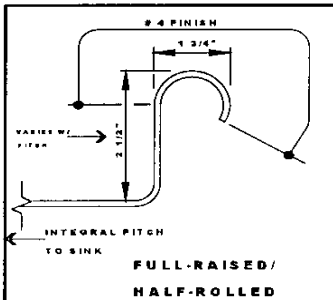
TYPE "C" EDGE



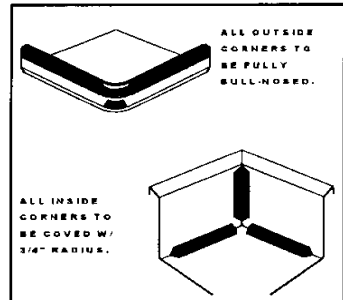
TYPE "D" EDGE



TYPE "E" EDGE



TYPE "F" EDGE



CORNERS

STANDARD EDGE DETAILS

NO SCALE

Whenever material has been depressed or sunken in by welding operations, such depressions shall be suitably hammered and peened flush with adjoining surfaces to then be polished and/or buffed to match adjoining surfaces to a degree consistent with good workmanship. Care shall be exercised in all grinding operations to avoid excessive heating of metal and metal discoloration. Abrasive wheels and belts used in grinding to be iron free and not having been used on carbon steel. In all cases, the grain or rough finish to be removed by successively finer polishing operations to be consistent with reasonable care and good workmanship. Final polishing operations to be uniform and smooth.

Where break band occurs, free of open texture or orange peel appearance, all such marks shall be removed by grinding, polishing and finishing. Wherever sheared edges occur, they shall be free from burrs, projections and fins to obviate all danger from cutting or laceration when hand is drawn over such sheared edges.

Where miters or bullnosed corner, they will be neatly ground to uniform condition and in no case will overlapping materials be acceptable.

Equipment quality finish consistent with high grade of manufacturing practiced in industry. All exposed surfaces to be commercial mill finishes known as #4 satin finish for corrosion resistant steel. All exposed edges to be furnished with a #7 mirror finish, unless otherwise noted in item specifications.

All cabinets, doors and shelves where exposed to be interpreted as meaning inside surface exposed to view when swinging door or sliding doors are opened. Unless otherwise specified, underside of shelves need not be satin finish.

Doors - Hinged

To be full height of door opening. Each door shall not be over 30" wide for high cabinets and 24" wide for low cabinets. Doors to be double pan construction flush type and braced and thoroughly sound deadened made of 18 ga. st. st. Inner and outer pans to be sealed with 3/4" long tack welds spaces

approximately 6" apart. Balance of the space to be completely sealed between tack welds with silver solder or N.S.F. approved hard solder (Silicone not approved).

All welds ground and polished smooth. All bracings to be on proper centers to fit door size.

Doors to be mounted on heavy semi concealed nickel bronze olive knuckle hinges fastened to inside ledge of door and cabinet so that only pin will be exposed to heavy st. st. piano hinges. Provide each door with Component Hardware #M22-2420.

Doors - Sliding

Make same as specified for hinged doors, except they shall operate on Component Hardware #B58-5513 and #B58-5523 nylon tire wheels running on one (1) piece drawn aluminum overhead Component Hardware #B57 tracks. Bottom shall be guided by st. st. Component Hardware #B56-1096 guide pins at center of door openings. Provide locks where called for in item specifications. Provide flush type polished handles. (Heated cabinets with sliding doors to use Component Hardware #B58-5511 and #B58-5523 st. st. ball bearing wheels).

"High" type fixtures to be fitted with two (2) sets of doors in height, each set opening into half height of fixture.

"Low" type fixtures to be fitted with (1) set of full height doors. No door length to exceed 36".

Sinks

All sinks to be made of 14 ga. st. st. unless otherwise specified. All corners shall be coved at least 5/8" radius, with all corners and joints welded, ground and polished smooth to a #4 satin finish. Sinks, unless otherwise specified, shall not be less than 14" deep. The use of solder or separate filler pieces to obtain coved corners will not be acceptable. All sink bottoms are to be integrally pitched to insure complete drainage of sink to waste opening. Edges at table height to have exposed edges formed to match adjoining table. Edges adjacent to table to be welded to table with all welds ground and polished smooth.

Unless otherwise specified, all sinks to be provided with backsplash 12" high x 2-1/2" wide to allow for pipe space in rear. Flange over at ends, with top edge turned back 2-1/2" at 45 degree angle and down 1". Provide openings for combination swinging type water faucet for each compartment.

In sinks of two (2) or more compartments, furnish between each sink compartment a 3/4" wide full height portion integrally welded to sinks at front, back and bottom maintaining smooth 5/8" radius coved corners as described in preceding paragraph.

Front of multiple compartment sinks shall consist of st. st. apron same gauge as sinks having length same as overall length of sink bowls and same depth as bowls. This apron shall be "L" shaped and welded to or part of the top rim.

Design of apron front to be such that sinks shall have an appearance of a continuous one (1) piece front face of all overlapping joints and open spaces between sink compartments.

Each compartment to be furnished with Component Hardware rotary handle type drain, connected rear overflow, 6" tailpiece and faucet of make and model number as called for in Item Specifications. Also each sink to be furnished with 14 ga. st. st. waste handle bracket welded to underside of sink.

Tables & Tops - Height

All working tops to be 34" high from floor, unless otherwise stated under specific item.

Metal Tops

Unless otherwise specified in Item Specifications, metal tops to be 14 ga. st. st. reinforced and braced on underside by framework consisting of 1-1/2" x 1-1/2" x 3/16" angles and 1" x 3" x 3/16" channels, galvanized where concealed and st. st. where exposed.

Framework angles to run full length and width and with angle crossbrace on not over 2'-6" centers. Channel reinforcing to run full length of tops down center of top. All tops with sinks shall be integrally pitched towards same.

All joints of framework to be welded with weld re-metalized. Tops to be bolted to framework in a concealed manner with st. st. bolts similar to AN-COR-LOX cup nuts. All metal tops to appear as one piece with all field and shop joints reinforced and welded, ground smooth, and polished, also to be made of largest piece obtainable.

No short pieces of metal will be acceptable. St. st. tops to have a #4 satin finish and all tops of this metal to be full 1/2" cove at re-entrant corners, also where turned up in rear or in front, such as dishtables. Solder filled corners will not be acceptable.

Metal edges to be made as described below and/or shown on detail drawings. Top to have all edges turned down 1-3/4" then back 1/2" at a 70 degree angle all around with all corners welded, ground, and polished smooth with no cracks or openings showing. All exterior corners to be well rounded bullnosed in 1-1/4" radius.

Dishtables & Pot Washing Tables

All free edges to be turned up 2-3/4" then rolled to 1-5/8" x 180 degrees and furnished with apron edge front, as per Edge Detail Sheet. All exposed and exterior corners to be coved at 5/8" radius with all joints welded, ground, and polished smooth.

Where tables abut a wall or other tall equipment, extend back and/or ends up 12" then back 2-1/2" at 45 degrees and down 1" parallel to wall. Provide with end filler pieces and all welded surfaces ground and polished smooth.

The underside of Dish and Pot Washing tables to be reinforced with 1-1/2" x 1-1/2" x 3/16" st. st. angles and 1" x 3" st. st. channels. Angles to run full length of tops at both front and rear of tops with crossbrace front to back on 2'-6"

centers. Channel bracing to run down center, full length of tops. Tops shall be integrally pitched to dishwasher and sinks.

Fastening Tops to Washers and Other Equipment

Where tops are shown adjacent to dish or glass washer, etc., ends are to be turned down 1-1/2" into fixture and bolted tightly to it with approved gaskets between body and turned down edges. Backsplashes to have edge against fixture turned out 1-1/2" and tightly fitted to it. Free edges to be neatly fitted to fixture corners to prevent water from dripping on floor. All tops to have integral pitch to drain towards dishwasher.

Dish & Pot Table Drainage

During installation of dish tables and dishwasher, FSEC shall water test all counter tops to make sure of proper pitch before final plumbing and electrical connections are made. All water on counter tops shall drain with no standing puddles allowed. Should the FSEC fail to pitch tables properly, he shall be responsible for disconnecting plumbing and electrical connections and re-adjust tables to insure proper pitch. FSEC shall also be responsible for re-connecting all service lines after tables have been re-aligned.

Pipe Stands

All equipment requiring pipe legs or stands to be provided with sufficient supports to carry superimposed load of 100 lbs. per sq. ft. Top to be fabricated of 16 ga. st. st. Tubing to be Component Hardware #A46-5288 complete leg assembly Model Number 2236HB, 1-5/8" O.D., with st. st. hex head bullet shaped feet as previously specified. All pipe stands to be braced with crossrails, Component Hardware #A46-4288, 1-5/8" st. st. pipe welded to legs approximately 10" above floor or braced by lower shelf as specified hereinafter. Provide Component Hardware #A18-0206 st. st. gussets as previously specified, welded to framework on underside of top.

In place of gussets, st. st. legs may be welded to st. st. channels 5" long which shall fit into channel crossbracing. Flange of both channels to be machine bolted

together. Holes for bolts to be slotted for adjustment. Provide legs on not over 5'-0" centers and additional if required or requested.

All pipe legs or vertical members to be set back from table top on ends and on front and back sufficient distance to offset any interference with workers, columns, walls or other items. Where tops are welded to sinks, omit pipe legs supporting top at sink location.

Shelves Under Tables

Under tops which are mounted on pipe legs or stands, shelves under table to be fabricated of 16 ga. st. st. with all edges flanged down 1-1/2" or as otherwise noted in the Item Specifications. Shelves to fit tightly around contour of legs and welded from underside. Shelves to be made up from long lengths with all joints welded, ground, and polished smooth.

Short lengths will not be permitted. Reinforced, as required, to support load of 50 lbs. per sq. ft. All sharp edges, burrs, and corners to be ground smooth and removed and then be slightly rounded. All shelves in cabinet bases are to be angle reinforced.

Cabinet Bases

Exterior cabinet bases to be constructed of 18 ga. st. st. with front face, exposed ends, rear, and corners integrally exposed with all welds ground and polished smooth to form a one piece construction appearance.

St. st. exterior to be mounted over a 1-1/2" x 1-1/2" x 1/8" all welded galvanized iron angle frame. Where st. st. exterior meets angle framework at drawer, door or shelf openings, exterior shall be turned in 1-1/2" over angle framework inside of openings. All drawers and doors to be flush with cabinet face.

All cabinet base bottoms to be enclosed with 18 ga. galvanized iron panels. Interior shelves of cabinet base to be constructed

of 16 ga. st. st. and be reinforced with 1-1/2" x 1-1/2" x 1/8" angles. Rear and ends of shelves to be turned up 2" with all interior corners coved to 5/8" radius.

Drawers

Drawer front to be 3/4" thick double pan construction with 16 ga. st. st. telescoping rear panels. Joints to be sealed same as specified for double pan hinged doors. Drawer front fitted with recessed st. st. grip handle, Component Hardware #CAGP63-1012. Drawer to be furnished with 18 ga. galvanized iron bottom with openings in front to accommodate drawer. Provide with cylinder type lock when specified under Item Specifications or shown on elevation details.

Opening in front to have edges turned in to fit drawer front which will be flush when drawer is closed. Bottom of enclosure to be open with edges turned in 1" on all sides.

All corners on enclosure to be continuously welded, then polished and ground smooth. Exposed rivets or screws will not be acceptable. Component Hardware #S81-2020 Drawer insert to consist of removable die-stamped 18 ga. st. st. pan approximately 20" square x 5" deep. Top edges of drawer insert to be flanged out on all sides, not less than 1/2" for resting on drawer extension glides. All sharp edges and burrs to be removed from drawer flange.

Housing supports to be made of 12 ga. st. st. formed into angles welded to underside of metal tops or screwed to underside of wood tops and to extend full width of top with rear enclosure, where exposed. All welded items to be ground and polished smooth. Screws for wood tops to be st. st. countersunk. Drawer housings to slide on 14 ga. st. st. telescoping channels with st. st. rollers, Component Hardware #S52 series extension roller slides.

Drawers

This mechanism must be designed so that drawer will not tilt when fully opened. Provide with stop mechanism to prevent

pulling the housing from slides but with suitable extension so it may be removed for cleaning.

Tier of Drawers

To be two (2) or three (3) in number of same size as specified for above and entirely enclosed with 18 ga. st. st. same as specified under cabinet bases with openings for drawers with all joints flush welded, grounded, and polished smooth.

Single drawers under table tops to be one inch (1") back of edge of fixture. All draws shall have front flush with cabinet body.

Fasteners

Exposed screw or bolt heads will not be permitted on fixtures. Rivets, if specified, shall be countersunk flush. Rivets to be same material as they join. Butt joints made by riveting straps under seams and then filling with solder or caulking will not be permitted or accepted.

Name Plates

All buy-out equipment shall be furnished with a permanently affixed metal name plate listing manufacturer's name, model number, voltage, cycle, phase, horsepower, etc., in an easily readable location. Dealers, installers, fabricators or service agencies name plate stickers shall not be fastened to any item without the approval of the Architect or Consultant.

7. MATERIALS AND WORKMANSHIP

Unless otherwise specified, all material shall be new and of best quality, perfect, and without flaws and shall be delivered upon completion in an undamaged condition.

Stainless Steel

Shall be type 304 having a standard analysis of 18% chrome and 8% nickel. St. st. to be as manufactured by Republic Steel Company, "Endure", Allegheny Metal Company, Crucible Steel

Company, "Rezistal" or approved equal. Gauge to be specified under Item Specifications and furnished with #4 satin finish, unless otherwise specified.

Galvanized Iron

Shall be American Rolling Mills "Armco", Republic Steel, Inland Steel, "Tocan" or approved equal.

Pipe legs shall be Standard-Keil #2235HB, 16 ga. st. st. (0.65" thick), tubing furnished with st. st. adjustable foot and Standard-Keil #481-58 with enclosed gusset welded to underside of table top reinforcing channel.

Tubing to be seamless drawn, ground, and polished smooth to a #4 satin finish. Bottom of legs to be swedged for close fit to adjustable foot. Where space permits furnish 1-1/4" dia. st. st. crossrails welded to leg uprights. All welds shall have radius corners and be ground and polished smooth to a #4 satin finish.

Handles, Hinges & Door Fasteners

All hardware and other fittings used in connection with the equipment to be cast nickel bronze or st. st. Handles to be welded or bolted to the equipment in a concealed manner. Bolts to be st. st. and hinges to be recessed in door with st. st. Component Hardware #M75-1002 lift-off, N.S.F. approved hinge. Hinges to be fastened in place with st. st. recessed rivets or welded in place with weld ground and polished smooth.

Sliding doors to be depressed type and furnished with Component Hardware Model #P62-1010 handles. Hinges to be olive knuckle, semi concealed type of nickel bronze or st. st. piano type as described under the specific item.

Painting and Coating

All metal that is not st. st. is to be painted with two (2) coats of an approved rust-proof paint such as Rustoleum or other approved equal of highest quality gray enamel.

Electric Receptacles

All 120V-1 phase duplex receptacles in cabinet bases to be Pass & Seymour Model #6307 and receptacles over 120 volt shall be Hubbel receptacles sized as per the rough-in drawings.

All receptacles are to be grounded type being both dust and moisture proof. Furnish outlets with st. st. face plates and neoprene mats. In cabinet bases, all receptacles are to be mounted in Chase #R-1 all coved corners st. st. recessed type enclosure mounted to cabinet base. Component Hardware #R73 - 1210 receptacles shall be pre-wired by FSEC to junction box in bottom of base cabinet left ready for final connection by Electrical Trades. All wiring between receptacles and junction box to be run in rigid conduit.

All counter top receptacles to be Component Hardware #R58 chrome plated type as specified in Item Specifications. Counter top receptacles to be pre-wired to junction box in rigid conduit same as previously specified. All wiring to be in strict compliance with latest standards of the National Sanitation Foundation and Board of Health Requirements.

Quietness of operation of all food service equipment is a requirement and the FSEC shall be required to remove or repair any equipment producing objectionable noises.

Shop Drawing Review

All submittals to be reviewed, stamped and dated by FSEC prior to sending them to the Contractor, Architect and Consultant. Submittals not bearing the FSEC's stamp will be rejected.

By reviewing and submitting shop drawings and samples, the FSEC thereby represents that he has verified all construction criteria, materials, catalog numbers and similar data and that he has checked and coordinated each shop drawing and sample with the requirements of the work and of the contract documents.

If shop drawings and/or samples are submitted without proper identification and in the Consultant's opinion it is evident that they have not been properly reviewed by the FSEC or if shop

drawings are submitted in an unprofessional manner, they will be returned to the FSEC for identification and/or review and re-submission. In such an event, it will be held that the FSEC has not complied with the above requirements for reviewing and identifying shop drawings and samples. The FSEC shall bear the risk of all delays in work or in work of any other trade, the same as if no shop drawing or samples had been submitted. The above requirements will be strictly enforced.

The Consultant will review and process only two (2) submissions of each shop drawing and/or sample. Shop drawings and samples returned because the FSEC has not complied with the above requirements shall be counted as the first submission. If more than two (2) submissions are required, the FSEC shall pay the Consultant's cost for reviewing and processing the third and subsequent submissions. (Which will be so identified by the Consultant when returned to the FSEC)

The Consultant's cost shall be computed at two and one half (2-1/2) times payroll plus reproduction and mailing expense.

Buy-out Booklets

By submitting prepared Buy-out Booklets, the FSEC thereby represents that he has determined and verified voltage and phase requirements and that he has checked and coordinated each item with shop drawings and contract documents.

Each item in the Buy-out booklet shall have a typed title page, complete with descriptive details and included accessories.

TITLE PAGE TO BE AS PER THE FOLLOWING PAGE.

8. EXECUTION

Inspections

The Owner, Architect, and/or their duly authorized representative shall have free access to the contractor's shop or shops during the construction of this equipment for the purpose of making inspections to see that the plans and specifications and detailed drawings are being adhered to carefully.

Contractor shall correct any errors found during the inspections, to the extent within the scope of the plans, specifications and detailed drawings.

Upon being notified of job completion, it shall be the responsibility of the Food Service Consultant to inspect the job site and prepare an itemized Punch List.

If items are found not to be complete per approved drawings, General Requirements and the Consultant's Item Specifications, upon receiving the Punch List, the FSEC shall correct all items on the list within thirty (30) days.

It shall be the responsibility of the Plumbing and Electrical Trades to check all rough-in connections installed by their personnel to make sure that they agree with the dimensioned

SAMPLE TITLE PAGE

Food Service Equipment Contractor _____

ITEM # _____ QUANTITY _____

Description: _____

Electrical

Motor H.P. _____ Volts _____ Phase _____ Cycle _____

Heating Element: KW _____ Volts _____ Phase _____

Lighting and/or Fan Circuit: _____ Volts _____ Phase _____

Refrigeration specs.

Plumbing

Cold Water _____ 140 degree water _____ 180 degree water _____

Steam in _____ Steam Pressure _____ Pounds _____

Steam Return _____ Connected Waste _____ Floor Waste _____

Gas

Kind _____ Size _____ B.T.U. _____

Spec. Gravity _____ Pressure _____

Direction of Feed for Dishwasher

Right to Left, Left to Right, Straight Thru, Corner type, Clockwise, and Counter Clockwise (circle unit required).

Door Hinged

Right Side, Left side (Circle unit required).

FSEC shall verify with the Electrical Trades the voltage and phase required for each piece of equipment that is to be supplied. Should the FSEC fail to verify the voltage characteristics it shall be his responsibility for changing the equipment on the job site to fit the voltage on the site.

When deemed necessary by the Architect or the Consultant, the FSEC shall meet on the job site with the Electrical and Plumbing Trades to determine the best way of offsetting rough-in connections that interfere with beams, foundations or other possible field obstructions.

The FSEC shall check all base sizes, after installation by the Architectural Trades, to make sure that they will fit his equipment. Should base be installed incorrectly, the FSEC shall advise the Architectural Trades in writing at once to have base corrected as required.

The FSEC shall check all walls where equipment abuts or fits between, after installation by the Architectural Trades, to make sure that the equipment will fit correctly.

9. PREPARATION

All gas equipment is to be furnished with appliance pressure regulators. Electrical requirements shall be in accordance with rough-in plan and verified on the job site.

Should the electrical requirements and the item specifications not agree with the rough-in plan or electrical requirements on the job site, it shall be the responsibility of the FSEC to send a written report to the Architect and Consultant advising them of the discrepancy. Should the FSEC fail to verify voltages on the job site, it shall be his full responsibility to make all necessary changes on his equipment at no cost to the Owner.

All measurements shall be verified at the building site and full responsibility for their correctness must be assumed by the Contractor.

No extra charge or compensation will be allowed on account of difference between actual dimensions and the measurements indicated on the drawings. All or any differences which may be found shall be submitted to the Architect for consideration before proceeding with the work.

10. INSTALLATION

Food Service Equipment

FSEC shall be responsible for assembly and erection of all equipment included herein and in required location as shown on drawings, leaving same with outlets for other contractors to make final steam, plumbing, electrical and ventilation connections.

FSEC is to provide a competent foreman to supervise the erection and placing of equipment and to advise other Trades in regards to connections at time of installation. Where applicable, he shall deliver to other Trades all plumbing, steam fittings, and electrical parts included with his equipment for their proper installation.

FSEC to have qualified personnel on job site while the Plumbing, Electrical, and H.V.A.C. Trades are making final connections between rough-in and equipment. Where necessary, FSEC is to move equipment to allow these Trades to make final connections.

Should the FSEC fail to assist the other Trades and final location of equipment is incorrect, it shall be the responsibility of the FSEC to move the equipment to correct location and assume the cost of disconnecting and reconnecting the service connections.

FSEC is responsible for cutting all holes thru tops, backsplashes, shelves and cabinets so the other Trades can make final connections to outlets in fixtures from his rough-in.

Should these Trades fail to check rough-in before slab is poured, they shall assume all responsibility for making necessary changes and paying all the costs involved. Should the dimensioned rough-in drawings be incorrect, it shall be the

responsibility of the FSEC to assume costs involved for revising all connections involved in the dimensioned error. FSEC shall verify with the Electrical Trades the voltage and phase required for each piece of equipment that is to be supplied. Should the FSEC fail to verify the voltage characteristics it shall be his responsibility for changing the equipment on the job site to fit the voltage on the site.

When deemed necessary by the Architect or the Consultant, the FSEC shall meet on the job site with the Electrical and Plumbing Trades to determine the best way of offsetting rough-in connections that interfere with beams, foundations or other possible field obstructions.

Rough-in Inspections

It shall be the responsibility of the Plumbing and Electrical Trades to check all rough-in connections installed by their personnel to make sure that they agree with the dimensioned rough-in drawings as prepared by the FSEC.

Should these Trades fail to check rough-in before slab is poured, they shall assume all responsibility for making necessary changes and paying all the costs involved. Should the dimensioned rough-in drawings be incorrect, it shall be the responsibility of the FSEC to assume costs involved for revising all connections involved in the dimensioned error.

FSEC to have qualified personnel on job site while the Plumbing, Electrical, and H.V.A.C. Trades are making final connections between rough-in and equipment. Where necessary, FSEC is to move equipment to allow these Trades to make final connections. Should the FSEC fail to assist the other Trades and final location of equipment is incorrect, it shall be the responsibility of the FSEC to move the equipment to correct location and assume the cost of disconnecting and reconnecting the service connections.

FSEC is responsible for cutting all holes thru tops, backsplashes, shelves and cabinets so the other Trades can make final connections to outlets in fixtures from his rough-in.

Should specified equipment arrive at the job site with incorrect finish, model number, damaged, etc. A replacement item must be ordered immediately. Should the project schedule require the incorrect unit for opening operation, existing unit is to be left in operation until replacement is available, at no cost to the owner. It shall be the responsibility of the FSEC to assume all costs for re-stocking, re-selling, etc., of the incorrect items that have been used by the Owner.

All holes or openings must be cut in a workmanlike manner, with all edges ground and polished smooth and free of sharp edges. Opening in rear of base cabinet must not be larger than 1" bigger than pipe extending thru cabinet. Oversize cutouts with rough edges will not be approved.

All faucets and waste assemblies to be furnished by the FSEC and to be turned over to the Plumbing Trades for their installation. NOTE! Faucets and waste assemblies to be tagged properly to insure proper installation of these items on the correct fixtures.

Ventilating Trades

This Trade will furnish all ductwork to openings on top hoods, furnished by the FSEC.

Electrical and Plumbing Trades

These Trades shall furnish all final electrical and plumbing connections between fixtures and rough-in outlets in walls or floors.

Internal connections on booster heater and disposer to be furnished by the Plumbing and Electrical Trades and proper installation of these above named items. FSEC shall also include detailed drawings showing proper location of all accessories. General Building Contractor shall furnish all masonry platforms, tile bases and floor depressions.

Trimming & Sealing Equipment

Space between units to walls, ceilings, and floors and adjoining units not portable and with enclosed bodies, shall be completely sealed against entrance of food particles or vermin by means of st. st. trim strips, welding or commercial joint material suitable to the nature of the equipment. Sealer when not exposed to extreme heat shall be silicone construction sealant in the appropriate color. Ends of hollow sections to be closed. Enclosed fixtures without legs mounted on masonry bases or floor shall be sealed watertight to base of floor.

All equipment setting on masonry bases will be constructed to overhang to provide toe spaces, however, metal framework and/or housings are to be turned under a sufficient distance to overlap masonry base and eliminate openings at these points. Bases to be sealed with Dow Corning sealant #786 or approved G.E. sealant.

Caulking at all backsplash areas in pot washing, dishwashing and preparation sinks and counters shall not have any recessed or convex areas which will allow for debris and water to sit on caulk.

Upright penetrations in backsplash and counter tops to have gap sealed with silicone.

11. ADJUST & CLEAN

FSEC shall adjust and lubricate all moving parts for smooth quiet operation. The FSEC shall touch up scratches, marred or abraded surfaces to restore equipment to the original condition.

The FSEC shall also remove all crating and packing material from the job site and shall also remove fingerprints and leave equipment and adjacent equipment or surfaces clean.

The FSEC shall be responsible for missing items unless he can produce signed receipts from the Owner's personnel that the items were received and an accounted for. Owner cannot be responsible for items that were dropped off at the job site and were not signed for by the Owner's personnel or representatives.

12. DEMONSTRATION

The FSEC shall arrange a demonstration date with the Owner and at the same time check out all loose items with the Food Service Manager. Copy of signed receipts shall be mailed to E. F. WHITNEY, INC., showing all loose items, such as st. st. pans, mixer attachments, etc.

13. GUARANTEE

All items furnished by the Food Service Equipment Contractor as part of this Contract, shall be guaranteed against defects in workmanship and material for a period of one (1) year.

Manufacturers of standard items of equipment as supplied under this Contract are to provide a one (1) year warranty on parts and labor.

In addition, connected pieces of equipment requiring calibration are to be so calibrated by a qualified person as part of this Contract.

Commencement date for warranty purposes is as follows:

- a. Connected equipment: - When equipment is started up for intended use."
- b. Non-connected equipment: - At date of Owner acceptance."

14. PROTECTION OF EQUIPMENT

Fabricated fixtures such as custom st. st. & plastic laminate items are to have fiberboard or plywood taped to tops and exposed body panels. Protective covering is to be left in place until all trades are completed.

Manufactured equipment is to have fiberboard or plywood tape as required per equipment shape and installation access requirements.

Prohibited use of equipment; tool and material storage area,
workbench, scaffold, stacking area, etc.

15. APPROVED CUSTOM ST. ST. FABRICATORS

The following is a list of fabricators who have demonstrated the ability to provide quality equipment.

Florida Stainless
Oviedo, FL

American Stainless Steel Corp
Englewood, CO.

PRS
Warren, MI

Great Lakes Stainless
Traverse City, MI

MCM Fixture Co.
Hazel Park, MI

Midwest Stainless Fabricating Co.
Livonia, MI

Nationwide Fabrication, Inc.
Northglenn, CO

Stainless Fixtures Inc.
Pomona, CA

Use of a food service equipment fabricator other than those listed must be specifically approved in writing by the consultant prior to submission of food service equipment bids on this project.

ITEM #1 PORTABLE CASHIERS STAND

One (1) ATLAS Model # BLM-1 L MO Cashier Stand furnished per manufacturers standards. See plan for tray slide location.

Include the following Accessories:

- One (1) 34" High working height
- One (1) Punch out in top with grommet sized to accommodate cord and plug.
- One (1) Lot laminate panels (verify color at later date) One (1) Solid bottom shelf
- One (1) St. St. locking drawer
- One (1) TS-1 12" wide st. st. tray slide mounted at 29" high A.F.F.
- One (1) Convenience Outlet under top for cash register
- One (1) Locking device to connect counters - (Future use)
- One (1) Lot casters, two (2) with locks

Submit shop drawing for review and approval. See rough in plan for cord and plug requirements

ITEM #2 POS REGISTER

One (1) Unit furnished and installed by owner. "NIC"

ITEM #3 8 CASE MILK COOLER

One (1) BEVERAGE AIR model SMF-34S 8 case forced air milk cooler. Unit to be provided per manufacturers standards. Include the following standard and optional accessories:

- One (1) Lot locking casters
- One (1) Lid lock
- One (1) UL cord and plug
- One (1) Thermometer
- One (1) Year Refrigeration Service Policy
- Five (5) Year Compressor warranty

ITEM #4 FLAT TOP COUNTER

QTY: One (1)

MFR./MODEL: ATLAS BLU-1 MO

SPECIFICATIONS: Provide one mobile serving unit with flat top. The top of the unit shall be constructed of 16 gauge type 304 stainless steel. The frame shall be constructed of hi-tensile square aluminum tubing.

ACCESSORIES:

One (1) 30" high working height
One (1) Laminate Panel (color to be determined by architect)
One (1) TS-1, 12" folding tray slide mounted at 29" A.F.F.
One (1) Lot Under shelves, full middle and bottom, stainless steel
One (1) Hinged door with lock
One (1) Lot heavy duty casters ,two with wheel locks
One (1) SH-1 8" wide stainless steel work shelf
One (1) Locking device to connect counters

DETAILS: Unit to be 24" L x 30.5 D x 30" H.

Submit shop drawing for approval

ITEM #5 COLD FOOD COUNTER

One (1) ATLAS BLC-4 RM MO 63.5" long self-serve four pan cold food counter. The cold pan shall be constructed of 18 gauge type 304 stainless steel with a solid vinyl gasket. The top of the unit shall be constructed of 16 gauge type 304 stainless steel. Unit shall be provided with a fully self-contained condensing unit. The frame shall be constructed of hi-tensile square aluminum tubing. Unit shall be provided with enclosed base and 5" diameter casters.

ACCESSORIES:

One (1) 30" high modified elementary height
One (1) Lot Sliding doors with locks

One (1) Lot casters, two (2) with locks
One (1) 12" St. St. Tray Slide mounted at 29" A.F.F.
One (1) Lot Cam locking devices
One (1) Laminate Panel (color to be determined by architect)
One (1) BCL Self-serve single side protecto with fluorescent lights & side panels
One (1) Bottom shelf
One (1) Drain with shut off valve
One (1) UL Cord and plug for lights & compressor.
One (1) Year refrigeration Service
Five (5) Year compressor warranty

Submit shop drawing for review and approval.

ITEM #6 HOT FOOD COUNTER

QTY: One (1)

MFR: ATLAS BLH-4-OT MO

SPECIFICATIONS: Provide one mobile serving unit with four (4) 12" x 20" x 6" hot food wells. Each well shall be provided with an 850 watt heating element. The top of the unit shall be constructed of 16 gauge type 304 stainless steel. The frame shall be constructed of hi-tensile square aluminum tubing.

ACCESSORIES:

One (1) 34" working height
One (1) Lot sliding doors with locks
One (1) TS-4, 12" Folding Tray Slide mounted at 29" A.F.F.
One (1) PRCL-4-ADJ Protector Case with adjustable glass panel and fluorescent light, and two (2) Plexiglas end panels
One (1) Lot of Plastic Laminate Panels (color to be determined)
One (1) USB-4 Bottom Shelf
One (1) EFW Rotated pan for easy reach to drains.
One (1) Lot of Drains and valves with individual valves, manifolded to operator's side
One (1) SH-4 8" wide stainless steel work shelf
One (1) lot of Apron Mounted Controls AMC-4
One (1) Lot casters, two (2) with locks
One (1) UL Cord and plug

One (1) Locking device to connect counters

Unit to be 30.5" W plus tray slide and work shelf x 63-3/4" x 34" H. See rough in plan for cord and plug requirements.

Submit shop drawing for approval

ITEM #7 12 CASE MILK COOLER

One (1) BEVERAGE AIR model SMF-58S 12 case forced air milk cooler. Unit to be provided per manufacturers standards. Include the following standard and optional accessories:

One (1) Lot locking casters

One (1) Lid lock

One (1) UL cord and plug

One (1) Thermometer

One (1) Year Refrigeration Service Policy

Five (5) Year Compressor warranty

ITEM #8 ST. ST. WORK TABLE

One (1) ADVANCE TABCO SS-306 st. st. work table furnished per manufacturers standards. Include the following:

One (1) Heavy duty 20x20 enclosed drawer with cylinder lock

One (1) Full length undershelf

One (1) St. St. Legs with adjustable bullet feet.

ITEM #9 FIRE SYSTEM

One (1) system completely installed ANSUL R102 Wet Chemical Restaurant Kitchen Fire Suppression System sized to meet job requirements in accordance with the manufacturer's specifications and installed only by an authorized Ansul Pre-Engineered Restaurant Fire System Distributor. This system must be installed in accordance with UL-300, BOCA, NFPA-17A, NFPA-96 and the authority having jurisdiction. The ANSUL R102 installing company must carry complete Operations Liability Insurance of a minimum of \$1,000,000.

NOTE! Units MUST BE INSTALLED IN the ANSUL R102 factory stainless steel ENCLOSURES. Any Fire System not completely installed in an authorized cabinet must be approved by the Food Service Equipment Consultant in writing prior to such substitution. Cabinet installation must comply with CABO/ANSI A117.1-1992.

System to provide automatic fire suppression for the plenum area of Exhaust Hood, connecting exhaust ducts.

STANDARD: All equipment and the complete system shall conform to NFPA #96, vapor removal from cooking equipment Underwriters Laboratories File #EX2458.

APPROVALS: All devices furnished shall be constructed and installed in accordance with this specification and shall be U.L. approved.

MATERIAL: Exhaust Hood, Duct, and Cooking Appliance Fire Suppression shall be ANSUL R102.

INSTALLATION: System shall be installed in conformance with the latest edition of applicable standard of NFPA 17A, NFPA 96, BOCA, Manufacturer's manual and all applicable state and local codes.

1. Installer shall visit the job site, take all field measurements and verify all conditions affecting the work unless shown on attached plan.
2. Obtain and pay for any permits specifically required for the fire suppression installation.
3. Provide shop drawings showing the piping and mechanical detail of the fire system to the authority having jurisdiction.

TEST: Upon completion of installation, seller to perform all tests necessary to fulfill requirement of the authority having jurisdiction.

SPECIFIC JOB SITE REQUIREMENTS: System to be provided with Two (2) Micro switches (DPDT) mounted in the ANSUL R102 control

cabinet. Second switch to be interfaced with the building Fire Alarm, if required.

The ANSUL R102 System must be located where shown on the food service equipment drawings.

NOTE! ANY RELOCATION of the ANSUL R102 System MUST BE APPROVED by the Food Service Equipment Consultant in writing prior to such relocation.

The ANSUL R102 Fire System installer shall be responsible for cutting or punching holes in walls, ceilings and floors for installation of the equipment. The installer will be responsible for furnishing trim flanges or patching and painting of any holes required for the installation of the ANSUL R102 System.

PIPING: Fire System to be per ANSUL R102 standards. All piping and conduit of the ANSUL R102 is to be concealed where possible and all piping and conduit to be either chrome plated, chrome sleeved or stainless steel where exposure is necessary.

ELECTRICAL CONTRACTOR'S RESPONSIBILITIES: The Electrical Contractor shall be responsible for all labor and materials required to completely connect the cooking fuel shut-off system.

The Electrical Contractor shall be responsible for installing a ½" conduit and flush-mounted standard 4" X 4" electrical octagon box with screws at 2 & 8 o'clock for each ANSUL R102 system. Verify height requirement with Authority Having Jurisdiction.

This is to be used for the manual pull station to activate the Fire System. The ½" conduit should extend approximately 15" above the finished ceiling.

The following must be completed by the Electrical Contractor (See electrical rough-in plan for details):

1. All electrical under the Exhaust Hood must shut down upon activation of the ANSUL R102 Fire System. This includes all outlets, hard-piped appliances and all refrigeration stands.

2. All Make-up Air Units for the Exhaust Hoods in the kitchen must shut down.

3. Exhaust Hood Fans must continue to run.
4. If an electrical gas valve is used, a manual reset relay must be used. This relay is to be supplied by the ANSUL R102 installer.
5. If Fire Alarm notification is required, one of the micro switches is to be used for this purpose.
6. No electrical connections to be made inside the ANSUL R102 control cabinet.

ITEM #10 DOUBLE DECK CONVECTION OVEN

One (1) Blodgett full-size convection oven model ZEPHAIRE-200-E double compartment. Each compartment shall have porcelainized steel liner and shall accept five 18" x 26" standard full-size bake pans in left-to-right or front-to-back positions. Doors shall have dual pane thermal glass windows with single powder coated handle and simultaneous operation. Unit shall be electrically heated with three tubular heaters. Air in baking chamber distributed by single inlet blower wheel powered by a two-speed, 1/2 HP motor with thermal overload protection. Each chamber shall be fitted with five chrome-plated removable racks. Control panel shall be recessed with Cook/Cool Down mode selector, solid state manual infinite thermostat (200 - 500°F), and 60-minute timer. Provide options and accessories as indicated.

Note, unit to have removable shelves and shelf supports in order to accommodate owners existing wire baskets. FSEC to confirm arrange with owner prior to ordering to insure proper fit.

Provide unit with the following:

- One (1) Lot heavy duty casters, two with locks
- One (1) Lot SSM manual controls
- Five (5) Removable wire shelves per compartment. Unit to be furnished without shelves in place. Owner to install at later date if required.

NOTE! - Unit to be provide in same configuration as unit provided for Forest Elementary.

Electrical trades to be responsible for final connection with flexible conduit. Verify length with owner so unit can be moved for cleaning.

ITEM #11 ST. ST. EXHAUST HOOD/PANEL

One (1) CAPTIVEAIRE model # 6024 ND-2 exhaust only canopy rated for all types of cooking equipment. The hood shall have the size, shape and performance specified on drawings. Construction shall be type 430 stainless steel with a #4 polish where exposed. Individual component construction shall be determined by the manufacturer, ETL, and NSF. Construction shall be dependent on the structural application to minimize distortion and other defects. All seams, joints and penetrations of the hood enclosure to the lower outermost perimeter that directs and captures grease-laden vapor and exhaust gases shall have a liquid-tight continuous external weld in accordance with NFPA 96. Hood shall be wall type with a minimum of four connections for hanger rods. Connectors shall have 9/16" holes pre-punched in 1 ½" x 1 ½" angle iron at the factory to allow for hanger rod connection by FSEC. FSEC to hang hood in location as shown on plan from structural above provided by architectural trades. Final HVAC connection to be by ventilation trades.

Ventilator shall be furnished with U.L. classified high efficiency stainless steel baffle filters, supplied in size and quantity as required by ventilator. The filters shall extend the full length of the hood and the filler panels shall not be more than 6" in width.

The hood manufacturer shall supply complete computer generated submittal drawings including hood sections view and hood plan view. These drawings must be available to the engineer, architect and owner for their use in construction, operation and maintenance.

Exhaust duct collar to be 4" high with 1" flange. Duct sizes, CFM and static pressure requirements shall be as shown on drawings. Static pressure requirements shall be precise and

accurate; air velocity and volume information shall be accurate within 1-ft increments along the length of the ventilator.

The hood shall have:

A double wall insulated front to eliminate condensation and increase rigidity. The insulation shall have a flexural modulus of 475 EL, meet UL 181 requirements and be in accordance with NFPA 90A and 90B.

An integral front baffle to direct grease laden vapors toward the exhaust filter bank.

Removable grease cup for easy cleaning.

The hood shall be ETL Listed as "Exhaust Hood Without Exhaust Damper", NSF Listed and built in accordance with NFPA 96. The hood shall be listed for 450°F cooking surfaces at 150 CFM/ft, 600°F cooking surfaces at 200 CFM/ft, and 700°F cooking surfaces at 250 CFM/ft. The hood shall be ETL Listed as "Exhaust Hood Without Exhaust Damper".

Accessories to be included:

One (1) Lot 12x12 LED lights T8, Warm White color 3300K, Aluminum backing w/ Fixture
One (1) Full length st. st. tapered end panels with legs
One (1) Lot Stainless filters Captrate Solo filter with hook, ETL Listed. Particulate capture efficiency: 93% efficient at 9 microns, 72% efficient at 5 microns
One (1) Lot Field Wrapper Panels
One (1) Lot SC-011110FP Starter Coil Control Only w/ 1 Exhaust Fan, 1 Supply Fan, Exhaust on in Fire, Lights out in Fire, Fan(s) On/Off Thermostatically Controlled. Room temperature sensor shipped loose for field installation. Includes 1 Duct Thermostat kit. - 14 x 18 Stainless Steel Box. Includes latch and back plate - Digital Pre wire Lighting Relay Kit. Includes hood lighting relay & terminal blocks. Allows for up to 1400 Watt of lighting each. - Thermistor CABLE - 18/2 AWG GREEN WHITE, plenum rated. USED for thermistor duct stat. FSEC to turn box over and coordinate with mechanical and electrical trades for installation and wiring.

One (1) Lot of 18 ga. Stainless steel rear and side wall paneling sized per plan and elevation detail. Provide wall panels from bottom edge of hood down to top of base cove. Verify height of cover before fabrication. Provide panels with finish to match hood and in lengths to match hood(s) section(s) wherever possible. Panels to butt together with hairline joint and be installed with concealed fasteners.

FSEC to provide all necessary cut outs for utility lines.

Submit shop drawing for review.

ITEM #12 ROLL IN REFRIGERATOR

QTY: One (1)

MFG/MODEL: TRAULSEN/ARI232LUT-FHS

CONST: Cabinet exterior front, one piece sides, louver assembly and doors are constructed of 20 gauge stainless steel with #4 finish. Cabinet interior and door liners are constructed of anodized aluminum. The exterior cabinet top, back and bottom are constructed of heavy gauge aluminized steel. The interior floor is constructed of stainless steel and insulated with ¼" of resilient cork. A readily attachable stainless steel ramp is provided to facilitate loading/unloading.

DETAILS:

Doors are equipped with a heavy duty, extruded wiper gasket for sealing to bottom ramp, removable plug cylinder locks and guaranteed for life cam-lift, gravity actuated, self-closing metal, glide hinges with stay open feature at 120 degrees. Hinges include a concealed switch to automatically activate the interior LED Lighting. Guaranteed for life, work flow door handles are mounted horizontally over recess in door which limits protrusion from door face into aisle ways. Doors have seamless, polished metal corners.

Easily removable for cleaning, vinyl magnetic door gaskets assures tight door seal.

Both the cabinet and door are insulated with an average of 2" thick high density, non-CFC, foamed in place polyurethane.

Refrigeration System

A top mounted, self-contained balanced refrigeration system using R-134a refrigerant (or SNAP compliant refrigerant at time of production) located behind a one piece lift up louver to allow for easy cleaning of coils. Refrigeration system consists of condenser, thermostatic expansion valve, air-cooled hermetic compressor, plenum effect blower coil, large high humidity evaporator coil located outside the food zone and a top mounted non-electric condensate evaporator. 9' cord and plug is provided.

Controller

INTELA-TRAUL Microprocessor control which is NDP compatible and includes digital temperature display.

ACCESSORIES:

Six (6) Adjustable shelves mounted in the top half of the cabinet

Door Hinging: Per plans

FSEC to verify size of owners existing roll in basket cart prior to ordering to insure proper fit. Unit to match configuration of unit provided for Forest Elementary.

Voltage: 115v/60/1

ITEM #13 REACH IN REFRIGERATOR

QTY: One (1)

MFG/MODEL: TRAULSEN/AHT132W-FHS

CONST: Cabinet exterior front, one piece sides, louver assembly and doors are constructed of 20 gauge stainless steel with #4 finish. Cabinet interior and door liners are constructed of

anodized aluminum. The exterior cabinet top, back and bottom are constructed of heavy gauge aluminized steel.

DETAILS:

Door is to be are equipped with a gasket protecting metal door pan, removable plug cylinder lock and guaranteed for life cam-lift, gravity actuated, self-closing metal, glide hinges with stay open feature at 120 degrees. Hinges include a concealed switch to automatically activate the interior LED lighting. Guaranteed for life, work flow door handles are mounted horizontally over recess in door which limits protrusion from door face into aisle ways. Doors have seamless, polished metal corners.

Gasket profile and Santoprene material simplify cleaning and increase overall gasket life. Anti-condensate heaters are located behind each door opening.

Both the cabinet and door are insulated with an average of 2" thick high density, non-CFC, foamed in place polyurethane.

Interior comes standard with 3 plated shelves

Refrigeration System

A top mounted, self-contained balanced refrigeration system using R-134a refrigerant (or SNAP compliant refrigerant at time of production) located behind a one piece lift up louver to allow for easy cleaning of coils. Refrigeration system consists of condenser, thermostatic expansion valve, air-cooled hermetic compressor, plenum effect blower coil, large high humidity evaporator coil located outside the food zone and a top mounted non-electric condensate evaporator. 9'cord and plug is provided.

Controller

INTELA-TRAUL Microprocessor control which is NDP compatible and includes digital temperature display.

ACCESSORIES:

One (1) set of 6" Casters

Three (3) Extra adjustable Plated Shelves
One (1) Door Hinging: Per plans

Voltage: 115v/60/1

Warranty:

Three year parts, 5 year total compressor

ITEM #14 REACH IN FREEZER

QTY: One (1)

MFG/MODEL: TRAUlsen/ALT232WUT-FHS

CONST: Cabinet exterior front, one piece sides, louver assembly and doors are constructed of 20 gauge stainless steel with #4 finish. Cabinet interior and door liners are constructed of anodized aluminum. The exterior cabinet top, back and bottom are constructed of heavy gauge aluminized steel.

DETAILS:

Doors are equipped with a gasket protecting metal door pan, removable plug cylinder lock and guaranteed for life cam-lift, gravity actuated, self-closing metal, glide hinges with stay open feature at 120 degrees. Hinges include a concealed switch to automatically activate the interior LED lighting. Guaranteed for life, work flow door handles are mounted horizontally over recess in door which limits protrusion from door face into aisle ways. Doors have seamless, polished metal corners.

Gasket profile and Santoprene material simplify cleaning and increase overall gasket life. Anti-condensate heaters are located behind each door opening.

Both the cabinet and door are insulated with an average of 2" thick high density, non-CFC, foamed in place polyurethane.

Interior comes standard with 3 plated shelves

Refrigeration System

A top mounted, self-contained balanced refrigeration system using R-134a (or SNAP compliant refrigerant at time of production) refrigerant located behind a one piece lift up louver to allow for easy cleaning of coils. Refrigeration system consists of condenser, thermostatic expansion valve, air-cooled hermetic compressor, plenum effect blower coil, large high humidity evaporator coil located outside the food zone and a top mounted non-electric condensate evaporator. 9' cord and plug is provided.

Controller

INTELA-TRAUL Microprocessor control which is NDP compatible and includes digital temperature display.

ACCESSORIES:

One (1) set of 6" Casters
Three (3) Extra adjustable Plated Shelves
Two (2) Doors Hinging: Per plans

Voltage: 115v/60/1

Warranty:

Three year parts, 5 year total compressor

ITEM #15 HOLDING CABINET, HUMIDIFIED HEATED

One(1) FWE model #MTU-12D L portable hot food cart. Units to be sized to accommodate both 12 x 20 & 18 x 26 pans and trays. Provide units with the following standard and optional accessories:

One (1) Lot Dutch Doors
One (1) Lot Lexan view windows in each door
One (1) Lot of locking casters
One (1) UL Approved cord and plug - CRDSET10-115-59D

ITEM #16 WIRE STORAGE SHELVING

QTY: Two (2)

MFG & MODEL: InterMetro Industries Corp Super Brite Super Erecta Shelving

CONST: All carbon steel construction. Shelves to have 10 ga. mat wires spaced 21/32" apart. Mat wires to be supported by 6 ga. support wire. Support wire spacing specific to shelf size. Shelf width greater than 18" include one to two 7 ga. snake wire supports running the length of the shelf. Shelf frame to be made up of 7 ga. snake wire with two 6 ga. snake support wire. A round 1 1/2" steel collar is welded at each corner. All contact points are to be welded.

Posts are to be provided as 1" O.D. Round tubes notched every 1" of the post. A polypropylene post cap will be installed on the top of each post. The bottom of the post to be furnished with heavy duty casters, two with locks.

Finish will be Super Brite, a zinc based chromate bath.

DETAILS: Each shelving to be furnished five (5) tiers high with four (4) 84" high posts.

Shelving size and quantity to be sized per plan.

ITEM #17 NOT USED

ITEM #18 NOT USED

ITEM #19 NOT USED

ITEM #20 THREE COMPARTMENT SINK

One (1) Advance Tabco Model No. 93-23-60-24RL MODIFIED or custom fabricated 3-compartment, with left & right-hand drainboards, 20" x 20" wide sink compartments, 12" deep, with 11" high splash, stainless steel legs with welded front-to-rear and adjustable left-to-right cross rails, 28" drainboards, 1" adjustable bullet feet, 14 gauge 304 series stainless steel,

Splash to be provided with two sets of holes for two faucets.
NOTE! FSEC to field verify wall to wall length. Unit to be modified to fit job site conditions.

Include the following:

One (1) Lot Drain board modification to 28"
Two (2) St. St. Undershelves (under each drainboard)
Two (2) T&S Model B-0290-112X (3/4" I.P.S) to fit in rear of Backsplash to accommodate 3/4" water lines Left hand Pre-rinse w/ 10" "Add a Faucet" (1) T&S Model B-0287-427-B, Remove T&S Model 114X, 12" spout and provide T&S Model 112x 10" spout.

Furnish each faucet complete with T&S Model B-0427 Assembly to facilitate fastening to Backsplash

Three (3) T&S Model B-3950-01 Twist Handle Drains with connected rear overflow & 010387-45 removable basket strainers. Twist Handle Drains Furnished with 14 ga. st. st. bracket welded to underside of sink.

Sink trim to be furnished with identification tags and signed over to Plumbing Trades for their internal and final connections to rough-in locations.

FSEC to seal unit wall with clear silicone.

Submit shop drawing for review and approval.

ITEM #21 ST. ST. WALL CABINETS

Two (2) ADVANCE TABCO WCH-1536 st. st. wall cabinets furnished per manufactures standards. Units to be provided with locking hinged doors. Interior to have fixed bottom and two adjustable mid shelves. FSEC to mount units to wall with heavy duty anchors and st. st. screws. Edges to be sealed with silicone.

ITEM #22 ST. ST. WALL PANELING

One (1) Lot of Custom Fabricated 18 ga. st. st. rear and side wall paneling full length of three compartment sink as shown on plan. Panel to run up to bottom edge of wall cabinets, and 30"

high in center area. Furnish paneling hair line butt joints. Paneling to be sealed on sides and top with clear silicone sealant. Submit shop drawing for approval.

ITEM #23 ST. ST. HAND SINK

QTY: One (1)

MFG. & MODEL: ADVANCE #7-PS-50

CONST: Sink to be constructed of Stainless Steel. Sink to be furnished with 8" backsplash with 2" return to wall and flange down.

ACCESSORIES: Furnish with strainer type 6" tailpiece and "P" trap all to be chrome plated brass. ADVANCE K-590MIT to delete standard faucet & ADVANCE K-472 faucet hole revision for single hole faucet. Faucet shall be T&S EC 3101-TMV electronic gooseneck faucet, wall mount, gooseneck, AC/DC control module, thermostatic mixing valve, 100-240 VAC adapter. Soap and towel dispenser to be provided by owner. Provide st. st. splash shield on right hand side.

DETAILS: Sink to be mounted with rim 34" above finished floor with rough-in for water and waste located 4-7/8" below the 6-1/2" deep sink.

ITEM #24 CONDIMENT TABLE

QTY: One (1)

MFR./MODEL: ATLAS BLU-3 MO

SPECIFICATIONS: Provide one mobile serving unit with flat top. The top of the unit shall be constructed of 16 gauge type 304 stainless steel. The frame shall be constructed of hi-tensile square aluminum tubing.

ACCESSORIES:

One (1) 30" high working height

One (1) Laminate Panel (color to be determined by architect)

Two (2) TS-3, 12" folding tray slide mounted at 29" A.F.F.
One (1) Lot Under shelves, full middle and bottom, stainless steel
One (1) Lot sliding doors with lock
One (1) Lot heavy duty casters ,two with wheel locks
One (1) Locking device to connect counters

DETAILS: Unit to be 50" L x 30.5 D x 30" H.

Submit shop drawing for approval

ITEM #25 FIELD ERECTION LABOR

FSEC shall deliver, unload, uncrate, and install all items herein specified ready for final plumbing, electrical and ventilation connections furnished by respective trades as outlined in the General Requirements.

All equipment shall be cleaned and polished before demonstrating equipment to the Owner. All crating and packing material to be removed from job site.

FSEC shall arrange demonstration date with Owner and at the same time check out all loose items with the Food Service Manager.

FSEC shall be responsible for missing items unless he can produce signed receipts from Owner's personnel that the items were received and accounted for. Owner cannot be responsible for items delivered to the job site that were dropped off without being signed for by Owner's personnel or representatives.

Rough-in plans to be submitted at a scale of 1/4" = 1'-0". When present equipment is re-used at new locations, it shall be the FSEC'S responsibility to show necessary rough-in requirements for these items. (See General Requirements for complete details relating to submission of shop drawings). Two (2) Buyout Books to be sent to EFW for review and approval. Additional copies for use in field etc., to be made up as required after being check by EFW.

FARMINGTON PUBLIC SCHOOLS
2017 RENOVATIONS-BID PACK #5
ELEMENTARY SCHOOLS

161664B

NOVEMBER 30, 2016

Two (2) complete sets of all final shop drawings, instructions, and parts lists are to be turned over to the Owner secured in a binder. This booklet shall include the telephone number and address of the service company for each piece of equipment.

NOTE! FSEC shall pay all sales, consumer, use and other similar taxes for the work or portions thereof provided by the Contractor which are legally enacted at the time bids are received, whether or not yet effective.

Final payment cannot be recommended until all of the above items have been completed to our satisfaction.

FARMINGTON PUBLIC SCHOOLS
2017 RENOVATIONS-BID PACK #5
ELEMENTARY SCHOOLS

161664B

NOVEMBER 30, 2016

ITEMIZED PROPOSAL FORM
WOODCREEK ELEMENTARY SCHOOL
FARMINGTON HILLS, MICHIGAN

NAME OF
BIDDER: _____

ADDRESS: _____

DATE: _____ TELEPHONE
NO _____

BASE BID

If this Proposal is accepted in writing within thirty (30) days from the date of the bid opening, undersigned having familiarized themselves with the drawings and specifications as prepared by E. F. WHITNEY, INC., agrees to enter into a Contract for furnishing all labor, materials, and facilities for Food Service Equipment in connection with the above named project for the total base bid sum amount of \$_____ including sales tax.

(\$ _____ DO
LLARS)

The amount shown shall be shown both words and figures. In case of a discrepancy, the amount shown in words shall govern. Sales tax amount must be shown.

TIME OF COMPLETION

The Bidder agrees to complete the above named project in _____ consecutive calendar days.

FARMINGTON PUBLIC SCHOOLS
2017 RENOVATIONS-BID PACK #5
ELEMENTARY SCHOOLS

161664B

NOVEMBER 30, 2016

BID GUARANTEE

TYPE: _____

AMOUNT \$ _____

CONTRACT ASSUMPTIONS

The Bidder agrees to enter into a sub contract with the General Construction Work Contractor, (Architectural Trades) as designated by the Owner. The sub contract shall be based upon the prices, terms, and conditions set forth in the Proposal.

ADDENDA

Proposal is based on the following Addenda:

Addendum # _____ Dated: _____

Addendum # _____ Dated: _____

Addendum # _____ Dated: _____

SIGNATURE

Signed By: _____

Dated and signed
at: _____

State of _____ this _____ day of _____, 2016

LEGAL STATUS OF BIDDER

A Corporation duly organized and doing business under the laws of the State of _____ for whom _____ whose signature is affixed to this Proposal is duly authorized to execute contracts.

A Partnership, all members:

An individual whose signature is affixed to this Proposal:

INSTRUCTIONS

The Base Bid must be on fixtures specified for a fair comparison of all the bids. Prices on alternate equipment will be accepted on a separate sheet made up by the Bidder with illustrations and alternate specifications.

The following pages contain a schedule of the various items of equipment. All manufacturers names and other data requested must be filled in by the Bidder.

ON FABRICATED ITEMS, PLEASE GIVE THE NAME OF YOUR FABRICATOR

ITEM	MANUFACTURER'S OR FABRICATOR'S NAME
------	--

FARMINGTON PUBLIC SCHOOLS
 2017 RENOVATIONS-BID PACK #5
 ELEMENTARY SCHOOLS

161664B

NOVEMBER 30, 2016

NUMBER	DESCRIPTION	QUANTITY	AND MODEL NUMBER
PRICE			
1	Portable Cashiers Stand		
2	POS Register		
3	8 Case Milk Cooler		
4	Flat Top Counter		
5	Cold Food Counter		
6	Hot Food Counter		
7	12 Case Milk Cooler		
8	St. St. Work Table		
9	Fire System		
10	Double Deck Convection Oven		
11	St. St. Exhaust Hood/Panel		
12	Roll In Refrigerator		

SECTION 11480 - GYMNASIUM EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Attention is directed to Division 0, Bidding and Contract Requirements, which are hereby made a part of this Section.

1.02 SCOPE OF WORK

- A. Work included in this section consists of furnishing all labor, materials, equipment and incidentals required for installation of equipment shown on drawings and specified herein.

1.03 QUALITY CONTROL

- A. Shop drawings: Submit four (4) copies for approval showing general layout, dimensions to structural supports, method of support from structural or attachment, finishes, materials and other pertinent details.
- B. Protection: Care and store as required to prevent damage or injury.
- C. Equipment: In accord with NCAA Basketball rules.
- D. Manufacturers: Performance Sports Systems or equivalent by Institutional Products, Inc., Jaypro, Inc., Medart, Draper, Fair-Play Scoreboards and Porter.

PART 2 - GENERAL

2.01 MATERIALS

- A. Basketball backstops.
 - 1. Superstructure: 3-1/2" round pipe complete with brackets and bracing required for building conditions. Main mast to be 6 5/8" O.D. with 2 3/8" O.D. heavy gauge diagonal braces to prevent sway.
 - 2. Backstops: Performance Sports systems Model PSS 3100 single post-dual backstop unit; Two (2) required. (welded front braced - front folding basketball backstop).

3. Winches: Performance Sports Systems model 1194 1 H.P. 110/120 -volt, 60-hertz, single phase, instant-reverse motor with thermal overload protection. Develops after 1000 lbs. of line pull at a speed of 12 feet per minute. Double self locking worm gearing plus passive unidirectional brake. A large grooved drum assures long cable life and proper coiling. Supported in large diameter ball bearing and with positive, through drum rope anchoring. A constant pressure type tension roller assures correct cable tracking even in slack conditions. Easy to set limit switches that will not lose critical setting due to vibration or environmental conditions.
4. Hoist supplied with 6' cord and 4-prong twist lock plug, female receptacle, 4" square cover and 110/120 volt keyed switch on cover. TO BE CONTROLLED VIA PERFORMANCE SPORTS SYSTEMS TSC2000X TOUCH SCREEN.
5. ALL OTHER ELECTRICAL, JUNCTION AND SYNCHRONIZER BOXES NOT MENTIONED ABOVE SHALL BE FURNISHED AND INSTALLED BY A CERTIFIED ELECTRICAL CONTRACTOR. FOLLOWING MANUFACTURER'S INSTRUCTIONS AND ALL LOCAL SAFETY CODES.
6. Backboards: Performance Sports systems Model LXP4200 (4), Steel Frame Rectangular Glass Backboard Model PMCE edge padding (COLORS SELECTED FROM MANUFACTURED STANDARD COLOR RANGE)
7. Goals: Performance Sports Systems model 2000+ breakaway (four required), 5/8" diameter cold rolled steel rod with 18" ID formed ring, "no tie" clips welded to rim, official enamel orange finish. Designed to fasten to backboard rear. Complete with 120 thread seine twine net.
8. Safety Straps: Provide locking safety straps for each backstop as manufactured by Performance Sports Systems Model 1100.

Unit shall prevent free-fall of backstops due to cable, pulley, support fitting or winch failure. Any sudden surge of speed due to failure shall instantly lock automatically.

- B. Total Control System: Provide TSC2000X total system control touch screen as manufactured by Performance Sports Systems, consisting of one keypad with touch screen to operate up to eight motorized systems and auxiliary lights (including backstops, height adjusters, divider curtain, bleachers, lighting, and scoreboard).
1. Operates on 110V w/touch screen communications at 24 volts. Mounts in standard 12" x 12" x 6" deep metal box. Relay panel (24" x 24" x 6") can be mounted in any remote location. MANUFACTURERS STANDARD KEY PAD NOT EQUAL. case of overload and will recommend electrical maintenance if TOUCH SCREEN OPERATION IS THE ONLY ACCEPTABLE METHOD.
 2. System has capability to operate equipment individually and has custom program options for multiple equipment configurations such as "game day" or "practice setup" system shall have unlimited expandability for operating additional equipment by adding relay boxes.
 3. System shall utilize a password control to prevent unauthorized use and press and hold features preventing authorized operator from walking away while equipment is in motion. Auto shut off will occur after thirty seconds of non-use. Unit shall be self diagnostic and have voltage-sensing shutdown feature in needed. NO SUBSTITUTIONS.
 4. Provide system with one year manufacturer's warranty covering defects in material and workmanship.

2.02 INSTALLATION

A. Backstops and Goals:

1. Determine from drawings, verify at job site, exact extent and layout of superstructure required for mounting and equipment at required locations.
2. Install boards at correct approved NCAA heights with all necessary bracing.

2.03 WARRANTY SERVICE

- A. Guarantee to replace 100% defective parts and workmanship or one (1) year period.

2.04 COMPLETION

- A. Instruct authorized Owner's representatives in complete operation of equipment included in this section.

2.05 OSHA STANDARDS

- A. Bidders are required to meet State and Federal OSHA standards on equipment where requirements have been enacted. The State and Federal OSHA standards will supersede the published specification.

END OF SECTION 11480

SECTION 12300 - PLASTIC LAMINATE CASEWORK

PART 1 - GENERAL

1.01 General Provisions

- A. Attention is directed to Division 0, Bidding and Contract Requirements and to Division 1 General Requirements which are hereby made a part of this Specification. Refer to other sections, divisions, and schedules for work in connection with this section.

1.02 Intent

- A. The intent of this specification is to establish minimum performance and quality criteria consistent with preestablished standards of design and function. Casework not meeting these minimum requirements will be unacceptable.
- B. The casework contractor shall be held in strict compliance with any specific materials, finishes, construction details and hardware that are specified herein. Bids proposing to supply casework not meeting these requirements will be rejected.

1.03 Work Included

- A. Furnish, deliver, and install to Owner's and Architect's satisfaction, all prefabricated plastic laminate casework as shown on drawings, schedules and equipment lists.
- B. Furnish and install all fillers, scribes, finished ends, finished backs, work surfaces/backsplashes, and cutouts required to provide a complete and finished project. Plastic laminate work surfaces shall include backer sheet.
- C. Provide sinks and fittings, electrical outlets and fixtures when specifically stated as being part of this contract.
- D. Provide locks on all tall storage, wardrobe cabinets and at all low cabinets, and upper wall cabinets unless noted otherwise. All cabinets are to be keyed alike per room. All locks are to be masterkeyable to room doors.

- E. Installation, connection, and testing of all sinks, fittings, electrical fixtures; providing all rough-ins: mechanical piping, electrical runs, and connections required for a complete project.
- F. Blocking, framing, and reinforcement in walls, ceilings, and floors for anchoring of cabinets and trim.

1.05 QUALIFICATIONS

- A. Plastic laminate casework shall be as manufactured by Stevens Cabinet Co. Division of Stevens Industries Inc., Teutopolis, Illinois. Products and catalog numbers are from Stevens catalog and are used as basis for identification, configuration, size and quality.
- B. Other pre-approved manufacturers are as follows:
 - TMI System Design Corp. Dickinson, North Dakota
 - Case Systems Inc., Midland, Michigan
 - LSI Corporation of America, Inc., Minneapolis, Minnesota
 - Polyvision Corporation, www.polyvision.com, Suwanee, Georgia
 - Fisher Hamilton, Two Rivers, Wisconsin
 - Wood Metal Casework
 - Mica-Tec, Inc.
- C. Casework of other manufacturers will be considered for approval providing written request is received at least ten (10) days prior to announced bid date and approved by addendum. Bidder shall state in writing any deviations from requirements and specifications. The casework shall conform to configuration, arrangement, design, material quality, joinery, panel thickness, and surfacing of that specified and shown on drawings.
- D. Manufacturers requesting approval shall submit samples with Cut-A-Ways showing cabinet construction, joinery, drawer and door construction, hardware, and materials; along with catalogs and specification in order that accurate evaluations can be made. Samples may be impounded for the duration of contract to insure construction specification compliance.

1.06 SUBMITTALS

- A. Shop drawings shall be submitted for approval within thirty (30) days after formal notification of award of contract. Drawings shall consist of floor plans indicating arrangement and relation to electrical, data technology and adjacent work and equipment, and complete elevations of casework. Centerline of service requirements shall be noted for use by other trades. A schedule of all sinks, fittings, and accessories that are part of this contract shall be provided.
- B. Color samples shall be submitted for selection and coordination at time of contract award. Samples of actual material and color shall be available as required.
- C. Additional catalog cuts, details and samples as requested by Architect for evaluation and coordination.
- D. Physical sample must be approved prior to fabrication.

1.07 PRODUCT DELIVERY AND STORAGE

- A. Protect cabinet and countertops during transit, delivery, storage and handling to prevent damage, soiling and deterioration.
- B. Store cabinets and countertops at project site installation and storage areas with similar ambient conditions as final installation. Storage areas must be kept dry, heated with low relative humidity and away from construction work such as painting, wet work, grinding and similar operations.

1.08 WARRANTY

- A. Casework manufacturer shall provide lifetime guarantee and limited warranty to the original Owner against defective material and fabrication for as long as they own the product - this is a warranty of replacement and repair only, the manufacturer will correct defects in material and/or fabrication without additional cost.
- B. Accessory equipment (sinks, fittings etc.) shall be warranted by appropriate manufacturer's guarantee.

PART 2 - PRODUCTS

2.01 CORE MATERIAL

- A. Cabinet components having particle board core material shall be of a minimum 45 lb. density, M-2 industrial grade. The particle board used shall have been tested under ANSI A208.1 1993 standards and/or ASTM D 1037-91A.
- B. Medium density fiberboard (MDF) shall be used in high stress areas as drawer members and shall be minimum 48 lb. density MD-21 grade and tested under ANSI A208.2 1994 Standards.
- C. Industrial hardboard shall be pre-finished 1/4" thickness composed of wood fibers, phenolic resin binders and moisture inhibitors that meet or exceed the hardboard product standard ANSI/AHA A135.4 1988.
- D. All countertops located with 3'-0" of any direction of built-in sink and/or bubblers shall be constructed of marine grade "Greenboard" MR moisture/water resistant particle board. The particle board shall be tested under ANSI A208.1 1-1993, M3 standards.

2.02 SURFACE MATERIAL

- A. Exposed exteriors shall be permanently thermofused melamine laminate, fused to core using a minimum average pressure of 320 PSI and average 320 degree F. temperature. Thermofused melamine laminate shall meet ALA 1996 specification standards, as tested against the high pressure laminate NEMA LD 3-1995, VGS.028 specification standards. (Warranted for life against delamination).
- B. Exposed doors and drawer fronts shall be permanently thermofused melamine laminate, fused to core using a minimum average pressure of 320 PSI and average 320 degree F. temperature. Thermofused melamine laminate shall meet ALA 1996 specification standards, as tested against the high pressure laminate NEMA LD 3-1995, VGS.028 specification standards, (Warranted for life against delamination).
- C. Exposed interiors shall be permanently thermofused

melamine laminate, fused to core using a minimum average pressure of 320 PSI and average 320 degree F. temperature. Thermofused melamine laminate shall meet ALA 1996 specification standards, as tested against the high pressure laminate NEMA LD 3-1995, VGS.028 specification standards. (Warranted for life against delamination).

- D. Semi-exposed and concealed surfaces shall be permanently thermofused melamine laminate or high pressure decorative plastic laminate cabinet liner, 0.020" thickness for balanced construction. Thermofused melamine laminate shall meet the ALA 1996 specifications standard, as tested against the high pressure laminate NEMA LD 3-1995, VGS.028 specification standards.

2.03 EDGINGS

- A. Exposed exterior cabinet front edges shall be banded with a contrasting or matching rigid PVC extrusion, 0.020" thickness, resistant to chip, crack and high impact. Edging shall have a satin finish with a UV cured top coat for additional durability. The 0.020" thick edging shall be applied with waterproof hot melt adhesive.
- B. Door and drawer front edges shall be banded with a contrasting or matching rigid PVC extrusion, 3mm (1/8") thickness, resistant to chip, crack, and high impact. Edging shall have a satin finish with UV cured top coat for additional durability. The 3mm thick edging shall be applied with waterproof hot melt adhesive, and shaped to provide radiused edges and radiused corners.
- C. Adjustable shelves shall be banded with PVC extrusion, resistant to chip, crack, and high impact. Edging shall have a satin finish with a UV cured top coat for additional durability. Edging shall be applied with waterproof hot melt adhesive. Shelves to be 1" thick. 0.020" thick PVC edging shall be applied to four (4) edges of adjustable shelf.
- D. All other interior components, including drawers, shall be banded with a PVC extrusion, 0.020" in thickness, resistant to chip, crack, and high impact. Edging shall have a satin finish with a UV cured top coat for additional durability. Edging to be machine applied with waterproof hot melt adhesive.

2.04 COLOR SELECTIONS

- A. Exposed cabinet exteriors shall be chosen from Thermofused melamine laminate selections as depicted in manufacturer's color selector guide. A minimum of seventy (70) colors and patterns shall be available as standard selection.
- B. Exposed doors and drawer fronts shall be chosen from Thermofused melamine laminate selections as depicted in manufacturer's color selector guide. A minimum of seventy (70) colors and patterns shall be available as standard selection.
- C. Semi-exposed surfaces, including drawer box components, shall be finished in either pearl or grey as selected from casework manufacturer's standard interior color selections.
- D. Exposed interior components, including both faces of shelves and interior face of backs to match exposed cabinet exterior color selection.
- E. Door and drawer front edges shall be chosen from one of twenty-two (22) trim group colors in 3mm thick PVC in contrasting or matching colors as depicted in manufacturer's color guide.
- F. Exposed front edge of cabinet, including exposed interior edges, shall be selected from one of seventy (70) trim group colors in 0.020" thick PVC in contrasting or matching colors as depicted in manufacturer's color guide, or commercial match to selected exposed exterior color based on availability.
- G. Semi-exposed edges of cabinet components including drawers, shall be either pearl or grey n 0.020" thick PVC.
- H. Pulls shall be available in chrome, brass, bent wire and injection molded pulls in either bent wire or contour design, to be available in twenty (20) colors as selected from manufacturer's color selector.
- I. Casework of substitute brands with lesser amounts or more restrictive selection requirements will not be considered equal and shall be rejected.
- J. Finishes to be laminate manufacturer's matte, suede, or

equivalent finish as approved by Architect. Samples will be reviewed by Architect for color, texture, and pattern only.

2.05 HARDWARE

A. Hinges

1. Institutional five-knuckle secured with minimum of eight screws. Hinge plate must extend into cabinet a minimum of 2 1/4" (56 mm) in order to assure maximum strength. Finish to be powder-coated baked on black enamel or brushed chrome US26D.

a. Two hinges used on all doors less than 48" (1220 mm) in height, three hinges used on all doors 48" (1220 mm) or greater in height. Hinge to accommodate 13/16" (21 mm) door.

B. Door catches shall be a heavy-duty spring loaded, large diameter (17.5mm - 11/16") roller type catch mounted at bottom edge. All doors over 48" in height shall be provided with roller catch at both top and bottom of door.

C. Catch strike plate shall be injection molded ABS, with an integrally molded engagement ridge. Strike plate shall also provide a wide face bumper insuring a positive door stop.

D. Pulls shall be impact resistant injection molded bent wire, 4" length available per color selection in Article 2.04.H.

E. Drawer and slide out shelves shall be suspended with bottom mount, side and bottom attached nylon roller epoxy coated steel slides to ensure quiet, smooth operation. Lateral stability is achieved thru a special formed captive profile. Slides shall have 100 lb. load rating, with both in and out drawer stop, 3" self close feature and a side adjustment cam allowing 3mm side to side alignment.

F. Drawers specifically noted for full extension file use shall be suspended with bottom mount, side and bottom attached nylon roller epoxy coated steel slides to ensure quiet, smooth operation. Lateral stability is achieved thru a special formed captive profile. Slides shall have 150 lb. load rating, with both in and out drawer stop, and 3" self close feature. File drawer shall include extruded

top mounted molded side rails to accept standard hanging file folders.

- G. Knee-space, pencil drawers, and keyboard trays, shall be designed to permit under counter or support frame mounting, with 100 lb. nylon roller epoxy coated steel slides.
- H. Hanger rods shall be heavy chrome plated tubing. Rod shall be securely affixed to cabinet shelves.
- I. Tote trays shall be of high impact polystyrene with smooth edges. Each tray to include an identification card holder and shall be suspended from rails securely attached to cabinet verticals.
- J. Shelf support clips for 1" thick adjustable shelves shall be injection molded clear polycarbonate. Support clips shall incorporate integral molded lock tabs to retain shelf from topping or inadvertently being lifted out. Support clip shall have 5mm dia. double pin engagement into precision bored hole pattern in cabinet vertical members. Clips shall have a molded ridge which provide pressure against edge of shelving to maintain positive pin engagement. Clip shall be designed in such a manner to provide means for permanent retention to shelf. Static test load must exceed 200lb. per clip.
- K. Dividers that are 1/4" thick shall be fully adjustable and retained with injection molded clear polycarbonate clip.
- L. Locks shall be cylinder type, diecast, with five (5) disc tumbler mechanism. Each lock shall be provided with milled brass key. Master key cabinets to room doors. Cabinets with multiple locks installed shall be keyed alike by room, with each cabinet in that room keyed the same unless otherwise specified. Locks shall be Remov-A-Core to give flexibility for different pass key options. Locks shall be provided on all cabinets capable of locking. Key all cabs and drawers within each room alike. Each room to be keyed differently. Provide 1 Master key for all locks. Note: Key each cabinet and drawer in Staff Lounge 152 differently with 1 Master key.
- M. Sliding door track shall be double channel rigid PVC

extrusion at both top and bottom of doors. Track shall be available in pearl, black or grey colors.

2.06 COMPONENTS

- A. Base, wall and tall cabinet ends shall be 3/4" thick particle board, laminated for balanced construction, surfaced as described in Article 2.02.A and edged as described in Article 2.03.A.
- B. Base and tall cabinet tops and bottoms shall be 3/4" thick particle board, laminated for balanced construction, surfaced as described in Article 2.02.C, and edged as described in Article 2.03.A.
- C. Wall cabinet top and bottom shall be 1" thick particle board, laminated for balanced construction, surfaced as described in Article 2.02.C, and edged as described in Article 2.03.A.
- D. Vertical cabinet members shall be 3/4" thick particle board, laminated for balanced construction, surfaced as described in Article 2.02.C, and edged as described in Article 2.03D.
- E. Cabinet backs shall be 1/4" thick pre-finished industrial hardboard.
- F. Frame rails shall be 3/4" thick x 3 3/4" wide particle board, laminated for balanced construction, surfaced as described in Article 2.02.C, and edged as described in Article 2.03.A.
- G. Sub base shall consist of two (2) toe kick support rails shall be 3/4" thick x 3 3/4" high particle board and be inset from cabinet front and back edge, to give additional load support.
- H. Mounting rails shall be 3/4" thick x 3 3/4" wide particle board. Wall cabinets shall have rails positioned at the top and bottom. Tall cabinets shall have rails positioned at the top and intermediate location. Base cabinet shall have rails positioned at the top of unit.
- I. Drawers shall be full box design with a separate front.

Drawer sides and ends shall be constructed of 5/8" medium density fiberboard with pearl or grey color thermofused melamine laminate and matching PVC top edges. Bottoms shall be 1/4" thick medium density fiberboard, pearl or grey color thermofused melamine laminate.

- J. Adjustable shelves shall be 1" thick. Edges of shelf shall be banded as described in Article 2.03.C with a high impact, rigid PVC extrusion, pearl or grey in color.
- K. Sliding display doors shall be constructed of 1/4" thick distortion free glazing sheet. Center edge shall be capped with full length aluminum channel. Aluminum channel shall be custom extruded, clear etched and anodized. Full length extruded aluminum channel shall be used on other edges.
- L. Solid hinged doors, sliding doors and drawer fronts shall be 3/4" thick material of balanced construction, surfaced as described in Section 2.02.B, edged as described in Article 2.03.B.

2.07 CONSTRUCTION

- A. Cabinet parts shall be accurately machined and precision bored for premium grade quality joinery construction, utilizing automatic machinery to ensure consistent sizing on modular cabinets. Cabinets shall be assembled under controlled case clamp conditions, assuring final cabinet squareness and proper joint compressions.
- B. Cabinet ends shall be bored to receive 8mm, industrial grade hardwood laterally fluted dowels with chamfered ends. Cabinet ends shall be prepared to receive adjustable shelf hardware at 32mm (approximately 1 1/4") centers. Door hinges and drawer slides shall be machined drilled to maintain vertical and horizontal alignment of components. Inset grooving with chamfer shall be machined 3/4" from rear edge to accept the 1/4" back. Base and tall units shall have one piece end panels continuous to floor for added load capabilities.
- C. Tops and bottoms shall be joined to cabinet ends using a minimum of six (6) dowels at each joint for twenty-four (24) inch deep cabinets and a minimum of four (4) dowels at each joint, for twelve (12) inch deep cabinets. All dowels to be industrial grade hardwood, laterally fluted, with chamfered ends and 8mm in diameter. Top of base cabinet will be full depth. Inset grooving with chamfer

shall be machined 3/4" from rear edge to accept the 1/4" back.

- D. Vertical dividers shall be bored to receive adjustable shelf hardware at 32 mm (approximately 1 1/4") centers. Dividers shall be joined to tops and bottoms with 8mm diameter hardwood dowels.
- E. Frame rails shall be joined to ends with 8mm diameter hardwood dowels.
- F. Two (2) toe kick supports shall be inset from cabinet front and back edges, and doweled into cabinet ends with 8mm hardwood dowels.
- G. Mounting rails shall be fully concealed behind backs. Rails shall be 3/4" thick and fastened to cabinet ends with 8mm hardwood dowels. Wall and tall cabinet shall incorporate two mounting rails. Wall cabinets shall have rails positioned at top and bottom. Tall cabinets shall have rails positioned at top and intermediate location. Base units shall have rail positioned in the upper back area.
- H. Back panels shall be 1/4" thick and inset 3/4" from rear edge of cabinet. Back shall be glued and continuously trapped in top, bottom and ends of cabinets.
- I. Drawer corner joints shall be interlocking dowel pin design. Hardwood dowel pins, 8mm diameter shall be inserted into drawer fronts and backs to fit into machined hole patterns in drawer sides. Bottoms shall be trapped into grooves on all four sides glued and mechanical fastened. Drawers shall be suspended on slides as described in Article 2.05.E.

2.08 WORK SURFACES

- A. Core material having particle board shall be of a minimum 45 lb. density, M-2 industrial grade. The particle board used shall have been tested under ANSI A208.1 1993 standards and/or ASTM D 1037-91A.
- B. Surface material shall be high pressure decorative plastic laminate thermoset to core using catalyzed PVA glue with a minimum average pressure of 90 PSI and average 180 degree F temperature. High pressure decorative plastic laminate shall meet NEMA LD 3-1995, HGP.039 specification standards.
- C. Color selection shall be high pressure decorative plastic

lamine selections as depicted in manufacturer's color selector guide. A minimum of seventy (70) colors and patterns shall be available as standard selection.

- D. Exposed edges shall be 90 degree plastic laminate with a chamfered edge.
- E. Underside of all work surfaces to have BK-20 backer or approved equivalent. This balance sheet shall be thermoset to core using catalyzed PVA glue with a minimum average pressure of 90 PSI and average 180 degree F. temperature.

F. Counter Tops - Plastic Laminate

1. Deck shall consist of two layers of 3/4" (19 mm) particle board at the front edge and all other exposed edges providing a total thickness of 1 1/2" (40 mm). Solid patterns or wood grain colors of ONLY WILSONART brand high-pressure plastic laminate may be selected for the surfaces. The method of application of the laminate to the substrate shall be as recommended by the Decorative Plastic Laminate Association.

2. Provide loose back splashes without scribes.

G. Physical Properties shall meet minimally:

1. Flexural Strength	ASTM-Method D-790	16,000/psi
2. Compressive Strength	ASTM-Method D-695	36,500/psi
3. Hardness Rockwell M	ASTM-Method D-785	110
4. Density Gr./CC.	ASTM-Method D-792	123.55 lbs/ft ³
5. Water Absorption	ASTM-Method D-570	0.0076%
6. Flame Test	ASTM-Method D-635	Self-Extinguishing

2.09 GLASS

- A. Wall unit full sliding glass doors: 1/4 inch laminated safety glass.
- B. Glass insert doors, hinged or sliding wall cabinets: 1/4 inch laminated safety glass.
- C. Glass insert doors, hinged or sliding tall or base cabinets. 1/4 inch laminate safety glass.
- D. Sliding doors mounted in aluminum track.
- E. Trim glass inserts: Extruded rigid PVC.

2.10 COLOR SELECTION

- A. Laminate Color Selection:
 - 1. Select from the full range of ONLY Wilsonart®, standard color charts for cabinet faces, exposed ends, open interiors and countertops.
- B. Hinge and Pull Color Selection:
 - 1. Select from full range of stock and custom colors to coordinate/match: Wilsonart®.
- C. Miscellaneous Hardware Color Selection (support brackets, table frames, rail):
 - 1. Select from full range of stock and custom colors to coordinate/match: Wilsonart®.
- D. 3mm PVC Edge Banding Color Selection:
 - 1. Select from full range of stock and custom colors to coordinate/match: Wilsonart®.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The Installer must examine the job site and the conditions under which the work in this section is to be performed, and notify the Construction Manager in writing of any unsatisfactory conditions. Do not proceed with work under this section until unsatisfactory conditions have been corrected in a manner acceptable to the installer.
- B. Casework, countertops, and related materials to be conditioned to average prevailing humidity condition in installation areas prior to start of work.
- C. Install casework and countertops with factory-trained supervision authorized by manufacturer. Casework shall be installed plumb, level, true and straight with no distortions. (Shim as required). Securely attached to building structure with anchorage devices of appropriate type, size and quantity to meet applicable codes, specifications and safety conditions. Where laminate clad casework and countertops abuts other finished work, scribe and trim to accurate fit.
- D. Adjust casework and hardware so that doors and drawers

operate smoothly without warp or bind. Lubricate operating hardware as recommended by the manufacturer.

- E. Repair, or remove and replace, defective work as directed upon completion of installation.
- F. Clean plastic surfaces, repair minor damage per plastic laminate manufacturer's recommendations. Replace other damaged parts of units.
- G. Advise Construction Manager of procedures and precautions for protection of casework and countertops from damage by other trades until acceptance of work by Owner.
- H. Cover casework with 4-mil polyethylene film for protection against soiling and deterioration during remainder of construction period.

END OF SECTION 12300

SECTION 12492 - WINDOW TREATMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Attention is directed to Division 0, Bidding and Contract Requirements, and to Division 1, General Requirements, which are hereby made a part of this Section.

1.02 DESCRIPTION OF WORK:

- A. The extent of window treatments is shown on the drawings.

1.03 SECTION INCLUDES:

- A. Window shades and accessories for glare and sunlight control.

1.04 QUALITY ASSURANCE:

- A. Manufacturer: Provide window treatments manufactured by one of the following:
 - 1. Draper.(Basis of Design)
 - 2. Hunter Douglas

1.05 PRODUCTS SUPPLIED:

- A. Furnish and install manual FlexShade System manufactured by Draper, Inc., 411 South Pearl Street, Spiceland, IN 47385. Phone number: (765)987-7999 Fax: (765) 987-7142. Contact: Art Tober (586) 416-0829, atober@draperinc.com

1.06 SUBMITTALS:

- A. Manufacturer's Product Data: Submit manufacturer's descriptive product data and installation instructions for each type of window treatment specified.
- B. Shop Drawings: Submit, indicating the following:
 - 1. Room schedule with field-verified dimensions of openings scheduled to receive manual FlexShades with brackets, fascia and endcaps, outside mount just beyond window mullion (unless indicated otherwise).
 - 2. Indicate fabric selection, operator, hardware style, and all associated material required for a complete installation.

1.07 PRODUCT DELIVERY

- A. Deliver to job site in manufacturer's original cartons.
- B. Manual FlexShades to be labeled according to room schedule.
- C. Manual FlexShades to be carefully handled and stored to prevent damage to materials, finishes, and operating mechanisms.
- D. Installer responsible for acceptable installation.

PART 2 - PRODUCT

2.01 MANUFACTURED UNITS

- A. Provide SheerWeave Series SW2703 fabric by Phifer-FlexShades as manufactured by Draper Systems Inc., Spiceland, IN. Color to be selected by Owner from manufacturer's standard colors. Exterior color shall be white.
 - 1. Shade fabric shall be as follows: A glare control shade fabric shall be 36% fiberglass, 64% vinyl on fiberglass, woven into a duplex basketweave pattern; washable and flame-retardant.
 - a. Fire Rating:
 - 1. NFPA - 701-1999 TM #1 (small scale)
 - 2. NFPA - 101 (Class A rating)
 - b. Fabric shall be min. 14.00 oz/s.y., .028" thick.
 - c. Fabric shall be avg. 3% open.
 - d. Roll width - window openings are shown on the drawings. Field verify each window opening.
 - e. Meet requirements of ASTM G-21 fungal growth testing and ASTM-G22.
 - 2. Provide manual FlexShade System using bead chain clutch operator with chain hold down device (mounted on RH side of shade, unless noted otherwise) and brackets, fascia and endcaps. Provide all mounting hardware for a complete system.

- a. For shades located in upper clerestory windows where the bottom of the opening is greater than 7'-0" A.F.F., provide bead chain in extended lengths to reach to 48" A.F.F. Verify all window heights in field.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Installer must examine the substrates and conditions under which the window treatments are to be installed, and notify the Construction Manager in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.
- B. Install in locations and at mounting height to comply with governing authorities. Prepare recesses in walls as required. Securely fasten to structure, square and plumb, in accordance with manufacturer's instructions.
- C. Install manual FlexShade System in accordance with Draper's specifications, standards and procedures as detailed in installation instructions. Installation contractor to be responsible for site measurements and suitability of mounting surfaces.
- D. Manufacturer's standard (25) year limited warranty applies.

END OF SECTION 12492

SECTION 12492 - WINDOW TREATMENT
FARMINGTON HIGH SCHOOL: RE-BID

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Attention is directed to Division 0, Bidding and Contract Requirements, and to Division 1, General Requirements, which are hereby made a part of this Section.

1.02 DESCRIPTION OF WORK:

- A. The extent of window treatments is shown on the drawings.

1.03 SECTION INCLUDES:

- A. Window shades and accessories for glare and sunlight control.

1.04 QUALITY ASSURANCE:

- A. Manufacturer: Provide window treatments manufactured by one of the following:
 - 1. Draper.(Basis of Design)
 - 2. Hunter Douglas
 - 3. OpenLight

1.05 PRODUCTS SUPPLIED:

- A. Furnish and install manual FlexShade System manufactured by Draper, Inc., 411 South Pearl Street, Spiceland, IN 47385. Phone number: (765)987-7999 Fax: (765) 987-7142. Contact: Art Tober (586) 416-0829, atober@draperinc.com

1.06 SUBMITTALS:

- A. Manufacturer's Product Data: Submit manufacturer's descriptive product data and installation instructions for each type of window treatment specified.
- B. Shop Drawings: Submit, indicating the following:
 - 1. Room schedule with field-verified dimensions of openings scheduled to receive manual FlexShades with brackets, fascia and endcaps, outside mount just beyond window mullion (unless indicated otherwise).

2. Indicate fabric selection, operator, hardware style, and all associated material required for a complete installation.

1.07 PRODUCT DELIVERY

- A. Deliver to job site in manufacturer's original cartons.
- B. Manual FlexShades to be labeled according to room schedule.
- C. Manual FlexShades to be carefully handled and stored to prevent damage to materials, finishes, and operating mechanisms.
- D. Installer responsible for acceptable installation.

PART 2 - PRODUCT

2.01 MANUFACTURED UNITS

- A. Provide SheerWeave Series SW2703 fabric by Phifer-FlexShades as manufactured by Draper Systems Inc., Spiceland, IN. Color to be selected by Owner from manufacturer's standard colors. Exterior color shall be white.
 1. Shade fabric shall be as follows: A glare control shade fabric shall be 36% fiberglass, 64% vinyl on fiberglass, woven into a duplex basketweave pattern; washable and flame-retardant.
 - a. Fire Rating:
 1. NFPA - 701-1999 TM #1 (small scale)
 2. NFPA - 101 (Class A rating)
 - b. Fabric shall be min. 14.00 oz/s.y., .028" thick.
 - c. Fabric shall be avg. 3% open.
 - d. Roll width - window openings are shown on the drawings. Field verify each window opening.
 - e. Meet requirements of ASTM G-21 fungal growth testing and ASTM-G22.

2. Provide manual FlexShade System using bead chain clutch operator with chain hold down device (mounted on RH side of shade, unless noted otherwise) and brackets, fascia and endcaps. Provide all mounting hardware for a complete system.
 - a. For shades located in upper clerestory windows where the bottom of the opening is greater than 7'-0" A.F.F., provide bead chain in extended lengths to reach to 48" A.F.F. Verify all window heights in field.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Installer must examine the substrates and conditions under which the window treatments are to be installed, and notify the Construction Manager in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.
- B. Install in locations and at mounting height to comply with governing authorities. Prepare recesses in walls as required. Securely fasten to structure, square and plumb, in accordance with manufacturer's instructions.
- C. Install manual FlexShade System in accordance with Draper's specifications, standards and procedures as detailed in installation instructions. Installation contractor to be responsible for site measurements and suitability of mounting surfaces.
- D. Manufacturer's standard (25) year limited warranty applies.

END OF SECTION 12492

SECTION 15010 - MECHANICAL GENERAL REQUIREMENTS

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUMMARY.....1
1.3 INDUSTRY STANDARDS.....2
1.4 PERFORMANCE REQUIREMENTS.....4
1.5 QUALITY ASSURANCE.....4
1.6 CODES, PERMITS AND FEES.....5
1.7 DRAWINGS.....5
1.8 MATERIAL AND EQUIPMENT MANUFACTURERS.....6
1.9 INSPECTION OF SITE.....7
1.10 ITEMS REQUIRING PRIOR APPROVAL7
1.11 SUBMITTALS8
1.12 COORDINATION DRAWINGS9
1.13 OPERATION AND MAINTENANCE INSTRUCTIONAL MANUALS9
1.14 RECORD DRAWINGS10
1.15 INSTRUCTION OF OWNER PERSONNEL11
1.16 WARRANTY11

PART 2 - PRODUCTS.....12

PART 3 - EXECUTION.....12
3.1 MECHANICAL DEMOLITION WORK.....12
3.2 REFRIGERANT HANDLING.....13
3.3 WORK IN EXISTING BUILDINGS.....13
3.4 TEMPORARY SERVICES.....14
3.5 WORK INVOLVING OTHER TRADES.....14
3.6 ACCEPTANCE PROCEDURE.....14

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to work of this Section.

1.2 SUMMARY

- A. This Section includes mechanical general administrative and procedural requirements. The following requirements are included in this Section to supplement the requirements specified in Division 01 Specification Sections.

1.3 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

1. AABC - Associated Air Balance Council; www.aabc.com.
2. AASHTO - American Association of State Highway and Transportation Officials; www.transportation.org.
3. ABMA - American Bearing Manufacturers Association; www.americanbearings.org.
4. ABMA - American Boiler Manufacturers Association; www.abma.com.
5. AGA - American Gas Association; www.aga.org.
6. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org.
7. AMCA - Air Movement and Control Association International, Inc.; www.amca.org.
8. ANSI - American National Standards Institute; www.ansi.org.
9. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.
10. ASME - ASME International; (American Society of Mechanical Engineers); www.asme.org.
11. ASSE - American Society of Sanitary Engineering; www.asse-plumbing.org.
12. ASTM - ASTM International; www.astm.org.
13. AWS - American Welding Society; www.aws.org.
14. AWWA - American Water Works Association; www.awwa.org.
15. CDA - Copper Development Association; www.copper.org.
16. CGA - Compressed Gas Association; www.cganet.com.
17. CISPI - Cast Iron Soil Pipe Institute; www.cispi.org.
18. CSA - CSA International; (Formerly: IAS - International Approval Services); www.csa-international.org.
19. CSI - Construction Specifications Institute (The); www.csinet.org.
20. CTI - Cooling Technology Institute; (Formerly: Cooling Tower Institute); www.cti.org.
21. FM Approvals - FM Approvals LLC; www.fmglobal.com.
22. HI - Hydraulic Institute; www.pumps.org.
23. ICC - International Code Council; www.iccsafe.org.

24. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
25. IGSHPA - International Ground Source Heat Pump Association; www.igshpa.okstate.edu.
26. Intertek - Intertek Group; (Formerly: ETL SEMCO; Intertek Testing Service NA); www.intertek.com.
27. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry Inc.; www.mss-hq.org
28. NADCA - National Air Duct Cleaners Association; www.nadca.com.
29. NAIMA - North American Insulation Manufacturers Association; www.naima.org.
30. NEBB - National Environmental Balancing Bureau; www.nebb.org.
31. NECA - National Electrical Contractors Association; www.necanet.org.
32. NEMA - National Electrical Manufacturers Association; www.nema.org.
33. NETA - InterNational Electrical Testing Association; www.netaworld.org.
34. NFPA - National Fire Protection Association; www.nfpa.org.
35. NSF - NSF International; www.nsf.org.
36. NSPE - National Society of Professional Engineers; www.nspe.org.
37. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
38. STI - Steel Tank Institute; www.steeltank.com.
39. TEMA - Tubular Exchanger Manufacturers Association, Inc.; www.tema.org.
40. UL - Underwriters Laboratories Inc.; www.ul.com.
41. USGBC - U.S. Green Building Council; www.usgbc.org.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.4 PERFORMANCE REQUIREMENTS

- A. Systems Components Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

1.5 QUALITY ASSURANCE

- A. Scope of Work: Furnish all labor, material, equipment, technical supervision, and incidental services required to complete, test and leave ready for operation the mechanical systems as specified and as indicated on Drawings.

1. Contract Documents are complimentary, and what is required by one shall be as binding as if required by all. In the event of inconsistencies or disagreements within the Construction Documents bids shall be based on the most expensive combination of quality and quantity of the work indicated.

- B. Ordinances and Codes: Perform all Work in accordance with applicable Federal, State and local ordinances and regulations, the Rules and Regulations of ASHRAE, NFPA, SMACNA and UL, unless otherwise indicated.

1. Notify the Architect/Engineer in writing before submitting a proposal should any changes in Drawings or Specifications be required to conform to the above codes, rules or regulations.

2. If the Contractor performs any work knowing it to be contrary to such laws, ordinances, rules and regulations, and without notice to A/E, the Contractor shall bear all costs arising from corrective measures.

- C. Source Limitations: Obtain equipment and other components of the same or similar systems through one source from a single manufacturer.

- D. Tests and Inspections: Perform all tests required by state, city, county and/or other agencies having jurisdiction. Provide all materials, equipment, etc., and labor required for tests.

- E. Performance Requirements: Perform all work in a first class and workmanlike manner, in accordance with the latest accepted standards and practices for the trades involved.

- F. Sequence and Schedule: Perform work to avoid interference with the work of other trades. Remove and relocate work which in the opinion of the Owner's Representatives causes interference.
- G. Labeling Requirement for Packaged Equipment: Electrical panels on packaged mechanical equipment shall bear UL label or label of other Nationally Recognized Testing Laboratory (NRTL) (Intertek, CSA, etc.).

1.6 CODES, PERMITS AND FEES

- A. Unless otherwise indicated, all required permits, licenses, inspections, approvals and fees for Mechanical Work shall be secured and paid for by the Contractor. All Work shall conform to all applicable codes, rules and regulations.
- B. Rules of local utility companies shall be complied with. Check with each utility company supplying service to the installation and determine all devices including, but not limited to, all valves, meter boxes, and meters which will be required and include the cost of all such items in proposal.
- C. All work shall be executed in accordance with the rules and regulations set forth in local and state codes. Prepare any detailed drawings or diagrams which may be required by the governing authorities. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern.
- D. Refer to Division 15 Section "Domestic Water Piping" for purchase and installation of potable water meters.

1.7 DRAWINGS

- A. The drawings show the location and general arrangement of equipment, piping and related items. They shall be followed as closely as elements of the construction will permit.
- B. Examine the drawings of other trades and verify the conditions governing the work on the job site. Arrange work accordingly. Provide fittings, valves, and accessories as required to meet actual conditions.

- C. Deviations from the drawings, with the exception of minor changes in routing and other such incidental changes that do not affect the functioning or serviceability of the systems, shall not be made without the written approval of the Architect/Engineer.
- D. The Architectural and Structural Drawings take precedence in all matters pertaining to the building structure, Mechanical Drawings in all matters pertaining to Mechanical Trades and Electrical Drawings in all matters pertaining to Electrical Trades. Where there are conflicts or differences between the drawings for the various trades, report such conflicts or differences to the Architect/Engineer for resolution.
- E. Drawings are not intended to be scaled for rough-in or to serve as shop drawings. Take all field measurements required to complete the Work.

1.8 MATERIAL AND EQUIPMENT MANUFACTURERS

- A. Equipment: All items of equipment shall be furnished complete with all accessories normally supplied with the catalog items listed and all other accessories necessary for a complete and satisfactory operating system. All equipment and materials shall be new and shall be standard products of manufacturers regularly engaged in the production of plumbing, heating, ventilating and air conditioning equipment and shall be the manufacturer's latest design.
- B. If an approved manufacturer is other than the manufacturer used as the basis for design, the equipment or product provided shall be equal in size, quality, durability, appearance, capacity, and efficiency through all ranges of operation, shall conform with arrangements and space limitations of the equipment shown on the plans and/or specified, shall be compatible with the other components of the system and shall comply with the requirements for Items Requiring Prior Approval specified in this section of the Specifications. All costs to make these items of equipment comply with these requirements including, but not limited to, piping, sheet metal, electrical work, and building alterations shall be included in the original Bid.

- C. All package unit equipment and skid mounted mechanical components that are factory assembled shall meet, in detail, the products named and specified within each section of the Mechanical and Electrical Specifications.
- D. Changes Involving Electrical Work: The design of the mechanical systems is based on the equipment scheduled on the Drawings. Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified with no additional cost to project. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
 - 1. Where equipment changes are made that involve additional Electrical Work (larger size motor, additional wiring of equipment, etc.) the Mechanical Trades involved shall compensate the Electrical Trades for the cost of the additional Work required.

1.9 INSPECTION OF SITE

- A. Visit the site, examine and verify the conditions under which the Work must be conducted before submitting Proposal. The submitting of a Proposal implies that the Contractor has visited the site and understands the conditions under which the Work must be conducted. No additional charges will be allowed because of failure to make this examination or to include all materials and labor to complete the Work.
- B. No contract sum adjustments or contract time extensions will be made for Contractor claims arising from conditions which were or could have been observable, ascertainable or reasonably foreseeable from a site visit or inquiry into local conditions affecting the execution of the work.

1.10 ITEMS REQUIRING PRIOR APPROVAL

- A. Bids shall be based upon manufactured equipment specified. All items that the Contractor proposes to use in the Work that are not specifically named in the Contract Documents must be submitted for review prior to bids. Such items must be submitted in compliance with Division 01 specifications. Requests for prior approval must be accompanied by complete catalog information, including but not limited to, model, size, accessories, complete

electrical information and performance data in the form given in the equipment schedule on the drawings at stated design conditions. Where items are referred to by symbolic designations on the drawings, all requests for prior approval shall bear the same designations.

1. Equipment to be considered for prior approval shall be equal in quality, durability, appearance, capacity and efficiency through all ranges of operation, shall fulfill the requirements of equipment arrangement and space limitations of the equipment shown on the plans and/or specified and shall be compatible with the other components of the system.
2. All costs incurred to make equipment comply with other requirements, including providing maintenance, clearance, piping, sheet metal, electrical, replacement of other components, and building alterations shall be included in the original bid.

- B. Voluntary alternates may be submitted for consideration, with listed addition or deduction to the bid, but will not affect the awarding of the contract.

1.11 SUBMITTALS

- A. Submit project specific submittals for review in compliance with Division 01.
- B. Prepare shop drawings to scale for the Architect/Engineer for review. Equipment and material submittals required are indicated in the Mechanical; Fire Suppression; Plumbing; and Heating, Ventilating and Air Conditioning Sections. Refer to Division 01 for submittal quantities.
- C. All submittals shall be submitted in groupings of similar and/or related items. Plumbing fixture submittals shall be submitted as one package including all fixtures intended to be used for this project. Incomplete submittal groupings will be returned "Rejected". Submit shop drawing with identification mark number or symbol numbers as specified or scheduled on the Mechanical Drawings.
- D. All submittals shall be project specific. Standard detail drawings and schedule not clearly indicating which data is associated with this Project will be returned "Rejected".
- E. Shop drawings shall be reviewed by the Mechanical Contractor for completeness and accuracy prior to

submitting to the Architect/Engineer for review. The shop drawings shall be dated and signed by the Mechanical Contractor prior to submission.

- F. No equipment shall be shipped from stock or fabricated until shop drawings for them have been reviewed by the Architect/Engineer. Review is only for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. Any action indicated is subject to the requirement of the plans and specifications.
 - 1. By the review of shop drawings, the Architect/Engineer does not assume responsibility for actual dimensions or for the fit of completed work in position, nor does such review relieve Mechanical Trades of full responsibility for the proper and correct execution of the work required.
 - 2. Contractor is responsible for:
 - a. Dimensions, which shall be confirmed and correlated at the job site.
 - b. Fabrication processes and techniques of construction.
 - c. Quantities.
 - d. Coordination of Contractor's work with all other trades.
 - e. Satisfactory performance of Contractor's work.
 - f. Temporary aspects of the construction process.
- G. Submit detailed shop drawings of piping systems showing pipe routing and types and locations of all pipe hangers.
- H. If deviations (not substitutions) from Contract Documents are deemed necessary by the Contractor, details of such deviations, including changes in related portions of the project and the reasons therefore, shall be submitted with the submittal for approval.

1.12 COORDINATION DRAWINGS

- A. Submit project specified coordination drawings for review in compliance with Division 01 Specification Sections.

1.13 OPERATION AND MAINTENANCE INSTRUCTIONAL MANUALS

- A. Submit project specific Operation and Maintenance Instructional Manuals for review in compliance with Division 01 Specification Sections.

- B. Provide complete operation and maintenance instructional manuals covering all mechanical equipment herein specified, together with parts lists. Maintenance and operating instructional manuals shall be job specific to this project. Generic manuals are not acceptable. One copy of all manuals shall be furnished for Owner. Maintenance and operating instructional manuals shall be provided when construction is approximately 75 percent complete.
- C. Format: Submit operations and maintenance manuals in the following format:
1. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to Architect.
 - a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.
 - b. Enable inserted reviewer comments on draft submittals.
- D. The operating and maintenance instructions shall include a brief, general description for all mechanical systems including, but not limited to:
1. Routine maintenance procedures.
 2. Lubrication chart listing all types of lubricants to be used for each piece of equipment and the recommended frequency of lubrication.
 3. Trouble-shooting procedures.
 4. Contractor's telephone numbers for warranty repair service.
 5. Submittals.
 6. Recommended spare parts lists.
 7. Names and telephone numbers of major material suppliers and subcontractors.
 8. System schematic drawings.

1.14 RECORD DRAWINGS

- A. Submit record drawings in compliance with Division 01.
- B. Contractor shall submit to the Architect/Engineer, record drawings on electronic media or vellum which have been neatly marked to represent as-built conditions for all new mechanical work.

- C. The Contractor shall keep accurate note of all deviations from the construction documents and discrepancies in the underground concealed conditions and other items of construction on field drawings as they occur. The marked up field documents shall be available for review by the Architect, Engineer and Owner at their request.

1.15 INSTRUCTION OF OWNER PERSONNEL

- A. Before final inspection, instruct Owner's designated personnel in operation, adjustment, and maintenance of mechanical equipment and systems at agreed upon times. A minimum of 24 hours of formal instruction to Owner's personnel shall be provided for each building. Additional hours are specified in individual specification sections.
- B. For equipment requiring seasonal operation, perform instructions for other seasons within six months.
- C. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
- D. In addition to individual equipment training provide overview of each mechanical system. Utilize the as-built documents for this overview.
- E. Prepare and insert additional data in operation and maintenance manual when need for such data becomes apparent during instruction.

1.16 WARRANTY

- A. Warranty: Comply with the requirements in Division 01 Specification Sections. Contractor shall warranty that the mechanical installation is free from defects and agrees to replace or repair, to the Owner's satisfaction, any part of this mechanical installation which becomes defective within a period of one year (unless specified otherwise in other Mechanical; Fire Suppression; Plumbing; or Heating, Ventilating and Air Conditioning Sections) from the date of substantial completion following final acceptance, provided that such failure is due to defects in the equipment, material, workmanship or failure to follow the contract documents.

- B. File with the Owner any and all warranties from the equipment manufacturers including the operating conditions and performance capacities they are based on.

PART 2 - PRODUCTS

- A. Not Applicable

PART 3 - EXECUTION

3.1 MECHANICAL DEMOLITION WORK

- A. All demolition of existing mechanical equipment and materials shall be done by the Contractor unless otherwise indicated. Include all items such as, but not limited to, existing piping, draining of piping, pumps, ductwork, supports and equipment where such items are not required for the proper operation of the modified system.
- B. In general, demolition work is indicated on the Drawings. However, the Contractor shall visit the job site to determine the full extent and character of this Work.
- C. Unless specifically noted to the contrary, removed materials shall not be reused in the work. Salvaged materials that are to be reused shall be stored safe against damage and turned over to the appropriate trade for reuse. Salvaged materials of value that are not to be reused shall remain the property of the Owner unless such ownership is waived. Remove items from the systems and turn over to the Owner in their condition prior to removal. The Owner shall move and store these materials. Items on which the Owner waives ownership shall become the property of the Contractor, who shall remove and legally dispose of same, away from the premises.
- D. Work that has been cut or partially removed shall be protected against damage until covered by permanent construction.
- E. Clean and flush the interior and exterior of all existing relocated equipment and its related piping, valves, and accessories that are to be reused of all mud, debris, pipe dope, oils, welding slag, loose mill scale, rust and other extraneous material so that the existing equipment and all accessories can be repainted and repaired as required to place in first-class working condition.

- F. Where existing equipment is to be removed, cap piping under floor, behind face of wall, above ceiling or at mains. Cap or plug piping with same or compatible piping material.
- G. Cap ductwork and cap piping immediately adjacent to demolition as soon as demolition commences in order to allow existing systems to remain in operation.
 - 1. Cap or plug piping with same or compatible piping material.
 - 2. Cap or plug ducts with same or compatible ductwork material.

3.2 REFRIGERANT HANDLING

- A. Refrigerant Installation and Disposal: Perform all work related to refrigerant contained in chillers, cooling coils, air conditioners, and similar equipment, including related piping, in strict accordance with the following requirements:
 - 1. ASHRAE Standard 15 and Related Revisions: Safety Code for Mechanical Refrigeration.
 - 2. ASHRAE Standard 34 and Related Revisions: Number Designation and Safety Classification of Refrigerants.
 - 3. United States Environmental Protection Agency (US EPA) requirements of Section 8 08 (Prohibition of Venting and Regulation of CFC) and applicable State and Local regulations of authorities having jurisdiction.
- B. Recovered refrigerant is the property of the Contractor. Dispose of refrigerant legally, in accordance with applicable rules and regulations.

3.3 WORK IN EXISTING BUILDINGS

- A. The Owner will provide access to existing buildings as required. Access requirements to occupied buildings shall be identified on the project schedule. The Contractor, once Work is started in the existing building, shall complete same without interruption so as to return work areas as soon as possible to Owner.
- B. Adequately protect and preserve all existing and newly installed Work. Promptly repair any damage to same at Contractor's expense.

- C. Consult with the Owner's Representative as to the methods of carrying on the Work so as not to interfere with the Owner's operation any more than absolutely necessary. Accordingly, all service lines shall be kept in operation as long as possible and the services shall only be interrupted at such time as will be designated by the Owner's Representative.
- D. Prior to starting work in any area, obtain approval for doing so from a qualified representative of the Owner who is designated and authorized by the Owner to perform testing and abatement, if necessary, of all hazardous materials including but not limited to, asbestos. The Contractor shall not perform any inspection, testing, containment, removal or other work that is related in any way whatsoever to hazardous materials under the Contract.

3.4 TEMPORARY SERVICES

- A. Provide temporary service as described in Division 01.
- B. The existing building will be occupied during construction. Maintain mechanical services and provide necessary temporary connections and their removal at no additional cost to the Owner.

3.5 WORK INVOLVING OTHER TRADES

- A. Certain items of equipment or materials specified in the Mechanical Division may have to be installed by other trades due to code requirements or union jurisdictional requirements. In such instances, the Contractor shall complete the work through an approved, qualified subcontractor and shall include the full cost for same in proposal.

3.6 ACCEPTANCE PROCEDURE

- A. Upon successful completion of start-up and recalibration, but prior to building acceptance, substantial completion and commencement of warranties, the Architect/Engineer shall be requested in writing to observe the satisfactory operation of all mechanical control systems.
- B. The Contractor shall demonstrate operation of equipment and control systems, including each individual component, to the Owner and Architect/Engineer.

- C. After correcting all items appearing on the punch list, make a second written request to the Owner and Architect/Engineer for observation and approval.
- D. After all items on the punch list are corrected and formal approval of the mechanical systems is provided by the Architect/Engineer, the Contractor shall indicate to the Owner in writing the commencement of the warranty period.
- E. Operation of the following systems shall be demonstrated:
 - 1. Air Handling Systems.
 - 2. Refrigeration Systems.
 - 3. Chilled Water Systems.
 - 4. Heating Systems.
 - 5. Domestic Hot Water Heaters.
 - 6. Domestic Hot Water Mixing Stations.
 - 7. Energy Recovery Systems.
 - 8. Temperature Controls.
 - 9. Building Automation System.
 - 10. Exhaust Systems.
- F. For systems requiring seasonal operation, demonstrate system performance within six months when weather conditions are suitable.

END OF SECTION

SECTION 15050 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL.....	2
1.1 RELATED DOCUMENTS.....	2
1.2 SUMMARY.....	2
1.3 DEFINITIONS.....	2
1.4 SUBMITTALS.....	3
1.5 QUALITY ASSURANCE.....	3
1.6 DELIVERY, STORAGE, AND HANDLING.....	4
1.7 COORDINATION.....	5
PART 2 - PRODUCTS.....	6
2.1 MANUFACTURERS.....	6
2.2 PIPE, TUBE, AND FITTINGS.....	6
2.3 JOINING MATERIALS.....	6
2.4 PIPE THREAD COMPOUNDS.....	8
2.5 TRANSITION FITTINGS.....	9
2.6 DIELECTRIC FITTINGS.....	10
2.7 MODULAR MECHANICAL SEALS.....	11
2.8 SLEEVES.....	12
2.9 ESCUTCHEONS.....	12
2.10 GROUT.....	13
2.11 EPOXY BONDING COMPOUND.....	13
2.12 PIPE ROOF PENETRATION ENCLOSURES.....	13
PART 3 - EXECUTION.....	14
3.1 PIPING SYSTEMS - COMMON REQUIREMENTS.....	14
3.2 PIPING JOINT CONSTRUCTION.....	19
3.3 ACCESS DOORS.....	23
3.4 EQUIPMENT CONNECTIONS.....	23
3.5 PIPING CONNECTIONS.....	24
3.6 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS.....	24
3.7 PAINTING.....	25
3.8 CONCRETE BASES.....	25
3.9 ERECTION OF METAL SUPPORTS AND ANCHORAGES.....	26
3.10 EPOXY BONDING TO EXISTING MATERIALS.....	26
3.11 JACKING OF PIPE.....	26
3.12 ERECTION OF WOOD SUPPORTS AND ANCHORAGES.....	27
3.13 GROUTING.....	27
3.14 CUTTING, CORING AND PATCHING.....	27
3.15 EXCAVATION AND BACKFILLING.....	27
3.16 FLASHING.....	28
3.17 LUBRICATION.....	28
3.18 FILTERS.....	28
3.19 CLEANING.....	29

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 15 Section "Mechanical General Requirements."
 - 2. Division 15 Section "Domestic Water Piping" for flushing and cleaning of potable water piping.
 - 3. Division 15 Section "Piping Systems Flushing and Chemical Cleaning" for flushing and cleaning of HVAC piping.

1.2 SUMMARY

- A. This section includes mechanical materials and installation methods common to mechanical piping systems, sheetmetal systems and equipment. This section supplements all other Division 13 Fire Protection Sections, Division 15 Mechanical Sections, and Division 01 Specification Sections.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
1. CPVC: Chlorinated polyvinyl chloride plastic.
 2. PE: Polyethylene plastic.
 3. PVC: Polyvinyl chloride plastic.
 4. RTRF: Reinforced thermosetting resin (fiberglass) fittings.
 5. RTRP: Reinforced thermosetting resin (fiberglass) pipe.
- G. The following are industry abbreviations for rubber materials:
1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Product Data: For the following:
1. Transition fittings.
 2. Dielectric fittings.
 3. Mechanical sleeve seals.
 4. Escutcheons.
- B. Welding certificates.
- C. Brazing Certificates: As required by ASME Boiler and Pressure Vessel Code, Section IX, or AWS B2.2.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.
- B. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for potable domestic water piping and components.

- C. Comply with NSF 372, "Drinking Water System Components - Lead Content" for potable domestic water piping and components.
 - D. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
 - E. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
 - F. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
 - G. Soldering: Qualify processes and operators according to AWS B2.3/2.3M, "Specification for Soldering Procedure and Performance Qualification."
 - H. Installer Qualifications:
 - 1. Installers of Grooved Components: Installers shall be certified by the grooved component manufacturer as having been trained and qualified to join piping with grooved couplings, fittings, and specialties.
 - 2. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
- 1.6 DELIVERY, STORAGE, AND HANDLING
- A. Storage and Protection: Provide adequate weather protected storage space for all mechanical equipment and materials deliveries to the job site. Storage locations will be designated by the Owner's Representative. Equipment stored in unprotected areas must be provided with temporary protection.

1. Protect equipment and materials from theft, injury or damage.
2. Protect equipment outlets, pipe and duct openings with temporary plugs or caps.
3. Materials with enamel or glaze surface shall be protected from damage by covering and/or coating as recommended in bulletin "Handling and Care of Enameled Cast Iron Plumbing Fixtures", issued by the Plumbing Fixtures Manufacturer Association, and as approved.
4. Electrical equipment furnished by Mechanical Trades and installed by the Electrical Trades: Turn over to Electrical Trades in good condition, receive written confirmation of same.
5. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
6. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations. Coordinate with other trades to ensure accurate locations and sizes of mechanical spaces, chases, slots, shafts, recesses and openings.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Install Work to avoid interference with work of other trades including, but not limited to, Architectural and Electrical Trades. Remove and relocate any work that causes an interference at Contractor's expense.
- D. Coordinate requirements for and provide access panels and doors for mechanical items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."
- E. The mechanical trades shall be responsible for all damage to other work caused by their work or through the neglect of their workers.

1. All patching and repair of any such damaged work shall be performed by the trades which installed the work. The cost shall be paid by the Mechanical Trades.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 15 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 15 piping Sections for special joining materials not listed below.
- B. Unions: Pipe Size 2 Inches and Smaller:
 1. Ferrous pipe: Malleable iron ground joint type unions.
 2. Unions in galvanized piping system shall be galvanized.
 3. Copper tube and pipe: Bronze unions with soldered joints.
- C. Flanges: Pipe Sizes 2-1/2 Inch and Larger:
 1. Ferrous pipe: Standard weight, forged steel weld neck flanges.
 2. Copper tube and pipe: Slip-on bronze flanges.
- D. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- E. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated. Square head bolts and nuts are not acceptable.
- F. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- G. Solder Filler Metals: ASTM B 32, lead-free, antimony-free, silver-bearing alloys. Include water-flushable flux according to ASTM B 813.
- H. Brazing Filler Metals: Alloys meeting AWS A5.8.
 1. Use Type BcuP Series, silver-bearing, copper-phosphorus alloys for joining copper or bronze socket fittings with copper pipe. Flux is prohibited unless used with bronze fittings.
 2. Use Type Bag Series, cadmium-free silver alloys for joining copper with steel, stainless steel, or other ferrous alloys.
- I. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- J. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.
- K. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.

- L. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
- M. Solvent Cements for Joining ABS Piping: ASTM D 2235.
- N. Solvent Cements for Joining PVC to ABS Piping Transition: ASTM D 3138.
- O. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.4 PIPE THREAD COMPOUNDS

- A. Pipe thread compounds for the fluid service compatible with piping materials provided.
- B. Compounds for potable water service and similar applications acceptable to U.S. Department of Agriculture (USDA) or Food and Drug Administration (FDA). Compounds containing lead are prohibited.
- C. Inorganic zinc-rich coatings or corrosion inhibited proprietary compounds for galvanized carbon steel systems to coat raw carbon steel surfaces, in lieu of subsequent painting.
 - 1. Manufacturers:
 - a. Carboline "Carbo-Zinc 12."
 - b. Tnemec.
 - c. Koppers.
- D. Graphite and oil or proprietary corrosion inhibited compounds suitable for system temperatures for steam or condensate.
 - 1. Manufacturers:
 - a. WKM; Division of Cooper Industries, Inc., Key "Graphite Paste."
 - b. Other approved.
- E. Use tetrafluoroethylene (Teflon) tape 2 to 3 mils thick for natural gas system threaded joints.
 - 1. Manufacturers:
 - a. Cadillac Plastic.

- b. Permacel.
- c. Other approved.

2.5 TRANSITION FITTINGS

- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

- 1. Manufacturers:

- a. Cascade Waterworks Mfg. Co.
- b. Dresser Industries, Inc.; DMD Div.
- c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
- d. JCM Industries.
- e. Smith-Blair, Inc.
- f. Viking Johnson.

- 2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
- 3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
- 4. Aboveground Pressure Piping: Pipe fitting.

- B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

- 1. Manufacturers:

- a. IPEX Inc. (formerly Eslon Thermoplastics).

- C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

- 1. Manufacturers:

- a. Thompson Plastics, Inc.

- D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

1. Manufacturers:

- a. NIBCO INC.
- b. NIBCO, Inc.; Chemtrol Div.

E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

1. Manufacturers:

- a. Cascade Waterworks Mfg. Co.
- b. Fernco, Inc.
- c. Mission Rubber Company.
- d. Plastic Oddities, Inc.
- e. Can-Tex Industries Division of Harsco Corp. "CT-Adaptors".
- f. Joint Inc., "Caulder".

2.6 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Brass Unions, Brass Nipples, Brass Couplings: For systems up to 286 deg F.

D. Dielectric-Flange Kits: Include full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Manufacturers:

- a. Advance Products & Systems, Inc.
- b. Calpico, Inc.
- c. Capitol Manufacturing Co.
- d. Central Plastics Company.
- e. Epco Sales, Inc.
- f. Pipeline Seal and Insulator, Inc.
- g. Watts Water Technologies, Inc.; Watts Regulator Co.

- h. Zurn Industries, Inc.; Wilkins Div.
 - 2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
 - E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; female NPT threaded ends; and 300-psig minimum working pressure at 225 deg F.
 - 1. Manufacturers:
 - a. Lochinvar Corp.; V-Line Insulating Couplings.
 - F. Dielectric Nipple/Waterway Fittings: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, male NPT threaded, or grooved ends; and 300-psig minimum working pressure at 230 deg F.
 - 1. Manufacturers:
 - a. Anvil International, Inc.; Gruvlok Manufacturing; DI-LOK Nipples.
 - b. Elster Group; Perfection Corp.; ClearFlow.
 - c. Precision Plumbing Products, Inc.; ClearFlow.
 - d. Sioux Chief Manufacturing Co., Inc.
 - e. Tyco Fire & Building Products; Grinnell Mechanical Products; Figure 407 ClearFlow.
 - f. Victaulic Co. of America; Style 47 ClearFlow.
- 2.7 MODULAR MECHANICAL SEALS
- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve or pipe and core drilled hole.
 - 1. Manufacturers:
 - a. Advance Products & Systems, Inc.; Innerlynx.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.; Thunderline Link Seal.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.8 SLEEVES

- A. Steel Pipe: ASTM A53, Type E, Grade B, Schedule 40, and 0.375 inch wall black.
- B. Steel Pipe: ASTM A53, Type E, Grade B, Schedule 40, and 0.375 inch wall galvanized, plain ends.
- C. Water Stop: Cast or ductile-iron; fabricated steel; PVC; or rotationally molded HDPE pipe; with plain ends and integral water stop, unless otherwise indicated.

1. Manufacturers:

- a. Advance Products & Systems, Inc.; Infinity and Gal-Vo-Plast Sleeves.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

2.9 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

1. New Piping:

- a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.

- b. Chrome-Plated Piping or Piping in High Humidity Areas: One-piece, cast-brass type with polished chrome-plated finish.
- c. Insulated Piping: One-piece, stamped-steel type with spring clips.
- d. Bare Piping in Finished Spaces: One-piece, stamped-steel type.
- e. Bare Piping in Unfinished Service Spaces or Equipment Rooms: Split-plate, stamped-steel type with concealed hinge and set screw.

2. Existing Piping: Use the following:

- a. Chrome-Plated Piping or Piping in High Humidity Areas: Split-casting, cast-brass type with chrome-plated finish.
- b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.
- c. Bare Piping: Split-plate, stamped-steel type with set screw or spring clips.

2.10 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.11 EPOXY BONDING COMPOUND

- A. Two-component system suitable for bonding wet or dry concrete to each other and to other materials.

B. Manufacturers:

1. Euco 452 #450; Euclid Chemical Co.
2. Epobond; L & M Construction Chemicals.
3. Sikadur 87; Sika Corp.

2.12 PIPE ROOF PENETRATION ENCLOSURES

- A. Manufacturers:

1. Pate Company (The).
 2. Portals Plus, Inc.
 3. Thybar Corporation; Thycurb.
- B. Minimum 18 gage welded galvanized steel construction.
- C. Integral base plate.
- D. Built-in fully mitered cant.
- E. Factory installed insect and decay resistant wood nailer.
- F. Factory installed 1-1/2 inch thick, 3 pounds per cubic foot density rigid insulation.
- G. EPDM compression molded rubber cap for single or multiple pipes as required.
- H. Stainless steel draw-band clamps.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Refer to piping application schedules on the Drawings.
- B. Install piping according to the following requirements and Division 15 Sections specifying piping systems, and in accordance with manufacturer's instructions.
- C. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. The Drawings shall be followed as closely as elements of construction will permit.
- D. During the progress of construction, protect open ends of pipe, fittings, and valves to prevent the admission of foreign matter. Place plugs or flanges in the ends of all installed work whenever work stops. Plugs shall be commercially manufactured products.
- E. Prior to and during laying of pipe, maintain excavations dry and clear of water and extraneous materials. Provide minimum 4 inches of clearance in all directions for pipe passing under or through building grade beams.

- F. Weld-o-lets and thread-o-lets can be used for annular flow measuring devices, temperature control components, and thermal wells in steel pipe. Pipe taps shall be drilled and deburred. Torch cutting is not acceptable.
- G. Brazolets can be used for annular flow measuring devices, temperature control components, and thermal wells in copper tube. Pipe taps shall be drilled and deburred. Torch cutting is not acceptable.
- H. Clean and lubricate elastomer joints prior to assembly.
- I. Clean damaged galvanized surfaces and touch-up with a zinc rich coating.
- J. Install piping to conserve building space and not interfere with use of space.
- K. Group piping whenever practical at common elevations.
- L. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- M. Slope piping and arrange systems to drain at low points.
- N. Slope horizontal piping containing noncondensable gases 1 inch per 100 feet, upward in the direction of the flow.
- O. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- P. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- Q. In concealed locations where piping, other than black steel, cast-iron, or galvanized steel, is installed through holes or notches in studs, joists, rafters or similar members less than 1-1/2 inches from the nearest edge of the member, the pipe shall be protected by shield plates. Protective shield plates shall be a minimum of 1/16 inch thick steel, shall cover the area of the pipe where the member is notched or bored, and shall extend a minimum of 2 inches above sole plates and below top plates.

- R. Do not penetrate building structural members unless specifically indicated on drawings.
- S. Install piping above accessible ceilings to allow sufficient space for ceiling panel and light fixture removal.
- T. Install valves with stems upright or horizontal, not inverted.
- U. Provide clearance for installation of insulation and access to valves and fittings.
- V. Install piping to permit valve and equipment servicing. Do not install piping below valves and/or terminal equipment. Do not install piping above electrical equipment.
- W. Install piping at indicated slopes. Provide drain valves with hose end connections and caps at all piping low points, where piping is trapped and at all equipment.
- X. Install piping free of sags and bends.
- Y. Install fittings for changes in direction and branch connections.
- Z. Unless otherwise indicated or specified, install branch connections to mains using tee fittings in main pipe:
 - 1. Branch connected to bottom of main pipe for HVAC systems. Side connection is acceptable. Connection above centerline of main is unacceptable. For up-feed risers, connect branch to top of main pipe.
 - 2. Branch connected to top of main for steam and condensate, plumbing systems, compressible gasses, and vacuum.
- AA. Install piping to allow application of insulation.
- BB. Select system components with pressure rating equal to or greater than system operating pressure.
- CC. After completion, fill, clean, and treat systems. Refer to Division 15 Sections "Hydronic Piping," "Piping Systems Flushing and Chemical Cleaning," and "HVAC Water Treatment."

- DD. Install escutcheons for penetrations of walls below ceiling, and ceilings.
- EE. Sleeves are not required for core-drilled holes in poured concrete walls.
- FF. Permanent sleeves are not required for holes formed by removable PE sleeves in poured concrete walls.
- GG. Install sleeves for pipes passing through footings and foundation walls, masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
1. Cut sleeves to length for mounting flush with both surfaces of walls.
 - a. Exception: Extend sleeves installed in floors 2 inches above finished floor level.
 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Schedule 40 Black Steel Sleeves: For pipes smaller than NPS 12 penetrating interior walls.
 - b. 0.375 Inch Wall Black Steel Sleeves: For pipes NPS 12 and larger penetrating interior walls.
 - c. Schedule 40 Galvanized Steel Sleeves: For pipes smaller than NPS 12 penetrating floors, and roof slabs.
 - d. 0.375 Inch Wall Galvanized Steel Sleeves: For pipes NPS 12 and larger penetrating floors and roof slabs.
 - e. For pipes penetrating floors with membrane water proofing provide cast iron sleeve with clamping flanges. Secure/seal membrane to sleeves with clamping flanges.
 4. Seal sleeves in concrete floors roof slabs and masonry walls with grout.
 5. Seal sleeves in plaster/gypsumboard partitions with plaster or dry wall compound and caulk with non-hardening silicone sealant to provide airtight installation.

6. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

HH. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and modular mechanical seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing modular mechanical seals.

1. Install Schedule 40 galvanized steel pipe for sleeves smaller than 12 inches in diameter.
2. Install 0.375 galvanized steel pipe for sleeves 12 inches and larger in diameter.
3. Modular Mechanical Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble modular mechanical seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

II. New, Poured Concrete, Underground, Exterior-Wall and Slab on Grade Pipe Penetrations: Install water stop sleeves prior to pour. Seal pipe penetrations using modular mechanical seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing modular mechanical seals.

1. Modular Mechanical Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble modular mechanical seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

JJ. Existing Underground, Exterior-Wall and Slab on Grade Pipe Penetrations: Seal core drilled pipe penetrations using modular mechanical seals. Allow for 1-inch annular clear space between pipe and cored opening for installing modular mechanical seals.

1. Modular Mechanical Seal Installation: Select type and number of sealing elements required for pipe material

and size. Position pipe in center of cored hole. Assemble modular mechanical seals and install in annular space between pipe and cored opening. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

KK. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Specification Sections for materials.

LL. Seal openings around pipes in sleeves and around duct openings through walls, floors and ceilings, and where floors, fire rated walls and smoke barriers are penetrated. Fire and/or smoke barriers shall be UL listed firestopping and shall have a fire rating equal to or greater than the penetrated barrier. Refer to Division 07 Specification Sections for materials.

MM. Pipe Roof Penetration Enclosures:

1. Coordinate delivery of roof penetration enclosures to jobsite.
2. Locate and set curbs on roof.
3. Framing, flashing, and attachment to roof structure are specified under Division 07.
4. Attach cap to curbs, cut pipe boots to fit pipe, and clamp boots to pipe or conduit.

NN. Verify final equipment locations for roughing-in.

OO. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 15 Sections specifying piping systems.

B. Cut piping square.

C. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

- D. Remove scale, slag, dirt, oil, and debris from inside and outside of pipe and fittings before assembly.
- E. Clean damaged galvanized surfaces and touch-up with a zinc rich coating.
- F. Use standard long sweep pipe fittings for changes in direction. No mitered joints or field fabricated pipe bends will be permitted. Short radius elbows may be used where specified or specifically authorized by the Architect.
- G. Make tee connections with screwed tee fittings, soldered fittings or specified welded connections. Make welded branch connections with either welding tees or forged branch outlet fittings in accordance with ASTM A234, ANSI B16.9 and ANSI B16.11. For forged branch outlets, furnish forged fittings flared for improved flow where attached to the run, reinforced against external strains and to full pipe-bursting strength requirements. "Fishmouth" connections are not acceptable.
- H. Use eccentric reducers for drainage and venting of pipe lines; bushings are not permitted.
- I. Provide pipe openings using fittings for all systems control devices, thermometers, gauges, etc. Drilling and tapping of pipe wall for connections is prohibited.
- J. Provide temperature sensing device thermal wells and similar piping specialty connections.
- K. Provide instrument connections except thermal wells with specified isolating valves at point of connection to system.
- L. Locate instrument connections in accordance with manufacturer's instructions for accurate read-out of function sensed. Locate instrument connections for easy reading and service of devices.
- M. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- N. Brazed Joints: Construct joints according to AWS's "Brazeing Handbook," "Pipe and Tube" Chapter.

- O. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- P. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
1. Weld-o-lets and thread-o-lets can be used for annular flow measuring devices, temperature control components, and thermal wells. Pipe taps shall be drilled and deburred. Torch cutting is not acceptable.
- Q. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on gaskets and bolt threads.
1. Assemble flanged joints with fresh-stock gasket and hex head nuts, bolts or studs. Make clearance between flange faces such that the connections can be gasketed and bolted tight without strain on the piping system. Align flange faces parallel and bores concentric; center gaskets on the flange faces without projection into the bore.
 2. Lubricate bolts before assembly to insure uniform bolt stressing. Draw up and tighten bolts in staggered sequence to prevent unequal gasket compression and deformation of the flanges. Do not mate a flange with a raised face to a companion flange with a flat face; machine the raised face down to a smooth matching surface and use a full face gasket. After the piping system has been tested and is in service at its maximum temperature, check bolting torque to provide required gasket stress.
- R. Grooved Joints: Assemble joints with grooved-end-pipe or grooved-end-tube coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's

written instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Galvanized piping shall be cut grooved to prevent damage to galvanizing on internal pipe surfaces. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved joint products. The manufacturer's representative shall periodically visit the jobsite and review installation. Contractor shall remove and replace any joints deemed improperly installed.

- S. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.
- T. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.
- U. Dissimilar-Metal Piping Joints: Construct joints using dielectric fittings compatible with both piping materials. Refer to Application Schedules on the Drawings.
- V. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
 - 3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 - 5. PVC Nonpressure Piping: Join according to ASTM D 2855.
 - 6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
- W. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

- X. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
 - Y. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
 - 1. Plain-End Pipe and Fittings: Use butt fusion.
 - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.
 - Z. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.
 - AA. Remake joints which fail pressure tests with new materials including pipe, fittings, gaskets and/or a filler.
- 3.3 ACCESS DOORS
- A. Provide access doors for installation by architectural trades. Provide access doors in the walls, as required to make all valves, controls, coils, motors, air vents, filters, electrical boxes and other equipment installed by the Contractor accessible. Minimum size 12 inches x 12 inches. Provide access doors in the ceiling, for accessibility as mentioned above, 24 inches x 24 inches minimum size. Areas with accessible ceilings (ceilings where lay-in panels are not fastened in place and can be individually removed without removal of adjacent tiles) will not require access doors. Refer to Division 08 Section "Access Doors and Frames" for manufacturers and model numbers and additional information.
 - B. When access doors are in fire resistant walls or ceilings, they shall bear the Underwriters' Laboratories, Inc., Label, with time design rating equal to or greater than the wall or ceiling unless they were a part of the tested assembly.
- 3.4 EQUIPMENT CONNECTIONS
- A. Make connections to equipment, fixtures, and other items included in the work in accordance with the submittals and rough-in measurements furnished by the manufacturers of the particular equipment furnished.

1. Any and all additional connections not shown on the drawings but shown on the equipment manufacturer's submittal or required for the successful operation of the equipment shall be installed as part of this Contract at no additional charge to the Owner.

B. All piping connections to pumps, coils, and other equipment shall be installed without strain at the pipe connection of this equipment. When directed, remove the bolts in flanged connections or disconnect piping to demonstrate that piping has been so connected.

3.5 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, where indicated on Drawings, at final connection to each piece of equipment and at all control valves.

2. Install flanges, in piping NPS 2-1/2 and larger, where indicated on Drawings, at final connection to each piece of equipment and at all control valves.

3.6 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated. Housekeeping pad locations and sizes shall be coordinated by mechanical contractor prior to the placement of concrete slabs.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

E. For suspended equipment, furnish and install all inserts, rods, structural steel frames, brackets and platforms

required. Obtain approval of Architect for same including loads, locations and methods of attachment.

- F. Equipment Rigging Over Roof Areas: Protect building structure against damage during equipment rigging. Make provisions to distribute load of equipment to main roof structure, and to prevent damage to roof decking, roofing, or purlins.
- G. The Contract Documents indicate items to be purchased and installed. The items are noted by a manufacturer's name, catalog number and/or brief description. The catalog number may not designate all the accessory parts for a particular application. Arrange with the manufacturer for the purchase of all items required for a complete installation.

3.7 PAINTING

- A. Painting of mechanical systems, equipment, and components is specified in Division 09.
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.8 CONCRETE BASES

- A. Concrete housekeeping pads for floor mounted mechanical equipment shall be provided by Architectural Trades.
- B. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases as shown on Drawings or specified, but not less than 4 inches larger in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates,

diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section.

3.9 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- C. Where pipe and/or equipment support members must be welded to structural building framing, Contractor shall seek prior approval from Architect and structural engineer. Scrape, brush clean, and apply one coat of zinc rich primer after welding.
- D. Field Welding: Comply with AWS D1.1.

3.10 EPOXY BONDING TO EXISTING MATERIALS

- A. Use epoxy bonding compound to set sleeves or pipes in existing concrete to bond new concrete and/or grout to existing materials or to bond dissimilar materials.
- B. The compound, when applied in accordance with the manufacturer's instructions, shall be capable of initial curing within 48 hours at temperatures as low as 40 deg F and shall be capable of bonding any combination of the following properly prepared materials: Wet or dry, cured or uncured concrete or mortar; vitrified clay; cast iron and carbon steel.

3.11 JACKING OF PIPE

- A. Do not jack pipe in place except upon prior approval of proposed materials and complete details of methods.

3.12 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor mechanical materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.13 GROUTING

- A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

3.14 CUTTING, CORING AND PATCHING

- A. Refer to Division 01 Specification Sections for requirements for cutting, coring, patching and refinishing work necessary for the installation of mechanical work.
- B. All cutting, coring, patching and repair work shall be performed by the Contractor through approved, qualified subcontractors. Contractor shall include full cost of same in bid.

3.15 EXCAVATION AND BACKFILLING

- A. Refer to Division 02 Specification Sections.

- B. Provide all excavation, trenching, tunneling and backfilling required for the mechanical work.
- C. Provide all pumping and/or well pointing required for the mechanical work.
- D. Provide foundations if required to support underground piping.
- E. Backfill all excavations with well-tamped granular material. Backfill all excavations under wall footings with lean mix concrete up to underside of footings and extend concrete within excavation a minimum of four (4) feet each side of footing. Granular backfill shall be placed in layers not more than 8 inches in thickness, 95 percent compaction throughout with approved compaction equipment. Tamp, roll as required. Excavated material shall not be used.

3.16 FLASHING

- A. Provide all flashing required for mechanical work. Refer to Division 07 Specification Sections.

3.17 LUBRICATION

- A. Provide all lubrication for the operation of the equipment until acceptance by the Owner. Contractor is responsible for all damage to bearings up to the date of acceptance of the equipment. Protect all bearings and shafts during installation. Thoroughly grease steel shafts to prevent corrosion. Provide covers as required for proper protection of all motors and other equipment during construction.

3.18 FILTERS

- A. Provide and maintain filters in air handling systems throughout the construction period and prior to final acceptance of the building. Do not run air handling equipment, including fan coil units, without all prefilters and final filters as specified.
- B. Immediately prior to final building acceptance by the Owner, Contractor shall:

1. Thoroughly wash, recharge and reinstall cleanable type air filters.
2. Replace all disposable type air filters with new units.

3.19 CLEANING

- A. Each Mechanical Trade shall be responsible for removing all debris daily as required to maintain the work area in a neat, orderly condition.
- B. After equipment, steam, condensate and HVAC water piping systems have been completed and tested, each entire system shall be cleaned and flushed. Refer to Division 15 Section "Piping Systems Flushing and Chemical Cleaning" for requirements. Provide temporary bypass piping and fittings, temporary valves and strainers, temporary water make-up piping with approved means of backflow prevention, and temporary pumps as needed to perform specified flushing and cleaning requirements.
- C. Prior to connection of new HVAC piping to existing HVAC piping systems, all new piping shall be subject to initial flushing, cleaning and final flushing. Refer to Division 15 Section "Piping Systems Flushing and Chemical Cleaning" for requirements. Provide temporary bypass piping and fittings, temporary valves and strainers, temporary water make-up piping with approved means of backflow prevention, and temporary pumps as needed to perform specified flushing and cleaning requirements.
- D. Flushing, cleaning, and disinfection of domestic water piping is specified in Division 15 Section "Domestic Water Piping."
- E. Exterior surfaces of all piping, ductwork and equipment shall be wiped down to remove excess dirt and debris prior to concealment by Architectural Trades work.
- F. Upon completion of work in each respective area, clean and protect work. Just prior to final acceptance, perform additional cleaning as necessary to provide clean equipment and areas to the Owner.

END OF SECTION 15050

SECTION 15053 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUMMARY.....2
1.3 SUBMITTALS.....2
1.4 QUALITY ASSURANCE.....2
1.5 ENVIRONMENTAL REQUIREMENTS.....2

PART 2 - PRODUCTS.....2
2.1 MANUFACTURERS.....2
2.2 FAN SHAFTS.....3
2.3 FAN POWER TRANSMISSION.....3
2.4 SHEAVES.....3
2.5 V-BELT FAN DRIVES.....4
2.6 FAN DRIVE, SHAFT, AND COUPLING GUARDS.....4
2.7 BELT DRIVE GUARDS.....5
2.8 V-BELTS.....5
2.9 V-BELT DRIVE MOTOR BASES.....6
2.10 AIR HANDLING SYSTEM BALANCING PROVISIONS6
2.11 FLEXIBLE COUPLINGS (DIRECT DRIVE)6
2.12 MOTOR REQUIREMENTS7
2.13 FAN BEARINGS7
2.14 IDENTIFICATION7
2.15 ACCESSORIES7

PART 3 - EXECUTION.....8
3.1 INSTALLATION.....8

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 15 Section "Mechanical General Requirements."
 - 2. Division 15 Section "Basic Mechanical Materials and Methods."
 - 3. Division 15 Section "Testing, Adjusting, and Balancing."

1.2 SUMMARY

- A. This Section includes common requirements for fans and air moving equipment.

1.3 SUBMITTALS

- A. Product Data: For the following:
 - 1. Fan bearings.
 - 2. V-belt fan drives.
 - 3. Direct drive couplings.

1.4 QUALITY ASSURANCE

- A. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
- B. Fan Performance Data: AMCA Standard 210.
- C. Sound Power Level Ratings:
 - 1. Ducted Fans - Rated per AMCA 301, when tested per AMCA 300.
 - 2. Nonducted Fans - Rated in Zones at 5 feet from acoustic center of fan rated per AMCA 301, tested per AMCA 300 and converted per AMCA 302.

1.5 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate equipment for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 FAN SHAFTS

- A. Fan Shafts: Ground from solid cold rolled steel, and proportioned to run at least 25 percent below the first critical speed.

2.3 FAN POWER TRANSMISSION

- A. V-Belt Type Fan Drives: In accordance with Engineering Standard Specification for Drives Using Multiple V-Belts, sponsored by the Mechanical Power Transmission Association and the Rubber Manufacturer's Association.
- B. A given manufacturer's V-belt drive, as applied to specific equipment provided under the Contract, shall conform to the equipment manufacturer's published recommendations, except as otherwise specified.
- C. Base horsepower rating of drive on minimum pitch diameter of small sheave.
- D. Locate belt drives outboard of bearings. Align drive and driven shafts by the four-point method.
- E. Adjust belt tension in accordance with the manufacturer's recommendations.
- F. Perform alignment and final belt tensioning in the presence of the Architect.

2.4 SHEAVES

- A. Furnish sheaves of machined cast iron or carbon steel, bushing type of fixed bore, secured to the shaft by key and keyway.
- B. For all constant speed fans at or above 2 inches of total static pressure, Contractor shall provide and install two sets of fixed sheaves. First set shall be installed for initial start-up and shall be based on scheduled data. The second set shall be installed after system balance is complete and shall be based on actual field conditions.

- C. For all constant speed fans below 2 inches total static pressure, Contractor shall provide and install two sets of adjustable sheaves. First set shall be installed for initial start-up and shall be based on scheduled data. The second set shall be installed after the balance is complete and shall be based on actual field conditions, and selected at mid-range of the sheave.
- D. Set pitch diameters of fixed pitch and adjustable or variable pitch sheaves when adjusted as specified, at not less than that recommended by NEMA Standard MG1-14.42.
- E. For companion sheaves for adjustable or variable pitch drives, furnish wide groove spacing to match driving sheaves.
- F. For all variable frequency controller (VFC) operated fans, contractor shall provide and install one set of fixed sheaves sized to allow full utilization of fan motor horsepower provided, with VFC at 100 percent of fan motor RPM.

2.5 V-BELT FAN DRIVES

- A. Fan Drives: Multiple V-belt style with adjustable pitch driver sheaves for fans up to 2 inches of total static pressure and fixed pitch driver sheaves for fans at or above 2 inches of total static pressure and up. Sheaves shall have split, taper style bushings. Drives shall be selected for a 150 percent service factor and shall provide for adjustment of both belt tension and alignment.
- B. Manufacturers:
 - 1. Emerson Power Transmission; Browning.
 - 2. Rockwell Automation; Dodge.
 - 3. T.B. Wood's Incorporated.

2.6 FAN DRIVE, SHAFT, AND COUPLING GUARDS

- A. Safety Provisions: Include guards and screens for power transmission equipment, but do not negate vibration isolation provision.
- B. Furnish ANSI and OSHA compliant mechanical power transmission apparatus guards except where superseded by other governing codes, and except as modified and

supplemented. Requirements specified apply to all types of fans.

- C. Fabricate mechanical power transmission device guards such that the completed structure is capable of withstanding a load of at least 200 pounds applied in any direction.
- D. Furnish a guard enclosure for each V-belt drive, coupling, shaft, and rotating component. Secure guards in place, easily removable for maintenance. Guard fasteners used for maintenance access shall be "captive type." Locate holes on each guard for tachometer readings on both the motor and fan shafts. Fabricate guard of minimum 16 gage sheet metal with hemmed edges at openings for shafts. Weld four mounting lugs or feet of 10 gage material to the guard. Fabricate guards for couplings five inches in diameter and larger of 12 gage sheet metal. Furnish holes in mounting feet sized for suitable machine screws.
- E. Centrifugal exhaust fans shall be provided with shaft seals.

2.7 BELT DRIVE GUARDS

- A. Belt Guards: ANSI and OSHA compliant with provision for readily viewing belt tension and measuring shaft speeds. Guards shall be installed with quick release pins, so that removal of three to five clip pins, will allow the guard to be removed from fan housing.
- B. Fabricate guards which completely enclose moving parts of the particular drive. Design and construct guards of such rigidity as to contain a belt which breaks during operation. Minimum material thickness, 16 gage sheet metal. Where ventilation is required, perforated metal shall be used for the sides. Fabricate top of solid sheet metal.

2.8 V-BELTS

- A. Notched or cogged style, endless type, of Dacron reinforced elastomer construction, with cross-section to suit sheave grooves. Determine the number of V-belts from the motor horsepower to which apply the service factor to obtain the design horsepower. Determine the corrected horsepower per belt by multiplying the nominal horsepower per belt by an arc of contact factor not greater than

0.85. Divide the design horsepower by the corrected horsepower per belt to obtain the number of belts required. In any case, furnish not less than two belts for each drive.

B. Furnish belts that have been factory or factory-authorized distributor matched and measured on a belt-matching machine. Selection by "code numbers," "sag numbers" or "match numbers" is not acceptable. Bind each belt set with wire and tag with equipment identification.

C. Manufacturers:

1. Emerson Power Transmission; Browning; AX, BX, and CX Series and 3VX and 5VX Series.
2. Rockwell Automation; Dodge; Classic Cog and Narrow Cog V-Belts.
3. T.B. Wood's Incorporated; Classical Cog and Narrow Cog V-Belts.

2.9 V-BELT DRIVE MOTOR BASES

- A. Furnish fan motors with slide or adjustable pivoted bases wherever equipment configuration permits proper installation.
- B. Provide for adjustment of both belt tension and alignment.

2.10 AIR HANDLING SYSTEM BALANCING PROVISIONS

- A. Provide extra sheaves, sized as recommended by the Balancing Agent, for the adjustment of fan speed for each air handling system during air quantity balancing operations. Furnish sheaves as specified in this Section.
- B. Provide sheaves, sized as recommended by the Balancing Agent, for the adjustment of fan speed for each existing air handling system requiring rebalancing during air quantity balancing operations. Furnish sheaves as specified in this Section.

2.11 FLEXIBLE COUPLINGS (DIRECT DRIVE)

- A. Fan shaft shall be connected to the motor shaft through a flexible coupling. The flexible member shall be a tire shape, in shear, or a solid mass serrated edge disc shape, made of chloroprene materials and retained by fixed

flanges. Flexible coupling shall act as a dielectric connector and shall not transmit sound, vibration or end thrust.

B. Manufacturer:

1. Falk Corporation (The).

2.12 MOTOR REQUIREMENTS

A. Furnish motors in accordance with Division 15 Section "Motors."

2.13 FAN BEARINGS

A. Bearings: Anti-friction ball or roller type with provision for self-alignment and thrust load. Made in U.S.A. with ABMA L₁₀ minimum life of 200,000 hours. Use cast iron housings and dust-tight seals suitable for lubricant pressures.

1. Lubrication Provisions - Use surface ball check type supply fittings. Provide extension tubes to allow safe maintenance while equipment is operating. Provide manual or automatic pressure relief fittings to prevent overheating or seal blow-out due to excess lubricant or pressure. Arrange relief fittings opposite supply but visible for normal maintenance observation.

2. Bearings on Equipment with less than 1/2 horsepower rating or on shafts smaller than 1-3/4 inch in diameter: Permanently sealed, pre-lubricated anti-friction bearings per specified materials and ABMA L₁₀ life requirements.

2.14 IDENTIFICATION

A. Nameplate: Affix metallic, corrosion-resistant data plate for each fan in a conspicuous location. Include selection point capacity conditions.

2.15 ACCESSORIES

A. Bird Screens: Of material to match adjacent contact construction, 1/2 inch mesh or equal expanded metal. Use on inlet or outlet of each nonducted fan.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Field Rigging: Do not negate balancing. Do not bend shaft. Use lifting eyes.
- B. Install sheaves where recommended by Testing, Adjusting, and Balancing agency.
- C. Refer to individual Division 15 HVAC equipment Sections for additional requirements.

END OF SECTION 15053

SECTION 15055 - MOTORS

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUMMARY.....2
1.3 DEFINITIONS.....2
1.4 QUALITY ASSURANCE.....2
1.5 COORDINATION.....2

PART 2 - PRODUCTS.....4
2.1 MANUFACTURERS.....4
2.2 MOTOR REQUIREMENTS.....4
2.3 MOTOR CHARACTERISTICS.....4
2.4 POLYPHASE MOTORS.....5
2.5 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS.....9
2.6 SINGLE-PHASE MOTORS.....10
2.7 ENCLOSED CONTROLLERS.....11
2.8 ENCLOSED SWITCHES AND CIRCUIT BREAKERS.....11
2.9 FUSES.....11

PART 3 - EXECUTION.....11
3.1 FIELD QUALITY CONTROL.....11
3.2 ADJUSTING.....12
3.3 CLEANING.....12

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 15 "Mechanical General Requirements."
2. Division 15 Section "Mechanical Vibration Controls" for mounting motors and vibration isolation devices.
3. Division 15 Section "Variable Frequency Controllers".
4. Division 15 Sections for application of motors and reference to specific motor requirements for motor-driven equipment.
5. Division 16 Section "Enclosed Switches and Circuit Breakers".
6. Division 16 Section "Enclosed Controllers".
7. Division 16 Section "Fuses".

1.2 SUMMARY

- A. This Section includes basic requirements for factory-installed motors.

1.3 DEFINITIONS

- A. ABMA: American Bearing Manufacturers Association. (Formerly AFBMA: Anti-Friction Bearing Manufacturers Association.)
- B. Factory-Installed Motor: A motor installed by motorized-equipment manufacturer as a component of equipment.
- C. Packaged Self Contained Equipment: Equipment which includes component mechanical and electrical equipment mounted on common bases, skids or frames or in common enclosures with internal control and power wiring factory installed and ready to accept a single electrical service connection. Provide the equipment complete with enclosed controllers, main disconnect switches, control transformers, control devices, wiring and accessories as required.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: A Nationally Recognized Testing Laboratory (NRTL), acceptable to authorities having jurisdiction, with the experience and capability to conduct the testing indicated.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

1.5 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices. Provide motors that are:
 - 1. Compatible with the following:
 - a. Magnetic controllers.
 - b. Multispeed controllers.

- c. Reduced-voltage controllers.
 - d. Solid-state controllers.
 - e. Variable frequency controllers.
 2. Designed and labeled for use with variable frequency controllers, and suitable for use throughout speed range without overheating.
 3. Matched to torque and horsepower requirements of the load.
 4. Matched to ratings and characteristics of supply circuit and required control sequence.
- B. Coordinate electrical scope of work to be provided by Division 15 with this Section, related Division 15 Specifications, Division 16 Specifications and the Drawings.
- C. Electrical work provided under Division 15: Furnish UL Listed components in accordance with this section, Division 16, and applicable NEMA and NEC (ANSI C 1) requirements. Provide wiring, external to electrical enclosures, in conduit.
- D. Furnished, installed and wired under Division 15 unless otherwise indicated:
 1. Disconnected components in packaged self-contained equipment that are so constructed that components of wiring must be disconnected for shipment and reconnected after installation.
- E. Furnished and installed under Division 15 and wired under Division 16 unless otherwise indicated:
 1. Motors required for mechanical equipment
 2. Packaged Self-Contained Equipment:
 - a. Provide equipment ready to accept a single electrical service connection.
 - b. For equipment with remote mounted control panels, provide mounting of the control panel and external wiring from the control panel to the package self-contained equipment.
 3. Variable frequency controllers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following:
1. Dayton.
 2. Toshiba Intl.
 3. Baldor Electric/Reliance.
 4. Rockwell Automation/Allen-Bradley.
 5. Nidec Motor Corporation; U.S. Electrical Motors.
 6. Regal Beloit/GE Commercial Motors.
 7. Regal Beloit/Leeson.
 8. Regal Beloit/Marathon.
 9. Siemens.

2.2 MOTOR REQUIREMENTS

- A. Motor requirements apply to factory-installed motors except as follows:
1. Different ratings, performance, or characteristics for a motor are specified in another Section.
 2. Manufacturer for a factory-installed motor requires ratings, performance, or characteristics, other than those specified in this Section, to meet performance specified.
 3. Submersible motors integral to pumps and excluded from NEMA and EISA standards.
- B. Electrical Power Supply Characteristics: Coordinate electrical system requirements with Division 16.
- C. Electrical Power System Characteristics: As scheduled on the Drawings.
- D. Electrical Connection: Conduit connection boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide screwed conduit connection in end frame.

2.3 MOTOR CHARACTERISTICS

- A. Motors 1/2 HP and Larger: Three phase, unless otherwise indicated.

- B. Motors Smaller Than 1/2 HP: Single phase, unless otherwise indicated.
- C. Frequency Rating: 60 Hz.
- D. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.
- E. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.
- F. Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 3300 feet above sea level.
- G. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
- H. Brake Horsepower Input: Shall not exceed 90 percent of the rated motor horsepower.
- I. Enclosure: Open dripproof (ODP) for motors installed indoors and out of the airstream. Totally-enclosed fan-cooled (TEFC) for motors installed outdoors or within the airstream.

2.4 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Fire pump motors, C-face motors, JP and JM frame motors, and motors over 200 horsepower shall be energy efficient motors. Efficiency of the motor shall be determined based on the NEMA MG1. The minimum efficiencies, nominal efficiencies and shall meet or exceed Table 12-11.

1800 RPM
 OPEN DRIP-PROOF
 MOTORS
 4 POLE

1800 RPM
 ENCLOSED MOTORS
 4 POLE

<u>HP</u>	1800 RPM OPEN DRIP-PROOF MOTORS 4 POLE		1800 RPM ENCLOSED MOTORS 4 POLE	
	<u>NOMINAL</u> <u>EFF</u>	<u>MINIMUM</u> <u>EFF</u>	<u>NOMINAL</u> <u>EFF</u>	<u>MINIMUM</u> <u>EFF</u>
1	82.5	81.5	82.5	81.5
1.5	84	82.5	84	82.5
2	84	82.5	84	82.5
3	86.5	85.5	87.5	86.5
5	87.5	86.5	87.5	86.5
7.5	88.5	87.5	89.5	88.5
10	89.5	88.5	89.5	88.5
15	91	90.2	91	90.2
20	91	90.2	91	90.2
25	91.7	91	92.4	91.7
30	92.4	91.7	92.4	91.7
40	93	92.4	93	92.4
50	93	92.4	93	93
60	93.6	93	93.6	93
75	94.1	93.6	94.1	93.6
100	94.1	93.6	94.5	94.1
125	94.5	94.1	94.5	94.1
150	95	94.5	95	94.5
200	95	94.5	95	94.5

	1200 RPM OPEN DRIP-PROOF MOTORS 6 POLE		3600 RPM OPEN DRIPPROOF MOTORS 2 POLE	
	NOMINAL <u>HP</u>	MINIMUM <u>EFF</u>	NOMINAL <u>EFF</u>	MINIMUM <u>EFF</u>
1	80	78.5	--	--
1.5	84	82.5	82.5	81.5
2	85.5	84	84	82.5
3	86.5	85.5	84	82.5
5	87.5	86.5	85.5	84
7.5	88.5	87.5	85.5	86.5
10	90.2	89.5	88.5	87.5
15	90.2	89.5	89.5	88.5
20	91	90.2	90.2	89.5
25	91.7	91	91	90.2
30	92.4	91.7	91	90.2
40	93	92.4	91.7	91
50	93	93	92.4	91.7
60	93.6	93	93	92.4
75	93.6	93	93	92.4
100	94.1	93.6	93	92.4
125	94.1	93.6	93.6	93
150	94.5	94.1	93.6	93
200	94.5	94.1	94.5	94.1

C. Efficiency: Motors 1 horsepower to 200 horsepower shall be premium efficient motors meeting requirements of NEMA Premium Efficiency Motor Program. Efficiency of the motor shall be determined based on the NEMA MG1. The nominal efficiencies shall meet or exceed Table 12-12.

Nominal Efficiencies For "NEMA Premium™" Induction Motors
 Rated 600 Volts or Less (Random Wound)

<u>HP</u>	<u>Open Drip-Proof</u>			<u>Totally Enclosed Fan-Cooled</u>		
	<u>6-pole</u>	<u>4-pole</u>	<u>2-pole</u>	<u>6-pole</u>	<u>4-pole</u>	<u>2-pole</u>
1	82.5	85.5	77.0	82.5	85.5	77.0
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2	87.5	86.5	85.5	88.5	86.5	85.5
3	88.5	89.5	85.5	89.5	89.5	86.5
5	89.5	89.5	86.5	89.5	89.5	88.5
7.5	90.2	91.0	88.5	91.0	91.7	89.5
10	91.7	91.7	89.5	91.0	91.7	90.2
15	91.7	93.0	90.2	91.7	92.4	91.0
20	92.4	93.0	91.0	91.7	93.0	91.0
25	93.0	93.6	91.7	93.0	93.6	91.7
30	93.6	94.1	91.7	93.0	93.6	91.7
40	94.1	94.1	92.4	94.1	94.1	92.4
50	94.1	94.5	93.0	94.1	94.5	93.0
60	94.5	95.0	93.6	94.5	95.0	93.6
75	94.5	95.0	93.6	94.5	95.4	93.6
100	95.0	95.4	93.6	95.0	95.4	94.1
125	95.0	95.4	94.1	95.0	95.4	95.0
150	95.4	95.8	94.1	95.8	95.8	95.0
200	95.4	95.8	95.0	95.8	96.2	95.4

Nominal Efficiencies For "NEMA Premium™" Induction Motors
 Rated Medium Volts for 5kV or Less (Form Wound)

<u>HP</u>	<u>Open Drip-Proof</u>			<u>Totally Enclosed Fan-Cooled</u>		
	<u>6-pole</u>	<u>4-pole</u>	<u>2-pole</u>	<u>6-pole</u>	<u>4-pole</u>	<u>2-pole</u>
250	95.0	95.0	94.5	95.0	95.0	95.0
300	95.0	95.0	94.5	95.0	95.0	95.0
350	95.0	95.0	94.5	95.0	95.0	95.0
400	95.0	95.0	94.5	95.0	95.0	95.0
450	95.0	95.0	94.5	95.0	95.0	95.0
500	95.0	95.0	94.5	95.0	95.0	95.0

- D. Stator: Copper windings, unless otherwise indicated.
- E. Rotor: Squirrel cage, unless otherwise indicated.

- F. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 120,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
 - G. Temperature Rise: Match insulation rating, unless otherwise indicated.
 - H. Insulation: Class F, unless otherwise indicated.
 - I. Code Letter Designation:
 - 1. Motors 10 HP and Larger: NEMA starting Code (KVA Code) F or G.
 - 2. Motors Smaller Than 10 HP: Manufacturer's standard starting characteristic.
 - 3. Fire Pump Motors: NEMA starting Code (KVA Code) B.
 - J. Enclosure: Cast iron for motors 7.5 hp and larger; rolled steel for motors smaller than 7.5 hp.
 - 1. Finish: Gray enamel.
 - K. Sound Level: Not to exceed NEMA MG-1 12.54.
- 2.5 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS
- A. Motors Used with Reduced-Inrush Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
 - B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - 2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.

C. Shaft Grounding: Provide a means to protect motor from common mode currents.

1. Required for:

- a. Motors used with variable frequency controllers.
- b. Motors 100 HP and larger.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Electro Static Technology, Inc.; Aegis SGR Conductive Microfiber.

D. Severe-Duty Motors: Totally enclosed, with 1.25 minimum service factor, greased bearings, integral condensate drains, and capped relief vents. Windings insulated with nonhygroscopic material.

1. Finish: Chemical-resistant paint over corrosion-resistant primer.

E. Source Quality Control: Perform the following tests on each motor according to NEMA MG 1:

1. Measure winding resistance.
2. Read no-load current and speed at rated voltage and frequency.
3. Measure locked rotor current at rated frequency.
4. Perform high-potential test.

2.6 SINGLE-PHASE MOTORS

A. Type: One of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split-phase start, capacitor run.
3. Capacitor start, capacitor run.

B. Shaded-Pole Motors: For motors 1/20 hp and smaller only.

C. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device

shall automatically reset when motor temperature returns to normal range.

- D. Bearings: Ball type for belt-connected motors and other motors with high radial forces on motor shaft; sealed, prelubricated-sleeve type for other single-phase motors.

2.7 ENCLOSED CONTROLLERS

- A. Provide enclosed controllers in accordance with requirements specified in Division 16 Section "Enclosed Controllers".

2.8 ENCLOSED SWITCHES AND CIRCUIT BREAKERS

- A. Provide enclosed switches and circuit breakers in accordance with requirements specified in Division 16 Section "Enclosed Switches and Circuit Breakers".

2.9 FUSES

- A. Provide fuses in accordance with requirements specified in Division 16 Section "Fuses".

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

- A. All three phase motors 1/2 HP and above shall be tested by the Testing Agency.
- B. Prepare for acceptance tests as follows:
 - 1. Check motor nameplates for horsepower, speed, phase and voltage.
 - 2. Check coupling alignment and shaft end play.
 - 3. Run each motor with its controller. Demonstrate correct rotation, alignment, and speed at motor design load.
 - 4. Test interlocks and control features for proper operation.
 - 5. Verify that current in each phase is within nameplate rating.
- C. Testing: Perform the following field quality-control testing:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.15.1. Certify compliance with test parameters.
2. Jog motor as required to verify proper phase and shaft rotation. Immediately after start-up, check bearing temperature and smooth operation. Take current reading at full load using a clamp-on ammeter. If ammeter reading is over the rated full load current, determine reason for discrepancy and take necessary corrective actions. Record all readings, motor nameplate data and overload heater data.
3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.2 ADJUSTING

- A. Align motors, bases, shafts, pulleys and belts. Tension belts according to manufacturer's written instructions.

3.3 CLEANING

- A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean motors, on completion of installation, according to manufacturer's written instructions.

END OF SECTION 15055

SECTION 15060 - HANGERS AND SUPPORTS

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 DEFINITIONS.....2
1.3 PERFORMANCE REQUIREMENTS.....2
1.4 SUBMITTALS.....2
1.5 QUALITY ASSURANCE.....3

PART 2 - PRODUCTS.....3
2.1 MANUFACTURERS.....3
2.2 HANGER ROD MATERIAL.....3
2.3 STEEL PIPE HANGERS AND SUPPORTS.....3
2.4 TRAPEZE PIPE HANGERS.....4
2.5 METAL FRAMING SYSTEMS.....4
2.6 METAL INSULATION SHIELDS.....5
2.7 PIPE COVERING PROTECTION SADDLES.....5
2.8 THERMAL-HANGER SHIELDS.....5
2.9 FASTENER SYSTEMS.....7
2.10 ROOF MOUNTED PIPING SUPPORTS8
2.11 ROOF MOUNTED EQUIPMENT SUPPORTS10
2.12 EQUIPMENT SUPPORTS11
2.13 MISCELLANEOUS MATERIALS11

PART 3 - EXECUTION.....11
3.1 HANGER AND SUPPORT APPLICATIONS.....11
3.2 HANGER AND SUPPORT INSTALLATION.....14
3.3 EQUIPMENT SUPPORTS.....19
3.4 METAL FABRICATIONS.....19
3.5 ADJUSTING.....20
3.6 PAINTING.....20

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

2. Division 13 Section "Fire-Suppression Piping" for pipe hangers for fire-protection piping.
3. Division 15 Section "Mechanical General Requirements."
4. Division 15 Section "Basic Mechanical Materials and Methods."
5. Division 15 Section "Mechanical Vibration Controls" for vibration isolation devices.
6. Division 15 Section "Pipe Expansion Fittings and Loops" for pipe guides and anchors.
7. Division 15 Section(s) "Metal Ducts" and "Nonmetal Ducts" for duct hangers and supports.

1.2 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- B. MFMA: Metal Framing Manufacturers Association.

1.3 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.4 SUBMITTALS

- A. Product Data: For the following:
 1. Steel pipe hangers and supports.
 2. Thermal-hanger shield inserts.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 1. Trapeze pipe hangers. Include Product Data for components.
 2. Metal framing systems. Include Product Data for components.
 3. Pipe stands. Include Product Data for components.
 4. Equipment supports.
- C. Welding certificates.

1.5 QUALITY ASSURANCE

- A. MSS Standards: Pipe hangers, supports, and accessories shall comply with the following:
 - 1. MSS SP-58, Pipe Hangers and Supports - Materials, Design and Manufacture.
 - 2. MSS SP-69, Pipe Hangers and Supports - Selection and Application.
 - 3. MSS SP-89, Pipe Hangers and Supports - Fabrication and Installation Practices.

- B. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code--Steel."
 - 2. AWS D1.2, "Structural Welding Code--Aluminum."
 - 3. AWS D1.3, "Structural Welding Code--Sheet Steel."
 - 4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
 - 5. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 HANGER ROD MATERIAL

- A. Threaded, hot rolled, steel rod conforming to ASTM A 36 or A575.
 - 1. Rod continuously threaded.
 - 2. Use of rod couplings is prohibited.

2.3 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-69, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article, and schedules and details on the

Drawings for where to use specific hanger and support types.

1. Hangers and Supports for Fire Protection Piping: UL listed or FMG approved.

B. Manufacturers:

1. Anvil International, Inc.
2. B-Line by Eaton.
3. Carpenter & Paterson, Inc.
4. Hilti USA.
5. ERICO International Corp.
6. PHD Manufacturing, Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.4 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.5 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:

1. Anvil International, Inc.; Anvil-Strut.
2. B-Line by Eaton.
3. Power-Strut Div.; Tyco International, Ltd.
4. Unistrut Corp.; Tyco International, Ltd.
5. Hilti USA.

C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

D. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

E. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.6 METAL INSULATION SHIELDS

A. Manufacturers:

1. Anvil International, Inc.
2. B-Line by Eaton.
3. Carpenter & Paterson, Inc.
4. ERICO International Corp.
5. PHD Manufacturing, Inc.

B. Description: MSS SP-69, Type 40, protective shields. Shields shall span an arc of 180 degrees.

C. Shield Dimensions for Pipe: Not less than the following:

1. NPS 1/4 to NPS 2: 12 inches long and 0.048 inch thick.

2.7 PIPE COVERING PROTECTION SADDLES

A. Manufacturers:

1. Anvil International, Inc.
2. B-Line by Eaton.
3. Carpenter & Paterson, Inc.
4. ERICO International Corp.
5. PHD Manufacturing, Inc.

B. Description: MSS SP-69, Type 39A and Type 39B, for suspension of insulated hot pipe where heat losses are to be kept to a minimum.

1. Saddles shall match insulation thickness.
2. Saddle length: 12 inches.
3. Furnish with center rib for pipe sized NPS 12 and larger.

2.8 THERMAL-HANGER SHIELDS

A. Manufacturers:

1. B-Line by Eaton.

2. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
 3. Rilco Manufacturing Company, Inc.
 4. American Mechanical Insulation Sales Inc. (AMIS).
 5. ERICO International Corp.
 6. Value Engineered Products, Inc.
- B. Description: Manufactured assembly consisting of insulation insert encased in 360 degree sheet metal shield.
1. Minimum Compressive Strength of Insert Material:
 - a. 100-psig- for sizes smaller than NPS 6.
 - b. 600-psig- for sizes NPS 6 and larger.
- C. Insulation-Insert Material for Cold Piping: Full 360 degree, water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.
- D. Insulation-Insert Material for Hot Piping: Full 360 degree, water-repellent treated, ASTM C 533, Type I calcium silicate.
- E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.
- F. Include carbon steel ASTM A36 load distribution plates as required by load, pipe movement, hanger style, and hanger spacing.
- G. Thermal-Hanger Shields for Flexible Foamed Elastomeric Insulated Piping:
1. Manufacturer:
 - a. B-Line by Eaton/Armacell; Armafix IPH.
 2. Insulation-Insert Material for Copper Piping with Flexible Foamed Elastomeric Insulation: Use the following:
 - a. Flexible foamed elastomeric, ASTM 534, Type I-Tubular Grade 1 with PUR/PIP support inserts.
- H. Thermal-Hanger Shields for Small Diameter Piping:

1. Manufacturer:
 - a. Hydra-Zorb Company; Klo-Shure Insulation Couplings.
2. Insulation-Insert Material for Small Diameter Piping with Flexible Foamed Elastomeric or Glass Fiber Insulation: Use the following:
 - a. Rigid Hytrel thermoplastic insulation coupling designed for use with pipe or tube NPS 1-1/2 and smaller, and insulation from 3/8 inch to 1-1/2 inch thick.

2.9 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:
 - a. B-Line by Eaton.
 - b. Empire Industries, Inc.
 - c. Hilti, Inc.
 - d. ITW Ramset/Red Head.
 - e. MKT Fastening, LLC.
 - f. Powers Fasteners.

- B. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened portland cement concrete, and tension and shear capacities appropriate for application. Exception: Do not use chemical fasteners to support hanger systems for fire protection piping.

1. Manufacturers:
 - a. Hilti, Inc.
 - b. ITW Ramset/Red Head.
 - c. MKT Fastening, LLC.
 - d. Powers Fasteners.
2. Bonding Material: ASTM C 881, Type IV, Grade 3, 2-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.

3. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
4. Washer and Nut: Zinc-coated steel.

C. Threaded Inserts: Galvanized malleable iron or galvanized steel for 3/4 inch bolts.

1. Manufacturers:

- a. Superior Concrete Accessories; Threaded Insert.
- b. Dayton Sure-Grip and Shore Co.
- c. Richmond Screw Anchor Co.

D. Slotted Inserts: Continuous galvanized steel with temporary slot fillers and complete with nuts, studs, washers and the like, for 3/4 inch bolts.

1. Manufacturers:

- a. B-Line by Eaton; B22-I Continuous Concrete Insert.
- b. Unistrut Corp.; P-3200 Continuous Insert.
- c. Hohman and Barnard, Inc.
- d. Richmond Screw Anchor Co.
- e. Hilti, Inc.; CIS13812/PG.

2.10 ROOF MOUNTED PIPING SUPPORTS

A. Low, Fixed-Height, Single-Base Stand: Assembly of base and horizontal member, and pipe support, for roof installation without membrane penetration.

1. Manufacturers:

- a. B-Line by Eaton; Dura-Blok.
- b. Eco Support Products.
- c. ERICO International Corp.
- d. MIRO Industries; Conduit and Condensate Supports.
- e. Portable Pipe Hangers.

2. Base: Plastic, stainless steel, or recycled rubber.

3. Horizontal Member: Cadmium-plated-steel or galvanized-steel strut designed for use with standard strut clamps and accessories.

B. Low, Fixed-Height, Single-Base Roller Stand: Assembly of base and horizontal roller, for roof installation without membrane penetration.

1. Manufacturers:
 - a. B-Line by Eaton; Dura-Blok.
 - b. Eco Support Products.
 - c. ERICO International Corp.
 - d. MIRO Industries; Gas and Mechanical Supports.
 - e. Portable Pipe Hangers.
 2. Base: Plastic, stainless steel, or recycled rubber.
 3. Horizontal Member: Cadmium-plated-steel rod and corrosion resistant roller designed for use with standard accessories.
- C. Custom, Multiple-Base Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports or rollers, for roof installation without membrane penetration.
1. Manufacturer:
 - a. B-Line by Eaton; Dura-Blok.
 - b. Eco Support Products.
 - c. ERICO International Corp.
 - d. MIRO Industries; Custom Design Products.
 - e. Portable Pipe Hangers.
 2. Bases: Four or more plastic, steel, or recycled rubber.
 3. Vertical Members: Two or more protective-coated-steel channels.
 4. Horizontal Member: Protective-coated-steel channel.
 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
 6. Pipe Rollers: Cadmium-plated-steel rod and corrosion resistant roller designed for use with standard accessories.
- D. Curb-Mounting Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.
1. Roof Curb Type Supports: Coordinate installation and type with Architectural Trades. Top shall be level and extend a minimum of 10 inches above top of roof insulation.

a. Manufacturers:

- 1) Pate.
- 2) Thybar; Thycurb.
- 3) Roof Products and Systems.
- 4) Greenheck.
- 5) Creative Metals.

2.11 ROOF MOUNTED EQUIPMENT SUPPORTS

A. Non-Penetrating Equipment Supports: Assembly of two or more bases and horizontal members, for roof installation without membrane penetration.

1. Manufacturers:

- a. B-Line by Eaton; Dura-Blok.
- b. Eco Support Products.
- c. ERICO International Corp.
- d. MIRO Industries; HD and LD Mechanical Unit Supports.
- e. Portable Pipe Hangers.

2. Base: Plastic, stainless steel, or recycled rubber.

3. Horizontal Member: Cadmium-plated-steel, galvanized-steel, or stainless steel strut, and planking; designed for use with standard strut clamps, all-thread rod, and accessories.

B. Roof Rail-Type Equipment Stands: Welded 18 gage galvanized steel shell, base plate and counter flashing. Factory installed chemically treated wood nailer. Fully mitered end sections. Internal bulkhead reinforcement.

1. Roof Rail Type Supports: Coordinate installation and type with Architectural Trades. Top shall be level and extend a minimum of 10 inches above top of roof insulation.

a. Manufacturers:

- 1) Pate.
- 2) Thybar; TEMS Series.
- 3) Roof Products and Systems.
- 4) Greenheck.
- 5) Creative Metals.

2.12 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.13 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Refer to application schedules on the Drawings.
- B. For insulated pipe, oversize hanger elements to accommodate insulation thickness.
- C. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- D. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- E. Use hangers and supports with galvanized, metallic coatings for outdoor applications or where exposed to outdoor conditions.
- F. Use hangers and supports with plastic coating, or galvanized metallic coatings for applications in corrosive atmospheres.
- G. Use metal framing, with plastic coating, or galvanized metallic coatings for metal framing in corrosive atmospheres.
- H. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

- I. Use padded hangers for piping that is subject to scratching.
- J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. MSS Type 8 or spring type to meet system requirements.
- K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 - 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 - 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 - 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 - 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- L. Concrete Structure Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Anchor Devices, Concrete and Masonry: in accordance with Group I, Group II, Type 2, Class 2, Style 1 and Style 2, Group III and Group VIII or FS FF-S-325A. Furnish cast-in floor type equipment anchor devices with adjustable positions. Furnish built in anchor devices for masonry, unless otherwise approved by the Architect. Powder actuated anchoring devices shall not be used to support any mechanical systems components.
 - 2. Inserts, Concrete: TYPE 18 or 19. When applied to loads equivalent to piping in sizes NPS 2 and larger, and where otherwise required by imposed loads, a one foot length of 1/2 inch NPS 4 reinforcing rod shall be inserted and wired through wing slots. Proprietary type continuous inserts may be proposed and shall be submitted for approval.
 - 3. Use mechanical-expansion anchors where required in concrete construction.
 - 4. Use chemical fasteners where required in concrete construction.

M. Steel Frame Structure Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Beam Clamps:

- a. Center Loading: TYPE 21, 28, 29 and 30, unless otherwise indicated. Type 27 shall be allowed to support single pipes NPS 6 size or smaller only.
- b. "C" Clamps: Type 19, 20 or 23, for supporting single pipes NPS 2-1/2 size or smaller only. Use of "C" clamps, or beam clamps of "C" pattern, or any modification thereof, is prohibited for supporting multiple pipes or pipes larger than NPS 2-1/2.

N. Hanger-Rod Attachments for Wood Construction: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. All Steel Ceiling Plates: UL listed and suitable for attachment to wood beams. For pipe sizes NPS 1/2 to NPS 2. Install in accordance with manufacturer's instructions to maintain listing.
2. Threaded Side Beam Brackets: UL listed and FMG approved, suitable for attachment to wood beams. For pipe sizes NPS 2 to NPS 4. Install in accordance with manufacturer's instructions to maintain listing.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Use spring supports and sway braces TYPES 48, 49, 50, 51, 52, 53, 54, 55 or 56. For specific points:
 - a. Provide spring supports at point of support where vertical movement will occur.
 - b. For light loads and vertical movement less than 1/4 inch, TYPES 48 or 49 spring cushion supports.
 - c. For vertical movements in excess of 1/4 inch but less than 1/2 inch, TYPES 51, 52 or 53 variable spring supports shall be used, loaded to not more than 75 percent of published load rating.
 - d. For vertical movements of 1/2 inch and more, TYPES 54, 55 and 56 constant support spring hangers.
 - e. Sway braces; TYPE 50.

f. Variable spring hangers in accordance with referenced MSS Standards with "medium" allowable load change.

- P. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- Q. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structural frame.
- B. Provide necessary piping and equipment supporting elements including: building structure attachments, supplementary steel, hanger rods, stanchions and fixtures, vertical pipe attachments, horizontal pipe attachments, anchors, guides, spring supports in accordance with the referenced codes, standards, and requirements specified. Support piping and equipment from building structure, not from roof deck, floor slab, other pipe, duct or equipment.
- C. At connections between piping systems, hangers and equipment of dissimilar metals, insulate, using dielectric insulating material, nonferrous piping against direct contact with the building steel by insulating the contact point of the hanger and pipe or the hanger and building steel. Test each point of dielectric insulation with an ohm meter to ensure proper isolation of dissimilar materials. Test shall be observed by the Owner's Representative and/or Architect.
- D. Use copper plated or plastic coated supporting element in contact with copper tubing or glass piping.
- E. File and paint cut ends and shop or field prime paint supporting element components.
- F. Hang piping parallel with the lines of the building, unless otherwise indicated. Route piping in an orderly manner and maintain gradient. Space piping and components

so a threaded pipe fitting may be removed between adjacent pipes and so there will be not less than 1/2 inch of clear space between finished surfaces and piping. Arrange hangers on adjacent parallel service lines in line with each other.

- G. Flange loads on connected equipment shall not exceed 75 percent of maximum allowed by equipment manufacturer. Flange loads in liquid containing systems shall be checked in the presence of the Architect when piping is full of liquid. No flange load is allowed on pumps, vibration isolated equipment or flexible connectors.
- H. Spring supports, within specified limitations: Constant support type, where necessary to avoid transfer of load from support to support or onto connected equipment; otherwise, variable support type located at points subject to vertical movement.
- I. Incorporate pipe anchors into piping systems to maintain permanent pipe positions. Install alignment guides for the piping adjacent to and on each side of pipe expansion loops and expansion joints to maintain alignment.
- J. Where necessary, brace piping and supports against reaction, sway and vibration.
- K. Do not hang piping from joist pans, floor decks, roof decks, equipment, ductwork, or other piping.
- L. Install turnbuckles, swing eyes and clevises to accommodate temperature changes, pipe accessibility, and adjustment for load pitch. Rod couplings are not acceptable.
- M. Install hangers and supports for piping at intervals specified, at locations not more than 3 feet from the ends of each runout, not more than 3 feet from connections to equipment, and not over 25 percent of specified interval from each change in direction of piping and for concentrated loads such as valves, etc.
- N. Base the load rating for pipe support elements on loads imposed by insulated weight of pipe filled with water. The span deflection shall not exceed slope gradient of pipe.

- O. If structural steel, roofs, or tunnels will allow support spacing greater than that shown above, Contractor shall submit proposed support system along with structural calculations documenting the allowance of such spacing, in accordance with ANSI, B31.1, and MSS Guidelines.
- P. Support vertical risers independently of connected horizontal piping whenever practical, with supports at the base and at intervals to accommodate system range of load with thermal conditions. Support vertical risers at each floor penetration for piping in shafts or chases. Guide for lateral stability. Fit horizontal piping connected to moving risers with two spring supports connected adjacent to riser, spaced according to required hanger spacing.
- Q. For risers at temperatures of 100 deg F or less place riser clamps under fittings. Support carbon steel pipe at each operating level or floor and at not more than 15-foot intervals for pipe 2 inches and smaller, and at not more than 20 foot intervals for pipe 2-1/2 inches and larger.
- R. After the piping systems have been installed, tested and placed in satisfactory operation, firmly tighten hanger rod nut and jam nut and upset threads to prevent movement of fasteners.
- S. Attach pipe anchors and pipe alignment guides to the building structure where indicated. If not indicated, the method used is optional to the Contractor, subject to approval by the Architect. In the case of structural steel, make attachment by clamping in accordance with the American Institute of Steel Construction Specification for the Design, Fabrication and Erection of Structural Steel for Building.
- T. Attach supporting elements connected to structural steel columns to preclude vertical slippage and cascading failure.
- U. Attach pipe hangers and other supporting elements to roof purlins and trusses at panel points.
- V. Where eccentric loading beam clamps are approved and where other work is supported by similar eccentric loading support element from the same structural member, locate eccentric loading support elements to minimize structural member torsion load.

- W. Limit the location of supporting elements for piping and equipment, when supported from roof, to panel points of the bar joists.
- X. Building structure shall not be reinforced except as approved by the Architect in writing.
- Y. Use approved cast-in-place inserts or built-in anchors for attachment to concrete structure. Size inserts and anchors for the total applied load with a safety factor in accordance with applicable codes but in no case less than 5. Coordinate installation of all imbedded items in accordance with manufacturer's instructions. Position anchorage and imbedded items as indicated and/or where required and support against displacement during placing of concrete. Cutting or repositioning of concrete beam or girder or reinforcing steel to accommodate inserts will not be allowed. Provide removable closures in imbedded device openings to prevent entry of concrete.
- Z. Support piping and equipment from concrete building frame, not from roof or floor slabs unless otherwise indicated.
- AA. Use cast-in-place inserts in concrete beams and girders. Drilled anchors/wedge type inserts shall be used on vertical surfaces only. Coordinate with structural engineer.
- BB. Attach piping supports to the side of concrete beams and concrete joist. Provide supplementary support steel as required. Cast-in-place or drilled anchors will not be permitted in the bottom of concrete beams and concrete joist.
- CC. Attach piping supports to the side of concrete beams or concrete joist. Where intermediate hangers are required to meet the hanger spacing schedule, the Contractor may propose attachment of intermediate pipe supports to the bottom of the concrete slab pending submittal of a satisfactory pull out test. The Contractor shall submit pull out test criteria, pull out test results, proposed hanger detail and hanger point loads to the Architect for written approval.
- DD. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of

horizontal piping and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

EE. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

FF. Fastener System Installation:

1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

GG. Roof-Mounting Pipe and Equipment Stand Installation:

1. Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb or Rail Mounting Type Stands: Assemble components or fabricate stand and mount on permanent, stationary roof curb or rail. Refer to Division 07 Section "Roof Accessories" for curb and rail installation.
3. Maintain support manufacturer's recommended spacing.

HH. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

II. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

JJ. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

- KK. Install lateral bracing with pipe hangers and supports to prevent swaying.
- LL. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- MM. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- NN. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- OO. Refer to individual piping sections for hanger spacing and hanger rod sizes.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of

welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 15060

SECTION 15070 - MECHANICAL VIBRATION CONTROLS

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUBMITTALS.....1
1.3 QUALITY ASSURANCE.....2
1.4 COORDINATION.....2

PART 2 - PRODUCTS.....2
2.1 VIBRATION ISOLATION EQUIPMENT BASES.....2
2.2 VIBRATION ISOLATORS.....6
2.3 VIBRATION ISOLATION HANGERS.....9
2.4 FACTORY FINISHES.....11

PART 3 - EXECUTION.....11
3.1 EXAMINATION.....11
3.2 INSTALLATION.....11
3.3 APPLICATION.....11
3.4 CONNECTIONS.....12
3.5 EQUIPMENT BASES.....12
3.6 FIELD QUALITY CONTROL.....13
3.7 ADJUSTING.....13
3.8 CLEANING.....13

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 15 Section "Mechanical General Requirements."
 - 2. Division 15 Section "Basic Mechanical Materials and Methods."

1.2 SUBMITTALS

- A. Product Data: Include load deflection curves for each vibration isolation device.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Include the following:

1. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification that riser system has been examined for excessive stress and that none will exist.
3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.

C. Welding certificates.

1.3 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

1.4 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. Installation of these items is specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATION EQUIPMENT BASES

- A. **Type A:** Direct Isolator Attachment
 1. Unit to be isolated is so constructed that vibration isolators of the type specified may be directly attached, provided that the edge deflection of the isolated unit base over unsupported span between mountings does not exceed specified or manufacturer's limits. If units to be isolated will not meet required deflection provisions, Type B bases shall be provided.

B. **Type B:** Factory-fabricated, welded, structural-steel bases or rails.

1. Structural Steel Bases:

- 1) Amber/Booth; a VMC Group Company.
- 2) Kinetics Noise Control, Inc.
- 3) Korfund Dynamics; a VMC Group Company.
- 4) Vibration Eliminator Co., Inc.
- 5) Vibration Isolation Co., Inc. (Pump Bases Only)
- 6) Vibration Mountings & Controls; a VMC Group Company.
- 7) Vibro-Acoustics.

2. Structural-Steel Rails:

- 1) Amber/Booth; a VMC Group Company.
- 2) Kinetics Noise Control, Inc.
- 3) Korfund Dynamics; a VMC Group Company.
- 4) Vibration Eliminator Co., Inc.
- 5) Vibration Isolation Co., Inc. (Pump Bases Only)
- 6) Vibration Mountings & Controls; a VMC Group Company.
- 7) Vibro-Acoustics.

C. **Type C** Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for field-applied, cast-in-place concrete.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type BMK/KSL or a comparable product by one of the following:

- 1) Amber/Booth; a VMC Group Company.
- 2) Kinetics Noise Control, Inc.
- 3) Korfund Dynamics; a VMC Group Company.
- 4) Vibration Eliminator Co., Inc.
- 5) Vibration Isolation Co., Inc. (Pump Bases Only)
- 6) Vibration Mountings & Controls; a VMC Group Company.
- 7) Vibro-Acoustics.

2. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor

slide bases or rails. Include supports for suction and discharge elbows for pumps.

3. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
4. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
5. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

D. **Type D** Curb Mounted Aluminum Bases:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type CMAB or a comparable product by one of the following:
 - a. Kinetic Noise Control, Inc.
 - b. ThyCurb/Thybar.
 - c. Vibro-Acoustics.
2. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment.
3. Upper Frame: Corrosion resistant extruded aluminum. Upper frame shall overlap lower frame for water runoff. Mitered ends heliarc welded to prevent water leakage through corners.
4. Lower Frame: Corrosion resistant extruded aluminum. Lower framed shall overlap roof curb for water runoff. Mitered ends heliarc welded to prevent water leakage through corners.
5. Safety Stops: Neoprene, mounted in corners of lower frame for extreme wind conditions and mild seismic disturbances under normal conditions.
6. Isolators: Cadmium plated free-standing springs with positive spring retainer and flexible ties.
7. Splicing Kit: Required for bases shipped in multiple pieces.
8. Weatherseal: Flexible frictionless EPDM.
9. Static Deflection: Nominal 1 inch.

E. **Type E** Rooftop Spring Curb:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type RSC or a comparable product by one of the following:

- a. Kinetic Noise Control, Inc.
 - b. ThyCurb/Thybar.
 - c. Vibro-Acoustics.
2. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment; and to withstand wind forces as required by local codes.
 3. Lower Support Assembly: Sheet-metal "Z" section containing adjustable and removable steel springs that support upper floating frame. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist wind forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly.
 4. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on 1/4-inch- thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
 - 1) Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.
 - 2) Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 3) Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 4) Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
 - 5) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 6) Material: Bridge-bearing neoprene, complying with AASHTO M 251.
 - 7) Durometer Rating: 40.
 5. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.

6. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.
7. Sound Isolation: Within perimeter of roof curb rails and as detailed on the Drawings:
8. Static Deflection: Nominal 1 inch, 2 inches, or 3 inches.

2.2 VIBRATION ISOLATORS

- A. **Type 1a** Elastomeric Isolator Pads: Oil- and water-resistant elastomer, arranged in single or multiple layers (maximum 3 layers separated by steel shims) to achieve 90 percent efficiency, molded with a nonslip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type W, Super W, WSW, and WSWSW or comparable products by one of the following:
 2. Material: Standard neoprene for indoor applications.
 3. Material: Bridge-bearing neoprene, complying with AASHTO M 251 for outdoor applications.
- B. **Type 1b** Elastomeric Isolator Pads: Oil- and water-resistant elastomer, single layer, molded with a nonslip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and 1/4 inch steel load bearing plate. Factory cut to sizes that match requirements of supported equipment.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type Super WMSW and MBSW or a comparable product by one of the following:
 - a. Amber/Booth; a VMC Group Company.
 - b. Kinetics Noise Control, Inc.
 - c. Korfund Dynamcis; a VMC Group Company.
 - d. Vibration Eliminator Co., Inc.
 - e. Vibration Mountings & Controls; a VMC Group Company.
 - f. Vibro-Acoustics.
 2. Material: Standard neoprene for indoor applications.

3. Material: Bridge-bearing neoprene, complying with AASHTO M 251 for outdoor applications.
- C. **Type 2** Elastomeric Mounts: Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type ND or a comparable product by one of the following:
 - a. Amber/Booth; a VMC Group Company.
 - b. Kinetics Noise Control, Inc.
 - c. Korfund Dynamics; a VMC Group Company.
 - d. Vibration Eliminator Co., Inc.
 - e. Vibration Mountings & Controls; a VMC Group Company.
 - f. Vibro-Acoustics.
 2. Durometer Rating: Selected for maximum possible static deflection with the loading of each piece of equipment.
 3. Materials: Cast-ductile-iron housing containing two separate and opposing, molded, bridge-bearing neoprene elements that prevent central threaded sleeve and attachment bolt from contacting the casting during normal operation.
 4. Neoprene: Bridge-bearing neoprene as defined by AASHTO.
- D. **Type 3** Spring Isolators: Freestanding, open-spring isolators.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type SLF or a comparable product by one of the following:
 - a. Amber/Booth; a VMC Group Company.
 - b. Kinetics Noise Control, Inc.
 - c. Korfund Dynamics; a VMC Group Company.
 - d. Vibration Eliminator Co., Inc.
 - e. Vibration Mountings & Controls; a VMC Group Company.
 - f. Vibro-Acoustics.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 100 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

E. **Type 4** Restrained Spring Isolators: Restrained single and multiple spring mounts.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Types SLR and SLRS or comparable products by one of the following:
 - a. Amber/Booth; a VMC Group Company.
 - b. Kinetics Noise Control, Inc.
 - c. Korfund Dynamics; a VMC Group Company.
 - d. Vibration Eliminator Co., Inc.
 - e. Vibration Mountings & Controls; a VMC Group Company.
 - f. Vibro-Acoustics.
2. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

F. **Type 5** Thrust Restraints

1. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression or tension as required, and with a load stop. Include rod and angle-iron brackets with back-up plates for attaching to equipment and ductwork.

- a. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type WBI for fan inlet connections, and Type WBD for fan outlet connections, or comparable products by one of the following:
 - 1) Amber/Booth; a VMC Group Company..
 - 2) Kinetics Noise Control, Inc.
 - 3) Korfund Dynamics; a VMC Group Company.
 - 4) Vibration Eliminator Co., Inc.
 - 5) Vibration Mountings & Controls; a VMC Group Company..
 - 6) Vibro-Acoustics.
- b. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
- c. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
- d. Minimum Additional Travel: 50 percent of the required deflection at rated load.
- e. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
- f. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- g. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
- h. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch (6-mm) movement at start and stop.

2.3 VIBRATION ISOLATION HANGERS

- A. **Type 8a** Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type 30N or a comparable product by one of the following:
 - a. Amber/Booth; a VMC Group Company..
 - b. Kinetics Noise Control, Inc.
 - c. Korfund Dynamics; a VMC Group Company.

- d. Vibration Eliminator Co., Inc.
 - e. Vibration Mountings & Controls; a VMC Group Company..
 - f. Vibro-Acoustics.
2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 5. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
- B. **Type 8b** Spring Hangers with Vertical-Limit Stop: Precompressed combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type PC30N or a comparable product by one of the following:
 - a. Amber/Booth; a VMC Group Company.
 - b. Kinetics Noise Control, Inc.
 - c. Korfund Dynamics; a VMC Group Company.
 - d. Vibration Eliminator Co., Inc.
 - e. Vibration Mountings & Controls; a VMC Group Company.
 - f. Vibro-Acoustics.
 2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 5. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.

6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

2.4 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 1. Powder coating on springs and housings.
 2. All hardware shall be electrogalvanized. Hot-dip galvanize metal components for exterior use.
 3. Baked enamel for metal components on isolators for interior use.
 4. Color-code or otherwise mark vibration isolation devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation devices for compliance with requirements, installation tolerances, and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install roof curbs, equipment supports, and roof penetrations as specified in Division 07 Section "Roof Accessories."
- B. Install thrust limits at centerline of thrust, symmetrical on either side of equipment.

3.3 APPLICATION

- A. Refer to Vibration Isolator Application Schedule on the drawings for isolator application and minimum deflection.

3.4 CONNECTIONS

- A. Provide flexible electrical connections in the form of large radius, 360 degree loop of flexible conduit for all vibrating isolated equipment. Any cooling water lines, compressed air, or other piping services (except inlet and outlet water connections for pumps, chillers or cooling tower) shall be made with 360 degree loops of reinforced neoprene hose, which are attached using nipples of appropriate gender. All service connections made with neoprene hose shall have shut-off valves between the hose and the supply service.
- B. Vibration isolate piping connected to vibration isolated equipment using Type 8a or 8b spring hangers, and with distance to be isolated as scheduled on the Drawings. Maximum spacing between isolators same as maximum distance between pipe hangers and supports.
- C. Vibration isolate ductwork connected to air handling units, return air fans, and vibration isolated equipment using Type 8a or 8b spring hangers, and in accordance with isolation distances scheduled on the Drawings.

3.5 EQUIPMENT BASES

- A. Fill concrete inertia bases, after installing base frame, with 3000-psi concrete; trowel to a smooth finish.
 - 1. Cast-in-place concrete materials and placement requirements are specified in Division 03.
- B. Concrete Bases: Anchor equipment to concrete base according to supported equipment manufacturer's written instructions.
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 - 2. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.

5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
6. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.6 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing:
 1. Isolator deflection.
 2. Snubber minimum clearances.

3.7 ADJUSTING

- A. Adjust isolators after piping systems have been filled and equipment is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop.
- D. Adjust active height of spring isolators.
- E. Adjust snubbers according to manufacturer's written recommendations.

3.8 CLEANING

- A. After completing equipment installation, inspect vibration isolation devices. Remove paint splatters and other spots, dirt, and debris.

END OF SECTION 15070

SECTION 15075 - MECHANICAL IDENTIFICATION

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUBMITTALS.....1
1.3 QUALITY ASSURANCE.....2
1.4 COORDINATION.....2

PART 2 - PRODUCTS.....2
2.1 MANUFACTURERS.....2
2.2 EQUIPMENT IDENTIFICATION DEVICES.....3
2.3 PIPING IDENTIFICATION DEVICES.....4
2.4 DUCT IDENTIFICATION DEVICES.....5
2.5 VALVE TAGS.....5
2.6 VALVE SCHEDULES.....5
2.7 WARNING TAGS.....6

PART 3 - EXECUTION.....6
3.1 APPLICATIONS, GENERAL.....6
3.2 EQUIPMENT IDENTIFICATION.....6
3.3 PIPING IDENTIFICATION.....8
3.4 DUCT IDENTIFICATION.....9
3.5 VALVE-TAG INSTALLATION.....9
3.6 VALVE-SCHEDULE INSTALLATION.....9
3.7 HAZARDOUS MATERIAL IDENTIFICATION DEVICES.....9
3.8 WARNING-TAG INSTALLATION.....10
3.9 ADJUSTING.....10
3.10 CLEANING10
3.11 SCHEDULES10

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:

- 1. Division 15 Section "Mechanical General Requirements."

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Valve numbering scheme.
- D. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in Maintenance Manuals.

1.3 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME (ANSI) A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with location of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified:
 - 1. Seton.
 - 2. Brady.
 - 3. EMED.
 - 4. Craftmark.
 - 5. Brimar Industries, Inc.
 - 6. Marking Services Inc. (MSI).
 - 7. Kolbi Pipe Marker Co.

2.2 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.

1. Data:

- a. Manufacturer, product name, model number, and serial number.
- b. Capacity, operating and power characteristics, and essential data.
- c. Labels of tested compliances.

2. Location: Accessible and visible.

3. Fasteners: As required to mount on equipment.

B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.

1. Terminology: Match schedules as closely as possible.

2. Data:

- a. Name and plan number.
- b. Equipment service.
- c. Design capacity.
- d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.

3. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.

C. Equipment Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.

1. Data: Instructions for operation of equipment and for safety procedures.

2. Engraving: Manufacturer's standard letter style, of sizes and with terms to match equipment identification.

3. Thickness: Minimum 1/16 inch, unless otherwise indicated.

4. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

D. Access Panel and Door Markers: 1/16-inch- thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch center hole for attachment.

1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.3 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.

1. Colors: Comply with ASME (ANSI) A13.1, unless otherwise indicated.
2. Type and Size of Letters: Comply with ANSI A13.1, unless otherwise indicated.
3. Legends: Spelled out in full or commonly used and accepted abbreviations.
4. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
5. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
6. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Pretensioned Pipe Markers: Precoiled semirigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.

C. Shaped Pipe Markers: Preformed semirigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.

D. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.

E. Plastic Tape: Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

F. Underground Pipe Markers: Bright colored continuously printed plastic ribbon tape of not less than 6 inches wide by 4mil thick, manufactured for direct burial service.

G. Detectable Underground Pipe Markers: Continuously printed plastic ribbon tape with detectable aluminum core and with colors meeting APWA requirements, not less than 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.4 DUCT IDENTIFICATION DEVICES

A. Duct Markers: Engraved, color-coded laminated plastic. Include direction and quantity of airflow, air handling unit or fan number, and duct service (such as supply, return, and exhaust). Include contact-type, permanent adhesive.

B. Duct Markers: Vinyl, 2-inch minimum character height, with permanent pressure sensitive adhesive. Include direction and quantity of airflow, air handling unit or fan number, and duct service (such as supply, return, and exhaust).

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme to match existing numbering scheme. Provide 5/32-inch hole for fastener.

1. Material: 0.032-inch- thick brass.
2. Valve-Tag Fasteners: Brass wire-link chain or beaded chain.

2.6 VALVE SCHEDULES

A. Valve Schedules: For each piping system, on standard-size bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
2. Frame: Finished hardwood or extruded aluminum.
3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

2.7 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.
 1. Size: 3 by 5-1/4 inches minimum.
 2. Fasteners: Brass grommet and wire.
 3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

- A. Products specified are for applications referenced in other Division 15 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

- A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:
 1. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
 2. Pumps, compressors, chillers, condensers, and similar motor-driven units.
 3. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
 4. Fans, blowers, primary balancing dampers, and mixing boxes.
 5. Packaged HVAC central-station and zone-type units.

- B. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.
1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
 3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
 - a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 - b. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
 - c. Pumps, compressors, chillers, condensers, and similar motor-driven units.
 - d. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
 - e. Fans, blowers, primary balancing dampers, and mixing boxes.
 - f. Packaged HVAC central-station and zone-type units.
 - g. Tanks and pressure vessels.
- C. Install access panel markers with screws on equipment access panels.
- D. Area Served: Equipment serving different areas of a building other than where the equipment is installed shall be permanently marked in a manner that, in addition to identifying the equipment as specified in this Section, also identifies the area it serves.

3.3 PIPING IDENTIFICATION

- A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
1. Pipes with OD, Including Insulation, Less Than 6 Inches: Pretensioned pipe markers. Use size to ensure a tight fit.
 2. Pipes with OD, Including Insulation, Less Than 6 Inches: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, minimum 3/4 inch wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.
 3. Pipes with OD, Including Insulation, 6 Inches and Larger: Shaped pipe markers. Use size to match pipe and secure with fasteners.
 4. Pipes with OD, Including Insulation, 6 Inches and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, minimum 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.
- B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed locations as follows:
1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.
- C. Underground Pipe Markers: Install 6 to 8 inches below finished grade, directly above buried pipe.

3.4 DUCT IDENTIFICATION

- A. Identify ductwork with vinyl markers and flow direction arrows.
- B. Locate markers at air handling units, each side of floor and wall penetrations, near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following:
 - 1. Valve-Tag Size and Shape:
 - a. Cold Water: Minimum 1-1/2 inches, round or square.
 - b. Hot Water: Minimum 1-1/2 inches, round or square.
 - c. Fire Protection: Minimum 1-1/2 inches, round or square.
 - d. Gas: Minimum 1-1/2 inches, round or square.
 - e. Steam: Minimum 1-1/2 inches, round or square.

3.6 VALVE-SCHEDULE INSTALLATION

- A. Mount valve schedule on wall in accessible location in each major equipment room.

3.7 HAZARDOUS MATERIAL IDENTIFICATION DEVICES

- A. Mount to wall or door of room containing hazard. Indicate classification of refrigerant or other hazard.

3.8 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

3.9 ADJUSTING

- A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.10 CLEANING

- A. Clean faces of mechanical identification devices and glass frames of valve schedules.

3.11 SCHEDULES

- A. Paint colors are listed here for reference only. Painting is specified under Division 9.

PIPE LABELING AND COLOR CODING

<u>Pipe System Label</u>	<u>Drawing Ab-</u> <u>brev.</u>	<u>Labels</u>	<u>Piping</u>
Sanitary Sewer	SAN	White on Green	Dark Brown
Sanitary Vent	V	White on Green	Dark Brown
Rain Conductor	RC	White on Green	Dark Brown
Acid Waste	AW	Black on Yellow	Black
Acid Vent	AV	Black on Yellow	Black
Domestic Cold Water	CW	White on Green	Light Green
High Pressure Domestic Cold Water	HPCW	White on Green	Light Green
Non-Potable Cold Water	NPCW	Black on Yellow	
Domestic Hot Water	HW	Black on Yellow	Dark Green
High Pressure Domestic Hot Water	HPHW	Black on Yellow	Dark Green
High Pressure Domestic Hot Water Return	HPHWR	Black on Yellow	Dark Green
Domestic Hot Water Return	HWR	Black on Yellow	Dark Green

<u>Pipe System Label</u>	<u>Drawing Ab-</u> <u>brev.</u>	<u>Labels</u>	<u>Piping</u>
Soft Cold Water	SCW	White on Green	Light Green
Soft Hot Water	SHW	White on Green	Dark Green
Soft Hot Water Return	SHWR	White on Green	Dark Green
Natural Gas	G	Black on Yellow	Yellow
Fuel Oil Supply	FOS	Black on Yellow	Yellow
Fuel Oil Return	FOR	Black on Yellow	Yellow
Compressed Air (90psig)	A(90psig)	Black on Yellow	Dark Blue
Compressed Air (25psig)	A	White on Green	Dark Blue
Laboratory Vacuum	LVAC	Black on Yellow	Unpainted
Carbon Dioxide	CO ₂	Black on Yellow	Unpainted
High Purity Water	DI	White on Green	White
Hot Water Htg. Supply	HWHS	Black on Yellow	Dark Blue
Hot Water Htg. Return	HWHR	Black on Yellow	Dark Blue
Terminal Unit Heating Sup	THS	Black on Yellow	Dark Blue
Terminal Unit Heating Ret	THR	Black on Yellow	Dark Blue
Animal Heating Supply	AHS	Black on Yellow	Dark Blue
Animal Heating Return	AHR	Black on Yellow	Dark Blue
Energy Recovery Loop Sup.	ERLS	Black on Yellow	Dark Blue
Energy Recovery Loop Ret.	ERLR	Black on Yellow	Dark Blue
Chilled Water Supply	CHWS	White on Green	Light Blue
Chilled Water Return	CHWR	White on Green	Light Blue
Condenser Water Supply	CWS	White on Green	Light Green

<u>Pipe System Label</u>	<u>Drawing Ab-</u> <u>brev.</u>	<u>Labels</u>	<u>Piping</u>
Condenser Water Return	CWR	White on Green	Light Green
Process Cooling Water Sup.	PCWS	White on Green	Light Green
Process Cooling Water Ret.	PCWR	White on Green	Light Green
Refrigerant Liquid	RL	Black on Yellow	
Refrigerant Suction	RS	Black on Yellow	
Steam Condensate	LPC	Black on Yellow	Aluminum
Medium Pressure Steam Condensate	MPC	Black on Yellow	Aluminum
High Pressure Steam Condensate	HPC	Black on Yellow	Aluminum
Pumped Steam Condensate	PC	Black on Yellow	Aluminum
Medium Pressure Steam (60 psig)	MPS	Black on Yellow	Aluminum
High Pressure Steam,	HPS	Black on Yellow	Aluminum
Low Pressure Steam (5 psig)	LPS	Black on Yellow	Aluminum
Fire Protection	FP	White on Red	Bright Red
Medical Gases	Refer to Division 15 Section "Medical Gas Systems."		

SHEET METAL WORK

<u>Service</u>	<u>Abbrev.</u>	<u>Labels</u>	<u>Ductwork</u>
Air Conditioning Supply	Supply Air	White on Green	White
Air Conditioning Return	Return Air	White on Green	White
Exhaust Systems	Exhaust Air	Black on Yellow	Green
Outside Air Intake	Outside Air	White on Green	White
Mixed Air	Mixed Air	White on Green	White

END OF SECTION 15075

SECTION 15080 - MECHANICAL INSULATION

PART 1 - GENERAL.....	2
1.1 RELATED DOCUMENTS.....	2
1.2 SUMMARY.....	2
1.3 DEFINITIONS.....	2
1.4 INDOOR PIPING INSULATION SYSTEMS DESCRIPTION.....	3
1.5 INDOOR DUCT AND PLENUM INSULATION SYSTEMS DESCRIPTION.....	3
1.6 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SYSTEMS DESCRIPTION.....	3
1.7 EQUIPMENT INSULATION SYSTEMS DESCRIPTION.....	3
1.8 FIELD-APPLIED JACKETING SYSTEMS DESCRIPTION.....	3
1.9 SUBMITTALS.....	3
1.10 QUALITY ASSURANCE	4
1.11 DELIVERY, STORAGE, AND HANDLING	4
1.12 COORDINATION	4
1.13 SCHEDULING	5
PART 2 - PRODUCTS.....	5
2.1 INSULATION MATERIALS, GENERAL REQUIREMENTS.....	5
2.2 PIPE INSULATION MATERIALS.....	5
2.3 DUCTWORK INSULATION MATERIALS.....	6
2.4 EQUIPMENT INSULATION MATERIALS.....	7
2.5 FIRE-RATED INSULATION SYSTEMS.....	7
2.6 INSULATING CEMENTS.....	8
2.7 ADHESIVES.....	8
2.8 MASTICS.....	9
2.9 SEALANTS.....	10
2.10 FACTORY-APPLIED JACKETS	11
2.11 FIELD-APPLIED JACKETS	12
2.12 REMOVABLE AND REUSABLE INSULATION COVERS	14
2.13 TAPES	15
2.14 SECUREMENTS	17
2.15 CORNER ANGLES	21
PART 3 - EXECUTION.....	22
3.1 EXAMINATION.....	22
3.2 PREPARATION.....	22
3.3 COMMON INSTALLATION REQUIREMENTS.....	23
3.4 PENETRATIONS.....	25
3.5 GENERAL PIPE INSULATION INSTALLATION.....	26
3.6 FLEXIBLE ELASTOMERIC PIPE INSULATION INSTALLATION.....	29
3.7 GLASS-FIBER AND MINERAL WOOL PIPE INSULATION INSTALLATION.....	30
3.8 DUCT AND PLENUM INSULATION INSTALLATION.....	31
3.9 DUCT LAGGING INSTALLATION.....	34

3.10	EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION ..	35
3.11	FIELD-APPLIED JACKET INSTALLATION	37
3.12	FIRE-RATED INSULATION SYSTEM INSTALLATION	38
3.13	FINISHES	39

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 02 Section "Underground Hydronic Distribution Piping" for preinsulated piping systems.
2. Division 02 Section "Underground Steam and Condensate Distribution Piping" for preinsulated piping systems.
3. Division 15 Section "Mechanical General Requirements."
4. Division 15 Section "Basic Materials and Methods."
5. Division 15 Section "Hanger and Supports" for thermal hanger shield inserts.
6. Division 15 Section "Plumbing Fixtures: for protective shielding guards.
7. Division 15 Section "Medical Plumbing Fixtures" for protective shielding guards.
8. Division 15 Section "Metal Ducts" for duct liners.

1.2 SUMMARY

A. This Section includes mechanical insulation for pipe, duct, and equipment.

1.3 DEFINITIONS

- A. ASJ: All-service jacket.
- B. FSK: Foil, scrim, kraft paper.
- C. FSP: Foil, scrim, polyethylene.
- D. PVC: Polyvinyl Chloride.
- E. PVDC: Polyvinylidene chloride.
- F. SSL: Self-sealing lap.

1.4 INDOOR PIPING INSULATION SYSTEMS DESCRIPTION

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are scheduled on the Drawings, or identified for each piping system and pipe size range.

1.5 INDOOR DUCT AND PLENUM INSULATION SYSTEMS DESCRIPTION

- A. Acceptable indoor duct and plenum insulation materials and thicknesses are scheduled on the Drawings.

1.6 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SYSTEMS DESCRIPTION

- A. Acceptable outdoor duct and plenum insulation materials and thicknesses are scheduled on the Drawings.

1.7 EQUIPMENT INSULATION SYSTEMS DESCRIPTION

- A. Acceptable equipment insulation materials and thicknesses are scheduled on the Drawings.

1.8 FIELD-APPLIED JACKETING SYSTEMS DESCRIPTION

- A. Acceptable field-applied jacketing materials and thicknesses are scheduled on the Drawings.

1.9 SUBMITTALS

- A. Shop Drawings: Show details for the following:
 1. Application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 2. Attachment and covering of heat tracing inside insulation.
 3. Insulation application at pipe expansion joints for each type of insulation.
 4. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 5. Removable insulation at piping specialties, equipment connections, and access panels.
 6. Application of field-applied jackets.
 7. Application at linkages of control devices.
 8. Field application for each equipment type

9. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.10 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

- B. Ductwork Maximum Temperature Limits: Based on ASTM C 411 test procedures.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Prior to installation, protect insulation from exposure to water and from physical damage. Prior to installation, store insulation in manufacturer's original packaging.

1.12 COORDINATION

- A. Coordinate size and location of supports, hangers, and pre-insulated pipe shields/supports specified in Division 15 Section "Hangers and Supports."

- B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

- C. Coordinate installation and testing of heat tracing.

1.13 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS, GENERAL REQUIREMENTS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- E. Adhesives used shall be fire resistant in their dry states and UL listed.

2.2 PIPE INSULATION MATERIALS

- A. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
 - 1. Products: Subject to compliance with requirements, provide one of the products specified.
 - a. Armacell LLC; AP Armaflex.
 - b. IK Insulation Group; K-Flex USA LLC; Insul-Tube and Insul-Sheet.
- B. Glass-Fiber, Preformed Pipe Insulation, Type I:
 - 1. Products: Subject to compliance with requirements, provide one of the products specified.

- a. Johns Manville; Micro-Lok.
 - b. Knauf Insulation; 1000 Pipe Insulation.
 - c. Manson Insulation Inc.; Alley-K.
 - d. Owens Corning; Fiberglas Pipe Insulation.
2. Type I, 850 deg F Materials: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ or ASJ-SSL. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

2.3 DUCTWORK INSULATION MATERIALS

- A. Blanket Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket III with factory-applied FSP jacket. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the products specified.

- a. CertainTeed Corp.; Duct Wrap.
- b. Johns Manville; Microlite.
- c. Knauf Insulation; Duct Wrap.
- d. Manson Insulation Inc.; Alley Wrap FSK.
- e. Owens Corning; All-Service Duct Wrap.

- B. Board Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the products specified.

- a. CertainTeed Corp.; Commercial Board.
- b. Fibrex Insulations Inc.; FBX.
- c. Johns Manville; 800 Series Spin-Glas.
- d. Knauf Insulation; Insulation Board.
- e. Manson Insulation Inc.; AK Board.
- f. Owens Corning; Fiberglas 700 Series.

C. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.

1. Products: Subject to compliance with requirements, provide one of the products specified.

a. Armacell LLC; AP Armaflex.

b. IK Insulation Group; K-Flex USA LLC; Insul-Sheet.

2.4 EQUIPMENT INSULATION MATERIALS

A. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.

1. Products: Subject to compliance with requirements, provide one of the products specified.

a. Armacell LLC; AP Armaflex.

b. IK Insulation Group; K-Flex USA LLC; Insul-Sheet and Insul-Tube.

B. Board Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For equipment applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the products specified.

a. CertainTeed Corp.; Commercial Board.

b. Fibrex Insulations Inc.; FBX.

c. Johns Manville; 800 Series Spin-Glas.

d. Knauf Insulation; Insulation Board.

e. Manson Insulation Inc.; AK Board.

f. Owens Corning; Fiberglas 700 Series.

2.5 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested according to ASTM E2336.

1. Products: Subject to compliance with requirements, provide one of the products specified.

- a. Thermal Ceramics; FireMaster FastWrap XL and Pyroscat XL.
- b. 3M Fire Protection Products; Fire Barrier Duct Wrap 615+.
- c. Unifrax Corporation; FyreWrap Max 2.0.

2.6 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
 1. Products: Subject to compliance with requirements, provide one of the products specified.
 - a. Insulco, Division of MFS, Inc.; Triple I.
 - b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
 1. Products: Subject to compliance with requirements, provide one of the products specified.
 - a. P. K. Insulation Mfg. Co., Inc.; Thermal-V-Kote.

2.7 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to it and to surfaces to be insulated, unless otherwise indicated.
- B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 1. Products: Subject to compliance with requirements, provide one of the products specified.
 - a. Armacell LCC; 520 Adhesive.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-75.
 - c. RBX Corporation; Rubatex Contact Adhesive.
- C. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the products specified.
 - a. Childers Products, H.B. Fuller Company; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225.
 - e. Mon-Eco Industries, Inc.; 22-25.

D. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of the products specified.
 - a. Dow Chemical Company (The); 739, Dow Silicone.
 - b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C. Plastics, Inc.; Welding Adhesive.
 - d. Red Devil, Inc.; Celulon Ultra Clear.
 - e. Speedline Corporation; Speedline Vinyl Adhesive.

2.8 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the products specified.
 - a. Childers Products, H.B. Fuller Company; CP-35.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-90.
 - c. ITW TACC, Division of Illinois Tool Works; CB-50.
 - d. Marathon Industries, Inc.; 590.
 - e. Mon-Eco Industries, Inc.; 55-40.
 - f. Vimasco Corporation; 749.
2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.

4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, provide one of the products specified.
 - a. Childers Products, H.B. Fuller Company; CP-10.
 - b. Foster Products Corporation, H. B. Fuller Company; 35-00.
 - c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
 - d. Marathon Industries, Inc.; 550.
 - e. Mon-Eco Industries, Inc.; 55-50.
 - f. Vimasco Corporation; WC-1/WC-5.
2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 200 deg F.
4. Solids Content: 63 percent by volume and 73 percent by weight.
5. Color: White.

2.9 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the products specified.
 - a. Childers Products, H.B. Fuller Company; CP-76-8.
 - b. Foster Products Corporation, H. B. Fuller Company; 95-44.
 - c. Marathon Industries, Inc.; 405.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Vimasco Corporation; 750.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the products specified.
 - a. Childers Products, H.B. Fuller Company; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

C. Joint Sealants for Cellular-Glass, Phenolic-Foam, and Polyisocyanurate:

1. Products: Subject to compliance with requirements, provide one of the products specified.
 - a. Childers Products, H.B. Fuller Company; CP-76.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-45.
 - c. Marathon Industries, Inc.; 405.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Pittsburgh Corning Corporation; Pittseal 444.
 - f. Vimasco Corporation; 750.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.

2.10 FACTORY-APPLIED JACKETS

A. Insulation systems indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.11 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as specified; roll stock ready for shop or field cutting and forming.
 1. Products: Subject to compliance with requirements, provide one of the products specified.
 - a. Johns Manville; Zeston and Ceel-Co.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto PVC Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 2. Adhesive: As recommended by jacket material manufacturer.
 3. Color: White.
 4. Factory-fabricated tank heads and tank side panels.
- D. PVC Fitting Covers: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C, and including flexible glass fiber insulation inserts.
 1. Products: Subject to compliance with requirements, provide one of the products specified.
 - a. Johns Manville; Zeston and Ceel-Co.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto PVC Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 2. Adhesive: As recommended by manufacturer.
 3. Color: White.

4. Factory-fabricated fitting covers:

- a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, and mechanical joints.

E. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the products specified.

- a. PABCO-Childers Metals; ITW Insulation Systems; Metal Jacketing Systems.
- b. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.

- a. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
- b. Finish and thickness are indicated in field-applied jacket schedules.
- c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
- d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper or 2.5-mil-thick Polysurlyn.
- e. Factory-Fabricated Fitting Covers:

- 1) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
- 2) Provide factory fabricated PVC tee covers, flange and union covers, beveled collars and valve covers.
- 3) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

F. Self-Adhesive Outdoor Jacket for Piping: Laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a fabric reinforced insulation cladding with natural aluminum stucco embossed facing.

1. Products: Subject to compliance with requirements, provide one of the products specified.

- a. 3M VentureClad; 1579GCW-E.
 - b. Polyguard; Alumaguard.
- G. Self-Adhesive Outdoor Jacket for Ductwork: Laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with aluminum-foil facing.
1. Products: Subject to compliance with requirements, provide one of the products specified.
 - a. MFM Building Products Corp.; FlexClad-400
 - b. Polyguard; Alumaguard.
 - c. Venture Tape Corp.; VentureClad.
- H. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
1. Products: Subject to compliance with requirements, provide one of the products specified.
 - a. Dow Chemical Company (The), Saran 540 Vapor Retarder Film.
- I. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
1. Products: Subject to compliance with requirements, provide one of the products specified.
 - a. Dow Chemical Company (The), Saran 560 Vapor Retarder Film.
- 2.12 REMOVABLE AND REUSABLE INSULATION COVERS
- A. Flexible Style: Custom fabricated composite jackets for valves, flanges, and expansion joints consisting of 4 inches of high temperature fiberglass insulation compressed between Teflon impregnated fiberglass inner and outer facing stitched with fiberglass core Teflon thread,

and secured with Velcro fasteners and double D-ring cinching. Service temperature range of minus 40 deg F to 500 deg F.

1. Fabricators:

- a. Apex Energy & Environmental Products Inc.
- b. 3i Supply Co.; K-Tex.
- c. Valley Group of Companies.

B. Rigid Style: Custom fabricated composite jackets for valves, flanges, and expansion joints consisting of rigid foam insulation with silicone impregnated fiberglass outer facing stitched with fiberglass thread, and secured with Velcro fasteners and double D-ring cinching. Service temperature range of minus 40 deg F to 500 deg F.

1. Fabricators:

- a. Valley Group of Companies.

2.13 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136 and UL listed.

1. Products: Subject to compliance with requirements, provide one of the products specified.

- a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
- b. Compac Corp.; 104 and 105.
- c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
- d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.

3. Thickness: 11.5 mils.

4. Adhesion: 90 ounces force/inch in width.

5. Elongation: 2 percent.

6. Tensile Strength: 40 lbf/inch in width.

7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136 and UL listed.
1. Products: Subject to compliance with requirements, provide one of the products specified.
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
 - b. Compac Corp.; 110 and 111.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
 - d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
 2. Width: 3 inches.
 3. Thickness: 6.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, provide one of the products specified.
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
 - b. Compac Corp.; 130.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
 - d. Venture Tape; 1506 CW NS.
 2. Width: 2 inches.
 3. Thickness: 6 mils.
 4. Adhesion: 64 ounces force/inch in width.
 5. Elongation: 500 percent.
 6. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive and UL listed.
1. Products: Subject to compliance with requirements, provide one of the products specified.

- a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
 - b. Compac Corp.; 120.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
 - d. Venture Tape; 3520 CW.
2. Width: 2 inches.
 3. Thickness: 3.7 mils.
 4. Adhesion: 100 ounces force/inch in width.
 5. Elongation: 5 percent.
 6. Tensile Strength: 34 lbf/inch in width.
- E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the products specified.
 - a. Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.
 2. Width: 3 inches.
 3. Film Thickness: 4 mils.
 4. Adhesive Thickness: 1.5 mils.
 5. Elongation at Break: 145 percent.
 6. Tensile Strength: 55 lbf/inch in width.
- F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the products specified.
 - a. Dow Chemical Company (The); Saran 560 Vapor Retarder Tape.
 2. Width: 3 inches.
 3. Film Thickness: 6 mils.
 4. Adhesive Thickness: 1.5 mils.
 5. Elongation at Break: 145 percent.
 6. Tensile Strength: 55 lbf/inch in width.

2.14 SECUREMENTS

- A. Bands:

1. Products: Subject to compliance with requirements, provide one of the products specified.
 - a. PABCO-Childers Metals; ITW Insulation Systems; Pab-Bands and Fabstraps.
 - b. RPR Products, Inc.; Bands.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing or closed seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing or closed seal.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
 - a. Products: Subject to compliance with requirements, provide one of the products specified.
 - 1) AGM Industries, Inc.; CWP-1.
 - 2) GEMCO; CD.
 - 3) Midwest Fasteners, Inc.; CD.
 - 4) Nelson Stud Welding; TPA, TPC, and TPS.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 - a. Products: Subject to compliance with requirements, provide one of the products specified.
 - 1) AGM Industries, Inc.; CWP-1.
 - 2) GEMCO; Cupped Head Weld Pin.
 - 3) Midwest Fasteners, Inc.; Cupped Head.

- 4) Nelson Stud Welding; CHP.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, provide one of the products specified.
 - 1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
 - 2) GEMCO; Perforated Base.
 - 3) Midwest Fasteners, Inc.; Spindle.
 - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, provide one of the products specified.
 - 1) GEMCO; Nylon Hangers.
 - 2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
 - b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.

- c. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
- a. Products: Subject to compliance with requirements, provide one of the products specified.
 - 1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.
 - 2) GEMCO; Press and Peel.
 - 3) Midwest Fasteners, Inc.; Self Stick.
 - b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive-backed base with a peel-off protective cover.
6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- a. Products: Subject to compliance with requirements, provide one of the products specified.
 - 1) AGM Industries, Inc.; RC-150.
 - 2) GEMCO; R-150.
 - 3) Midwest Fasteners, Inc.; WA-150.
 - 4) Nelson Stud Welding; Speed Clips.

- b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- a. Manufacturers:
 - 1) GEMCO.
 - 2) Midwest Fasteners, Inc.
 - C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
 - D. Wire: 0.062-inch soft-annealed, stainless steel.
 - 1. Manufacturers:
 - a. ACS Industries, Inc.
 - b. C & F Wire.
 - c. PABCO-Childers Metals; ITW Insulation Systems.
 - d. RPR Products, Inc.
- 2.15 CORNER ANGLES
- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
 - B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.
 - C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
 - 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 - 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 COMMON INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at the 4 o'clock or 8 o'clock position on horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive as recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install thermal hanger insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 4. Cover thermal hanger inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at the 4 o'clock or 8 o'clock position on the pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness. Where compression of insulation is possible, fabricate/install insulation per manufacturer's recommendations.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Below-Grade Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations that Are Not Fire Rated: Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations:

1. Terminate ductwork insulation at angle closure of fire damper sleeves.
2. Install pipe insulation continuously through penetrations of fire-rated walls and partitions.

a. Firestopping is specified in Division 07 Section "Through-Penetration Firestop Systems."

F. Insulation Installation at Floor Penetrations:

1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at angle closure of fire damper sleeves.
2. Pipe: Install insulation continuously through floor penetrations.

a. Seal penetrations through fire-rated assemblies according to Division 07 Section "Through-Penetration Firestop Systems."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this Article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible Elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

E. Install removable and reusable insulation covers in accordance with fabricator's instructions, and at the following locations:

1. At valves, flanges, and expansion joints. Expansion joints shall have jacket installed in a manner to allow for replacing of joints without removing insulation cover.

3.6 FLEXIBLE ELASTOMERIC PIPE INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.

4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.

2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.

2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 GLASS-FIBER AND MINERAL WOOL PIPE INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install PVC fitting covers when available.
2. When PVC fitting covers are not available, install preformed pipe insulation to outer diameter of pipe flange:
 - a. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - b. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with fiberglass or mineral wool blanket insulation as specified for system.

3. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install PVC fitting covers when available.
2. When PVC fitting covers are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install PVC fitting covers when available.
2. When PVC fitting covers are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 DUCT AND PLENUM INSULATION INSTALLATION

A. Blanket Insulation Installation on Ducts and Plenums:
Secure with insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions. Adhesive may be omitted from top surface of horizontal rectangular ducts.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install

- additional pins to hold insulation tightly against surface at cross bracing.
- c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not over compress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
 5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide

strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

- B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not over compress insulation during installation.
 - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

- a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- C. Flexible Elastomeric Thermal Insulation Installation for Ducts and Plenums: Install insulation over entire surface of ducts and plenums.
1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
 2. Seal longitudinal seams and end joints.
 3. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with strips of same material used to insulate duct and following manufacturer's installation instructions.
- 3.9 DUCT LAGGING INSTALLATION
- A. Install between silencers and shaft or Mechanical Equipment Room walls, and where indicated on Drawings.
 - B. Ensure sufficient clearance between ductwork to be lagged and adjacent items.
 - C. Install lagging as detailed on Drawings.
 - D. Adhere board insulation with adhesive. Do not use pins.

- E. Install gypsum board layers. Stagger joints between layers. Seal joints with acoustical sealant.

3.10 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

- A. Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
 - a. Do not weld anchor pins to ASME-labeled pressure vessels.
 - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
 - c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
 - d. Do not over compress insulation during installation.
 - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
 - f. Impale insulation over anchor pins and attach speed washers.
 - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed

aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.

7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch-diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from galvanized steel, at least 0.040 inch thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges

with replaceable gasket material to form a vapor barrier.

3.11 FIELD-APPLIED JACKET INSTALLATION

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
 - 1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 - 2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
 - 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- C. Where FSK jackets are indicated, install as follows:
 - 1. Draw jacket material smooth and tight.
 - 2. Install lap or joint strips with same material as jacket.
 - 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 - 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
 - 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- D. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
 - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- E. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation

manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

F. Where self-adhesive jackets are indicated, install according to manufacturer's instructions and details on the drawings. Overlap seams arranged to shed water.

G. Where PVDC jackets are indicated, install as follows:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch-circumference limit allows for 2-inch-overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fish mouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.12 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, install two layers in strict accordance with manufacturer's instructions, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

- B. Insulate duct access panels and doors in strict accordance with insulation manufacturer's to achieve same fire rating as duct.
- C. Maintain a copy of insulation manufacturer's installation instructions on site for Code Official.
- D. Where fire-rated plenum wrap system is indicated, secure to system piping to maintain a continuous UL-listed fire rating.
- E. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Through-Penetration Firestop Systems."

3.13 FINISHES

- A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system specified in Division 09 painting Sections.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

END OF SECTION 15080

SECTION 15110 - GENERAL DUTY VALVES FOR PLUMBING

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUMMARY.....2
1.3 DEFINITIONS.....2
1.4 SUBMITTALS.....2
1.5 QUALITY ASSURANCE.....2
1.6 DELIVERY, STORAGE, AND HANDLING.....3

PART 2 - PRODUCTS.....3
2.1 VALVES, GENERAL.....3
2.2 BRONZE BALL VALVES.....5
2.3 GENERAL SERVICE BUTTERFLY VALVES.....6
2.4 BRONZE CHECK VALVES.....7
2.5 IRON SWING CHECK VALVES.....7
2.6 LIFT CHECK VALVES.....8
2.7 SPRING-LOADED, CENTER-GUIDED LIFT-DISC (SILENT) CHECK
VALVES.....9
2.8 BRONZE GLOBE VALVES.....10
2.9 CAST-IRON ANGLE VALVES.....11
2.10 DRAIN VALVES11
2.11 SOURCE QUALITY CONTROL11

PART 3 - EXECUTION.....11
3.1 EXAMINATION.....11
3.2 VALVE INSTALLATION.....12
3.3 JOINT CONSTRUCTION.....13
3.4 ADJUSTING.....13

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 02 piping Sections for general-duty and specialty valves for site construction piping.
2. Division 15 fire-suppression piping and fire pump Sections for fire-protection valves.
3. Division 15 Section "Mechanical Identification" for valve tags and charts.

4. Division 15 piping Sections for specialty valves applicable to those Sections only.
5. Division 15 Section "General-Duty Valves for HVAC" for HVAC valves.
6. Division 15 Section "Temperature Controls" for control valves and actuators.

1.2 SUMMARY

- A. This Section includes valves for general plumbing applications. Refer to piping Sections for specialty valve applications.

1.3 DEFINITIONS

- A. The following are standard abbreviations for valves:
 1. CWP: Cold working pressure.
 2. EPDM: Ethylene-propylene-diene terpolymer rubber.
 3. NBR: Acrylonitrile-butadiene rubber.
 4. NRS: Nonrising stem.
 5. OS&Y: Outside screw and yoke.
 6. PTFE: Polytetrafluoroethylene plastic.
 7. RPTFE: Reinforced polytetrafluoroethylene plastic.
 8. SWP: Steam working pressure.
 9. TFE: Tetrafluoroethylene plastic.
 10. WOG: Water, oil, and gas.

1.4 SUBMITTALS

- A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.
 1. Certification that products for use in potable water systems comply with NSF 61 and NSF 372.

1.5 QUALITY ASSURANCE

- A. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

- B. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.
- C. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set angle, gate, and globe valves closed to prevent rattling.
 - 4. Set ball and plug valves open to minimize exposure of functional surfaces.
 - 5. Set butterfly valves closed or slightly open.
 - 6. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 VALVES, GENERAL

- A. Isolation valves are scheduled on the Drawings. For other general plumbing valve applications, use the following:
 - 1. Shutoff Service: Ball, butterfly valves.
 - 2. Throttling Service: Angle, ball, butterfly, or globe valves.
 - 3. Pump Discharge: Spring-loaded, lift-disc check valves; and bronze lift check valves.

- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
- D. For valves not indicated in the Application Schedules, select valves with the following end connections:
1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends, except provide valves with threaded ends for condenser water, heating hot water, steam, and steam condensate services.
 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged, solder-joint, or threaded ends.
 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
 4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
 5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends.
 6. For Steel Piping, NPS 5 and Larger: Flanged ends.
 7. For Grooved-End Systems: Valve ends may be grooved.
- E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted unless otherwise noted. Wetted surfaces of valves contacted by consumable water shall contain not more than 0.25 percent weighted average lead content.
1. Exceptions:
 - a. Valves in pumped sanitary systems.
 - b. Valves in pumped storm systems.
 - c. Drain valves.
 - d. Valves in general air or vacuum systems.
 - e. Valves in irrigation systems.
 - f. Valves in non-potable water systems.
 - g. Valves in other plumbing systems not intended for human consumption.
- F. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
- G. Valve Actuators:

1. Chainwheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.
 2. Gear Drive Operator: For quarter-turn valves NPS 8 and larger.
 3. Handwheel: For valves other than quarter-turn types.
 4. Lever Handle: For quarter-turn valves NPS 6 and smaller.
- H. Extended Valve Stems: On insulated valves.
- I. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.
- J. Valve Grooved Ends: AWWA C606.
- K. Solder Joint: With sockets according to ASME B16.18.
1. Caution: Disassemble valves when soldering, as recommended by the manufacturer, to prevent damage to internal parts.
- L. Threaded: With threads according to ASME B1.20.1.
- M. Valve Bypass and Drain Connections: MSS SP-45.
- 2.2 BRONZE BALL VALVES
- A. Bronze Ball Valves, General: MSS SP-110 and have bronze body complying with ASTM B 584, except for Class 250 which shall comply with ASTM B 61, full-depth ASME B1.20.1 threaded or solder ends, and blowout-proof stems.
- B. Two-Piece, Regular Port Bronze Ball Valves with Stainless-Steel Trim: Type 316 stainless-steel ball and stem, reinforced TFE seats, blow-out-proof stem, with adjustable stem packing, soldered or threaded ends; and 150 psig SWP and 600-psig CWP ratings.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; by Conbraco Industries, Inc.; Series 70LF-140/240.
 - b. Hammond Valve.
 - c. Milwaukee Valve Company; Model UPBA100S/150S.

- d. NIBCO INC.; Models S-580-70-66-LF/T-580-70-66-LF.
- e. Watts Water Technologies, Inc.

2.3 GENERAL SERVICE BUTTERFLY VALVES

- A. General: MSS SP-67, for bubble-tight shutoff, extended-neck for insulation, disc and lining suitable for potable water, unless otherwise indicated, and with the following features:
 - 1. Full lug, and grooved valves shall be suitable for bi-directional dead end service at full rated pressure without the use or need of a downstream flange.
 - 2. Valve sizes NPS 2 through NPS 6 shall have lever lock operator; valve sizes NPS 8 and larger shall have weatherproof gear operator.
- B. Lug-Style (Single-Flange) Size NPS 2-1/2 through NPS 12 , 200-psig CWP Rating, Aluminum-Bronze Disc, EPDM Seat, Ferrous-Alloy Butterfly Valves: Full-lug type with ductile-iron body, Type 416 stainless-steel stem, copper bushing, aluminum-bronze disc, and molded-in EPDM seat (liner).
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; by Conbraco Industries, Inc.; Series 143 and Series LD145.
 - b. Bray International, Inc.
 - c. DeZurik.
 - d. Forum Energy Technologies; ABZ Valve.
 - e. Hammond Valve.
 - f. Milwaukee Valve Company.
 - g. NIBCO INC.; LD-2000-3/5.
 - h. Pentair Valves & Controls; Keystone.
 - i. Tyco Flow Control; Grinnell Flow Control.
 - j. Watts Water Technologies.
- C. Grooved-End Butterfly Valves with EPDM-Encapsulated Ductile-Iron Disc: Ductile-iron body with grooved or shouldered ends and polyamide coating inside and outside; Type 416 stainless-steel stem, PTFE bronze sintered on steel bushing, and 300-psig CWP Rating for Valves NPS 2 through NPS 8, 200 psig CWP Rating for Valves NPS 10 through NPS 12.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Anvil International, Inc.
- b. NIBCO INC.; Model GD-4765-3/5.
- c. Tyco Fire & Building Products; Grinnell Mechanical Products.
- d. Victaulic Co. of America.

2.4 BRONZE CHECK VALVES

A. Bronze Check Valves, General: MSS SP-80.

B. Class 125, Bronze, Swing Check Valves with Bronze Disc: ASTM B-62 bronze body and seat with regrinding-type bronze disc, Y-pattern design, soldered or threaded end connections, and having 200 psig CWP rating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Apollo Valves; by Conbraco Industries, Inc.; Model 162T-LF and 163T-LF (61YLF Series).
- b. Milwaukee Valve Company; Model UP509/UP1509.
- c. NIBCO INC.; Models S-413-B-LF or T-413-B-LF.
- d. Watts Water Technologies; LFCVY/LFCVYS.

2.5 IRON SWING CHECK VALVES

A. Iron Swing Check Valves, General: MSS SP-71.

B. Class 125, Gray-Iron, Standard Swing Check Valves: ASTM A-126, Class B cast-iron body and bolted bonnet with flanged end connections; non-asbestos synthetic-fiber gaskets; bronze disc and seat; and having 200 psig CWP rating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Apollo Valves; by Conbraco Industries, Inc.; Model 910F.
- b. Crane Co.; Crane Valves.
- c. Crane Co.; Stockham Div.
- d. Hammond Valve; IR1124-HI.

- e. Milwaukee Valve Company; Model F-2974.
 - f. NIBCO INC.; Model F-918-B.
 - g. Watts Water Technologies.
- C. Class 250, Gray-Iron, Swing Check Valves: ASTM A-126, Class B cast-iron body and bolted bonnet with flanged end connections; non-asbestos synthetic-fiber gaskets; and bronze disc and seat; and having 500 psig CWP rating.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; by Conbraco Industries, Inc.; Model 920F.
 - b. Crane Co.; Crane Valves.
 - c. Crane Co.; Stockham Div.
 - d. Hammond Valve; IR322.
 - e. Milwaukee Valve Company; Model F-2970.
 - f. NIBCO INC.; Model F-968-B.
 - g. Watts Water Technologies.
- D. Grooved-End, Swing Check Valves: Ductile-iron body with grooved or shouldered ends; nonasbestos, synthetic-fiber gaskets; rubber seats; and having 250-psig CWP Rating.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Mueller Co.
 - b. NIBCO, INC.; Model G-917-W.
 - c. Tyco Fire & Building Products; Grinnell Mechanical Products.
 - d. Victaulic Co. of America.
- 2.6 LIFT CHECK VALVES
- A. Class 125, Lift Check Valves with Nonmetallic TFE Disc:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; by Conbraco Industries, Inc.; Model CBV-LF (61LF Series).
 - b. Hammond Valve; UP943 and UP947.

- c. Milwaukee Valve Company; UP548T and UP1548T.
- d. NIBCO INC.; Model S-480-Y-LF and T-480-Y-LF.
- e. Watts Water Technologies; LF600.

2. Description:

- a. Standard: MSS SP-80, Type 2.
- b. CWP Rating: 250 psig.
- c. Body Design: Vertical flow.
- d. Body Material: Lead free brass or bronze.
- e. Ends: Threaded or Solder.
- f. Disc: PTFE, or TFE.

2.7 SPRING-LOADED, CENTER-GUIDED LIFT-DISC (SILENT) CHECK VALVES

A. Lift-Disc Check Valves, General: FCI 74-1 and MIL-V-18436F, with spring-loaded, center-guided bronze disc and seat.

B. Class 125, Wafer, Lift-Disc Check Valves: Wafer style with cast-iron body with diameter made to fit within bolt circle, and having 200 psig CWP rating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. NIBCO INC.; Model W-910-B-LF.
- b. Mueller Steam Specialty.
- c. Milwaukee Valve Company.
- d. Hammond Valve.

C. Class 250, Wafer, Lift-Disc Check Valves: Wafer style with cast-iron body with diameter made to fit within bolt circle, and having 400 psig CWP rating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. NIBCO INC.; Model W-960-B-LF.
- b. Mueller Steam Specialty.
- c. Milwaukee Valve Company.
- d. Hammond Valve.

D. Class 125, Globe, Flanged Lift-Disc Check Valves: Globe style with cast-iron body and flanged ends, and having 200 psig CWP rating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. NIBCO INC.; Model F-910-B-LF.
- b. Mueller Steam Specialty.
- c. Milwaukee Valve Company.
- d. Hammond Valve.

E. Class 250, Globe, Flanged Lift-Disc Check Valves: Globe style with cast-iron body and flanged ends, and having 400 psig CWP rating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. NIBCO INC.; Model F-960-B-LF.
- b. Mueller Steam Specialty.
- c. Milwaukee Valve Company.
- d. Hammond Valve.

2.8 BRONZE GLOBE VALVES

A. Bronze Globe Valves, General: MSS SP-80, with malleable-iron handwheel.

B. Class 125, TFE Disc, Bronze Globe Valves: ASTM B-62 bronze body, bonnet, and seat, TFE disc, copper-silicone bronze stem, union-ring bonnet, soldered or threaded end connections; and having 200 psig CWP rating.

1. Manufacturers: Subject to compliance with requirements, Provide products by one of the following:

- a. Apollo Valves; by Conbraco Industries, Inc.; Model 121T-LF.
- b. Hammond Valve; UP418 and UP440.
- c. Milwaukee Valve Company; Model UP502 and UP1502.
- d. Watts Water Technologies, Inc.; LFGLV.

2.9 CAST-IRON ANGLE VALVES

- A. Cast-Iron Angle Valves, General: MSS SP-85, Type II; having ASTM A 126, Class B cast-iron body and bolted bonnet; bronze mounted, non-asbestos packing and gaskets; and flanged-end connections.
- B. Class 125, Cast-Iron, Standard Angle Valves: 200-psig CWP rating.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. NIBCO INC.; Model F-818-B.
 - b. Crane Co.; Stockham Valves.
 - c. Crane Co.; Crane Valves.

2.10 DRAIN VALVES

- A. Ball-Valve-Type, Hose-End Drain Valves:
 - 1. Bronze ball valve as specified in this Section. Lead free construction is not required.
 - 2. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.11 SOURCE QUALITY CONTROL

- A. Identification: Factory label or color coding to identify lead free valves.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

- C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- D. Examine threads on valve and mating pipe for form and cleanliness.
- E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Locate valves for easy access and provide separate support where necessary.
- D. Install valves in horizontal piping with stem at or above center of pipe. Butterfly valves shall be installed with stem horizontal to allow support for the disc and the cleaning action of the disc.
- E. Install valves in position to allow full stem movement.
- F. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Dual-Plate Check Valves: In horizontal or vertical position, between flanges.
 - 3. Lift Check Valves: With stem upright and plumb.

3.3 JOINT CONSTRUCTION

- A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

3.4 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 15110

SECTION 15112 - GENERAL-DUTY VALVES FOR HVAC

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUMMARY.....2
1.3 DEFINITIONS.....2
1.4 SUBMITTALS.....2
1.5 QUALITY ASSURANCE.....2
1.6 DELIVERY, STORAGE, AND HANDLING.....3

PART 2 - PRODUCTS.....3
2.1 VALVES, GENERAL.....3
2.2 BRONZE BALL VALVES.....5
2.3 GENERAL SERVICE BUTTERFLY VALVES.....5
2.4 BRONZE CHECK VALVES.....6
2.5 IRON SWING CHECK VALVES.....7
2.6 BRONZE LIFT CHECK VALVES.....8
2.7 SPRING-LOADED, CENTER-GUIDED LIFT-DISC (SILENT) CHECK
VALVES.....8
2.8 BRONZE GLOBE VALVES.....10
2.9 CAST-IRON GLOBE VALVES.....10
2.10 BRONZE ANGLE VALVES11
2.11 CAST-IRON ANGLE VALVES11
2.12 DRAIN VALVES11
2.13 CHAINWHEEL ACTUATORS12

PART 3 - EXECUTION.....12
3.1 EXAMINATION.....12
3.2 JOINT CONSTRUCTION.....13
3.3 ADJUSTING.....13

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 02 piping Sections for general-duty and specialty valves for site construction piping.
2. Division 15 fire-suppression piping and fire pump Sections for fire-protection valves.

3. Division 15 Section "Mechanical Identification" for valve tags and charts.
4. Division 15 Section "General-Duty Valves for Plumbing" for plumbing valves.
5. Division 15 Section "Temperature Controls" for control valves and actuators.

1.2 SUMMARY

- A. This Section includes valves for general HVAC applications. Refer to piping Sections for specialty valve applications.

1.3 DEFINITIONS

- A. The following are standard abbreviations for valves:
 1. CWP: Cold working pressure.
 2. EPDM: Ethylene-propylene-diene terpolymer rubber.
 3. NBR: Acrylonitrile-butadiene rubber.
 4. NRS: Nonrising stem.
 5. OS&Y: Outside screw and yoke.
 6. PTFE: Polytetrafluoroethylene plastic.
 7. RPTFE: Reinforced polytetrafluoroethylene plastic.
 8. SWP: Steam working pressure.
 9. TFE: Tetrafluoroethylene plastic.
 10. WOG: Water, oil, and gas.

1.4 SUBMITTALS

- A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.5 QUALITY ASSURANCE

- A. ASME Compliance: ASME B31.9 for building services piping valves.
- B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 VALVES, GENERAL

A. Isolation valves are scheduled on the Drawings. For other general HVAC valve applications, use the following:

1. Shutoff Service: Ball, butterfly valves.
2. Throttling Service: Angle, ball, butterfly, or globe valves.
3. Pump Discharge: Spring-loaded, lift-disc check valves; and bronze lift check valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

- D. For valves not indicated in the Application Schedules, select valves with the following end connections:
1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends, except provide valves with threaded ends for condenser water, heating hot water, steam, and steam condensate services.
 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged, solder-joint, or threaded ends.
 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
 4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
 5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends.
 6. For Steel Piping, NPS 5 and Larger: Flanged ends.
 7. For Grooved-End Systems: Valve ends may be grooved. Do not use for steam or steam condensate piping.
- E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- F. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
- G. Valve Actuators:
1. Chainwheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.
 2. Gear Drive Operator: For quarter-turn valves NPS 8 and larger.
 3. Handwheel: For valves other than quarter-turn types.
 4. Lever Handle: For quarter-turn valves NPS 6 and smaller.
- H. Extended Valve Stems: On insulated valves.
- I. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.
- J. Valve Grooved Ends: AWWA C606.
- K. Solder Joint: With sockets according to ASME B16.18.
1. Caution: Disassemble valves when soldering, as recommended by the manufacturer, to prevent damage to internal parts.

L. Threaded: With threads according to ASME B1.20.1.

M. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

A. Bronze Ball Valves, General: MSS SP-110 and have bronze body complying with ASTM B 584, except for Class 250 which shall comply with ASTM B 61, full-depth ASME B1.20.1 threaded or solder ends, and blowout-proof stems.

B. Two-Piece, Regular Port Bronze Ball Valves with Stainless-Steel Trim: Type 316 stainless-steel ball and stem, reinforced TFE seats, blow-out-proof stem, with adjustable stem packing, soldered or threaded ends; and 150 psig SWP and 600-psig CWP ratings.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Apollo Valves; by Conbraco Industries, Inc.; Series 70-140.
- b. Crane Co.; Crane Valves.
- c. Hammond Valve.
- d. Milwaukee Valve Company; Model BA100S.
- e. NIBCO INC.; Models S-580-70-66 or T-580-70-66.
- f. Watts Water Technologies, Inc.

2.3 GENERAL SERVICE BUTTERFLY VALVES

A. General: MSS SP-67, for bubble-tight shutoff, extended-neck for insulation, disc and lining suitable for potable water, unless otherwise indicated, and with the following features:

1. Full lug, and grooved valves shall be suitable for bi-directional dead end service at full rated pressure without the use or need of a downstream flange.
2. Valve sizes NPS 2 through NPS 6 shall have lever lock operator; valve sizes NPS 8 and larger shall have weatherproof gear operator.

B. Lug-Style (Single-Flange) Size NPS 2-1/2 through NPS 12 , 200-psig CWP Rating, Aluminum-Bronze Disc, EPDM Seat, Ferrous-Alloy Butterfly Valves: Full-lug type with ductile-iron body, Type 416 stainless-steel stem, copper

bushing, aluminum-bronze disc, and molded-in EPDM seat (liner).

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Apollo Valves; by Conbraco Industries, Inc.; Series 143 and Series LD 145.
- b. Bray International, Inc.
- c. DeZurik.
- d. Forum Energy Technologies; ABZ Valve.
- e. Hammond Valve.
- f. Milwaukee Valve Company.
- g. NIBCO INC.; LD-2000-3/5.
- h. Pentair Valves & Controls; Keystone.
- i. Tyco Flow Control; Grinnell Flow Control.
- j. Watts Water Technologies.

C. Grooved-End Butterfly Valves with EPDM-Encapsulated Ductile-Iron Disc: Ductile-iron body with grooved or shouldered ends and polyamide coating inside and outside; Type 416 stainless-steel stem, PTFE bronze sintered on steel bushing, and 300-psig CWP Rating for Valves NPS 2 through NPS 8, 200 psig CWP Rating for Valves NPS 10 through NPS 12.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Anvil International, Inc.
- b. NIBCO INC.; Model GD-4765-3/5.
- c. Tyco Fire & Building Products; Grinnell Mechanical Products.
- d. Victaulic Co. of America.

2.4 BRONZE CHECK VALVES

A. Bronze Check Valves, General: MSS SP-80.

B. Class 150, Bronze, Swing Check Valves with Bronze Disc: ASTM B-62 bronze body and seat with regrinding-type bronze disc, Y-pattern design, soldered or threaded end connections, and having 300 psig CWP rating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Apollo Valves; by Conbraco Industries, Inc.
- b. Crane Co.; Crane Valves.
- c. Crane Co.; Stockham Div.
- d. Hammond Valve.
- e. Milwaukee Valve Company; Model 515.
- f. NIBCO INC.; Models S-433-B or T-433-B.
- g. Watts Water Technologies.

2.5 IRON SWING CHECK VALVES

A. Iron Swing Check Valves, General: MSS SP-71.

B. Class 125, Gray-Iron, Standard Swing Check Valves: ASTM A-126, Class B cast-iron body and bolted bonnet with flanged end connections; non-asbestos synthetic-fiber gaskets; bronze disc and seat; and having 200 psig CWP rating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Apollo Valves; by Conbraco Industries, Inc.
- b. Crane Co.; Crane Valves.
- c. Crane Co.; Stockham Div.
- d. Hammond Valve.
- e. Milwaukee Valve Company; Model F-2974.
- f. NIBCO INC.; Model F-918-B.
- g. Watts Water Technologies.

C. Class 250, Gray-Iron, Swing Check Valves: ASTM A-126, Class B cast-iron body and bolted bonnet with flanged end connections; non-asbestos synthetic-fiber gaskets; and bronze disc and seat; and having 500 psig CWP rating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Apollo Valves; by Conbraco Industries, Inc.
- b. Crane Co.; Crane Valves.
- c. Crane Co.; Stockham Div.
- d. Hammond Valve.
- e. Milwaukee Valve Company; Model F-2970.

- f. NIBCO INC.; Model F-968-B.
- g. Watts Water Technologies.

D. Grooved-End, Swing Check Valves: Ductile-iron body with grooved or shouldered ends; nonasbestos, synthetic-fiber gaskets; rubber seats; and having 250-psig CWP Rating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Mueller Co.
- b. NIBCO, INC.; Model G-917-W.
- c. Tyco Fire & Building Products; Grinnell Mechanical Products.
- d. Victaulic Co. of America.

2.6 BRONZE LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Nonmetallic TFE Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Hammond Valve.
- b. Milwaukee Valve Company.
- c. NIBCO INC.; Model S-480-Y or T-480-Y.
- d. The Wm. Powell Company.

2. Description:

- a. Standard: MSS SP-80, Type 2.
- b. CWP Rating: 250 psig.
- c. Body Design: Vertical flow.
- d. Body Material: ASTM B 584 Alloy C844, bronze.
- e. Ends: Threaded or Solder.
- f. Disc: PTFE, or TFE.

2.7 SPRING-LOADED, CENTER-GUIDED LIFT-DISC (SILENT) CHECK VALVES

A. Lift-Disc Check Valves, General: FCI 74-1 and MIL-V-18436F, with spring-loaded, center-guided bronze disc and seat.

- B. Class 125, Wafer, Lift-Disc Check Valves: Wafer style with cast-iron body with diameter made to fit within bolt circle, and having 200 psig CWP rating.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. NIBCO INC.; Model W-910-B.
 - b. Mueller Steam Specialty.
 - c. Milwaukee Valve Company.
 - d. Hammond Valve.
- C. Class 250, Wafer, Lift-Disc Check Valves: Wafer style with cast-iron body with diameter made to fit within bolt circle, and having 400 psig CWP rating.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. NIBCO INC.; Model W-960-B.
 - b. Mueller Steam Specialty.
 - c. Milwaukee Valve Company.
 - d. Hammond Valve.
- D. Class 125, Globe, Flanged Lift-Disc Check Valves: Globe style with cast-iron body and flanged ends, and having 200 psig CWP rating.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. NIBCO INC.; Model F-910-B.
 - b. Mueller Steam Specialty.
 - c. Milwaukee Valve Company.
 - d. Hammond Valve.
- E. Class 250, Globe, Flanged Lift-Disc Check Valves: Globe style with cast-iron body and flanged ends, and having 400 psig CWP rating.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. NIBCO INC.; Model F-960-B.
- b. Mueller Steam Specialty.
- c. Milwaukee Valve Company.
- d. Hammond Valve.

2.8 BRONZE GLOBE VALVES

- A. Bronze Globe Valves, General: MSS SP-80, with malleable-iron handwheel.
- B. Class 150, TFE Disc, Bronze Globe Valves: ASTM B-62 bronze body, bonnet, and seat, TFE disc, copper-silicone bronze stem, union-ring bonnet, soldered or threaded end connections; and having 300 psig CWP rating.
 1. Manufacturers: Subject to compliance with requirements, Provide products by one of the following:
 - a. Apollo Valves; by Conbraco Industries, Inc.
 - b. Crane Co.; Crane Valves.
 - c. Hammond Valve.
 - d. Milwaukee Valve Company; Model 590.
 - e. NIBCO INC.; Models S-235-Y or T-235-Y.
 - f. Watts Water Technologies, Inc.

2.9 CAST-IRON GLOBE VALVES

- A. Cast-Iron Globe Valves, General: MSS SP-85 with bolted bonnet, flanged end connections, and non-asbestos packing and gasket.
- B. Class 125, Metal Seat, Cast-Iron Globe Valves: ASTM A-126, Class B cast-iron body and bonnet with bronze trim and having 200 psig CWP rating.
 1. Manufacturers: Subject to compliance with requirements, Provide products by one of the following:
 - a. Apollo Valves; by Conbraco Industries, Inc.
 - b. Crane Co.; Crane Valves.
 - c. Crane Co.; Stockham Valves.
 - d. Hammond Valve.
 - e. Milwaukee Valve Company; Model F-2981.
 - f. NIBCO INC.; Model F-718-B.
 - g. Watts Water Technologies, Inc.

2.10 BRONZE ANGLE VALVES

- A. Bronze Angle Valves, General: MSS SP-80, with silicon bronze stem, non-asbestos packing and malleable-iron handwheel.
- B. Class 150, Bronze Angle Valves: ASTM B 62 bronze body with TFE disc, union-ring bonnet, threaded ends, and having 300-psig CWP rating.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valves.
 - b. Crane Co.; Stockham Valves.
 - c. Hammond Valve.
 - d. Milwaukee Valve Company; Model 595T.
 - e. NIBCO INC.; Model T-335-Y.
 - f. The Wm. Powell Company.

2.11 CAST-IRON ANGLE VALVES

- A. Cast-Iron Angle Valves, General: MSS SP-85, Type II; having ASTM A 126, Class B cast-iron body and bolted bonnet; bronze mounted, non-asbestos packing and gaskets; and flanged-end connections.
- B. Class 125, Cast-Iron, Standard Angle Valves: 200-psig CWP rating.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. NIBCO INC.; Model F-818-B.
 - b. Crane Co.; Stockham Valves.
 - c. Crane Co.; Crane Valves.

2.12 DRAIN VALVES

- A. Ball-Valve-Type, Hose-End Drain Valves:
 - 1. Bronze ball valve as specified in this Section.
 - 2. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.13 CHAINWHEEL ACTUATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Babbitt Steam Specialty Co.
 - 2. Roto Hammer Industries, Inc.
- B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
 - 1. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve.
 - 2. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 - 3. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- D. Examine threads on valve and mating pipe for form and cleanliness.
- E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

- F. Do not attempt to repair defective valves; replace with new valves.
- G. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- H. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- I. Locate valves for easy access and provide separate support where necessary.
- J. Install valves in horizontal piping with stem at or above center of pipe. Butterfly valves shall be installed with stem horizontal to allow support for the disc and the cleaning action of the disc.
- K. Install valves in position to allow full stem movement.
- L. Install chainwheel operators on valves NPS 4 and larger and more than 84 inches above floor. Extend chains to 60 inches above finished floor elevation.
- M. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Lift Check Valves: With stem upright and plumb.

3.2 JOINT CONSTRUCTION

- A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 15112

SECTION 15121 - PIPE FLEXIBLE CONNECTORS, EXPANSION FITTINGS AND
LOOPS

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 DEFINITIONS.....1
1.3 PERFORMANCE REQUIREMENTS.....2
1.4 SUBMITTALS.....2
1.5 QUALITY ASSURANCE.....3

PART 2 - PRODUCTS.....3
2.1 MANUFACTURERS.....3
2.2 FLEXIBLE CONNECTORS.....3
2.3 EXPANSION JOINTS.....4
2.4 ALIGNMENT GUIDES.....5
2.5 SLIDING/GUIDING DEVICES.....5
2.6 MATERIALS FOR ANCHORS.....6

PART 3 - EXECUTION.....7
3.1 FLEXIBLE CONNECTOR APPLICATIONS.....7
3.2 EXPANSION-JOINT INSTALLATION.....7
3.3 PIPE BEND AND LOOP INSTALLATION.....9
3.4 SWING CONNECTIONS.....9
3.5 ALIGNMENT-GUIDE INSTALLATION.....9
3.6 ANCHOR INSTALLATION.....9

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 15 Section "Mechanical General Requirements."
 - 2. Division 15 Section "Basic Mechanical Materials and Methods."
 - 3. Division 15 Section "Refrigerant Piping."

1.2 DEFINITIONS

- A. BR: Butyl rubber.

- B. CR: Chlorosulfonated polyethylene synthetic rubber (Neoprene).
- C. CSM: Chlorosulfonyl-polyethylene rubber (Hypalon).
- D. EPDM: Ethylene-propylene-diene terpolymer rubber.
- E. NBR: Buna-N/Nitrile rubber.
- F. NR: Natural rubber.
- G. PTFE: Polytetrafluoroethylene plastic.

1.3 PERFORMANCE REQUIREMENTS

- A. Compatibility: Products shall be suitable for piping system fluids, materials, working pressures, and temperatures.
- B. Capability: Products shall absorb 150 percent of maximum axial movement between anchors.

1.4 SUBMITTALS

- A. Product Data: For each type of pipe flexible connector, expansion joint and alignment guide indicated.
- B. Delegated-Design Submittal:
 - 1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
 - 2. Locations of pipe anchors and alignment guides and expansion joints and loops.
- C. Shop Drawings: Signed and sealed by a qualified professional engineer.
 - 1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and bends.
 - 2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
 - 3. Alignment Guide Details: Detail field assembly and attachment to building structure.

4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

D. Product Certificates: For each type of pipe expansion joint, signed by product manufacturer.

E. Welding certificates.

F. Operation and Maintenance Data: For pipe expansion joints to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:

1. Steel Shapes and Plates: AWS D1.1, "Structural Welding Code - Steel."

2. Welding to Piping: ASME Boiler and Pressure Vessel Code: Section IX.

B. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.

C. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," and NSF 372 Drinking Water System Components - Lead Content for potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FLEXIBLE CONNECTORS

A. Hose and Braid Flexible Connectors:

1. Manufacturers:
 - a. Adscos Manufacturing, LLC.
 - b. Flex-Weld, Inc.
 - c. Hyspan Precision Products, Inc.
 - d. Metraflex, Inc.
 - e. Senior Flexonics, Inc.; Pathway Division.
 - f. Twin City Hose, Inc.
2. Flexible Connectors for Copper Piping: Multiple-ply phosphor-bronze corrugated hose with bronze outer braid, copper ferrule, and copper pipe end connections.
3. Flexible Connectors for Steel Piping: Multiple-ply stainless-steel corrugated hose with stainless steel outer braid, and steel pipe end connections.
4. Minimum Pressure Rating: 150 psig, unless otherwise indicated.
5. Maximum Temperature Rating: 450 deg F for copper piping connectors, 800 deg F for steel piping connectors.

2.3 EXPANSION JOINTS

- A. Flexible-Hose Expansion Joints: Manufactured assembly with two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose; with inlet and outlet elbow fittings, corrugated-metal inner hoses, and braided outer sheaths.

1. Manufacturers:
 - a. Flex-Hose Co., Inc.
 - b. Metraflex, Inc.; Metraloop.
 - c. Twin City Hose, Inc.
2. Flexible-Hose Expansion Joints for Copper Piping: Copper-alloy fittings with solder- or brazed- joint end connections.
 - a. NPS 2 and Smaller: Bronze hoses and single-braid bronze sheaths with minimum 300 psig at 70 deg F and 230 psig at 400 deg F ratings.
 - b. NPS 2-1/2 to NPS 4: Stainless-steel hoses and single-braid, stainless-steel sheaths with minimum 230 psig at 70 deg F and 180 psig at 400 deg F ratings.

3. Flexible-Hose Expansion Joints for Steel Piping: Carbon-steel fittings with threaded end connections for NPS 2 and smaller and flanged or weld end connections to match piping system for NPS 2-1/2 and larger.
 - a. NPS 2 and Smaller: Stainless-steel hoses and single-braid, stainless-steel sheaths with minimum 450 psig at 70 deg F and 325 psig at 600 deg F ratings; and 300 psig maximum saturated steam pressure rating.
 - b. NPS 2-1/2 to NPS 6: Stainless-steel hoses and single-braid, stainless-steel sheaths with minimum 165 psig at 70 deg F and 120 psig at 600 deg F ratings; and 130 psig maximum saturated steam pressure rating.
 - c. NPS 8 to NPS 12: Stainless-steel hoses and single-braid, stainless-steel sheaths with minimum 160 psig at 70 deg F and 115 psig at 600 deg F ratings; and 90 psig maximum saturated steam pressure rating.

2.4 ALIGNMENT GUIDES

- A. Description: Steel, factory fabricated, with bolted two-section outer cylinder and base for alignment of piping and two-section guiding spider for bolting to pipe.

1. Manufacturers:

- a. Adscos Manufacturing, LLC.
- b. Flex-Weld, Inc.
- c. Hyspan Precision Products, Inc.
- d. Metraflex, Inc.
- e. Senior Flexonics, Inc.; Pathway Division.

2.5 SLIDING/GUIDING DEVICES

- A. For pipe size 4 inch and smaller on all hot piping, provide guides equal to Flexonics semi-steel spider and guiding cylinder pipe alignment guides for all expansion joints and loops. Provide pipe alignment guides in quantities at all locations as required according to the manufacturer's design criteria and recommendations. Pipe alignment guides shall serve to guide the expansion joints, loops or bends.

1. Manufacturers:

- a. B-Line Systems, Inc.; a Division of Cooper Industries; Figure 3281 Series.
- b. Senior Flexonics.
- c. Sypris Technologies; Tube Turns Division;
- d. U.S. Flexible Metallic Tubing Co., Kelflex Type M.
- e. Metraflex, Inc.

B. For pipe sizes 6 inches and above and all guides on cold piping, furnish pre-engineered pre-insulated guides with published vertical and lateral load ratings. Construction shall consist of an insulated shield containing structural calcium silicate (100 psi non-load bearing and 600 psi load bearing) encased in 360 degrees of overlapping sheet metal. A 36 steel clamps torqued onto insulated shield with recommended catalog torque values. Slide service shall be stainless steel to polyethylene or Teflon with a maximum coefficient of friction of 0.15.

1. Manufacturers:

- a. Pipe Shields, Inc. B3000, B4000, B7000 and B8000 series.
- b. Carpenter and Paterson, Inc.
- c. Rilco Mfg. HG 3000, HG 4000, HG 7000, and HG 8000 series.

2.6 MATERIALS FOR ANCHORS

- A. Steel Shapes and Plates: ASTM A 36/A 36M.
- B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex head.
- C. Washers: ASTM F 844, steel, plain, flat washers.
- D. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, and tension and shear capacities appropriate for application.
 1. Stud: Threaded, zinc-coated carbon steel.
 2. Expansion Plug: Zinc-coated steel.
 3. Washer and Nut: Zinc-coated steel.

- E. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened portland cement concrete, and tension and shear capacities appropriate for application.
 - 1. Bonding Material: ASTM C 881, Type IV, Grade 3, 2-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
 - 2. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
 - 3. Washer and Nut: Zinc-coated steel.

- F. Concrete: Portland cement mix, 3000 psi minimum. Refer to Division 03 Section "Cast-in-Place Concrete" for formwork, reinforcement, and concrete.

- G. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink, nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 FLEXIBLE CONNECTOR APPLICATIONS

- A. Use hose and braid flexible pipe connectors at the inlet and outlet water connections of base mounted pumps, chillers, and cooling towers, unless otherwise indicated.
 - 1. Flexible Connectors: Stainless steel hose and braid style with threaded end connections for pipe sized NPS 2 and smaller.
 - 2. Flexible Connectors: Stainless steel hose and braid style with steel flange end connections for pipe sized NPS 2-1/2 and larger.

3.2 EXPANSION-JOINT INSTALLATION

- A. Install manufactured, nonmetallic expansion joints according to FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."

- B. Install expansion joints of sizes matching size of piping in which they are installed.

- C. Install alignment guides to allow expansion and to avoid end-loading and torsional stress.
- D. Install alignment guides at spacing recommended by expansion joint manufacturer.
- E. Control expansion joint movement by installing two rigid pipe guides on each side of the expansion joint. Spacing shall be as follows:

Nom. Pipe Size	Exp. Joint to 1st Guide	1st to 2nd Guide	Maximum Distance Between Intermediate Guides (Ft.) For Tabulated pressures, PSIG							
			50	100	150	200	250	300	350	400
(In.)	Guide	Guide	50	100	150	200	250	300	350	400
1	0'-4"	1'-4"	21	15	12					
1 1/4	0'-5"	1'-5"	23	17	13					
1 1/2	0'-6"	1'-9"	28	20	17					
2	0'-8"	2'-4"	32	23	18					
2 1/2	0'- 10"	2'11"	35	28	22					
3	1'-0"	3'-6"	21	19	17	16	15	14	13	13
4	1'-4"	4'-8"	35	29	25	22	20	19	18	17
6	2'-0"	7'-0"	57	44	37	32	29	27	25	23
8	2'-8"	9'-4"	66	52	45	40	36	33	31	29
10	3'-4"	11'- 8"	91	69	58	51	46	42	39	36
12	4'-0"	14'- 0"	107	79	66	58	52	48	44	41
14	4'-8"	16'- 4"	115	85	71	62	56	51	47	
16	5'-4"	18'- 8"	127	94	78	68	61	56	52	
18	6'-0"	21'- 0"	139	102	85	74	67	61	56	
20	6'-8"	23'- 4"	151	110	91	80	71			
24	8'-0"	28'- 0"	172	125	103	89	80			
30	10'- 0"	35'- 0"	200	144	118	103	92			

3.3 PIPE BEND AND LOOP INSTALLATION

- A. Install pipe bends and loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- B. Attach pipe bends and loops to anchors.
 - 1. Steel Anchors: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 2. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer's written instructions.

3.4 SWING CONNECTIONS

- A. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.
- B. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.
- C. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

3.5 ALIGNMENT-GUIDE INSTALLATION

- A. Install guides on piping adjoining pipe expansion joints and bends and loops.
- B. Attach guides to pipe and secure to building structure.

3.6 ANCHOR INSTALLATION

- A. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- B. Fabricate and install steel anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and AWS D1.1.
- C. Construct concrete anchors of poured-in-place concrete of dimensions indicated and include embedded fasteners.

- D. Install pipe anchors according to expansion-joint manufacturer's written instructions if expansion joints or compensators are indicated.
- E. Use grout to form flat bearing surfaces for expansion fittings, guides, and anchors installed on or in concrete.

END OF SECTION 15121

SECTION 15122 - METERS AND GAGES

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 DEFINITIONS.....2
1.3 SUBMITTALS.....2
1.4 QUALITY ASSURANCE.....2

PART 2 - PRODUCTS.....2
2.1 MANUFACTURERS.....2
2.2 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS.....2
2.3 THERMOWELLS.....3
2.4 PRESSURE GAGES.....3
2.5 TEST PLUGS.....5

PART 3 - EXECUTION.....5
3.1 THERMOMETER APPLICATIONS.....5
3.2 GAGE APPLICATIONS.....6
3.3 INSTALLATIONS.....6
3.4 CONNECTIONS.....7
3.5 ADJUSTING.....7

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 2 Section "Water Distribution" for domestic and fire-protection water service meters outside the building.
2. Division 13 Section "Fire-Suppression Piping" for listed or approved pressure gages.
3. Division 15 Section "Mechanical General Requirements."
4. Division 15 Section "Basic Mechanical Materials and Methods."
5. Division 15 Section "Domestic Water Piping" for domestic and fire-protection water service meters inside the building.
6. Division 15 Section "Steam and Condensate Piping" for steam and condensate meters.

7. Division 15 Section "Fuel Gas Piping" for gas utility meters.

1.2 DEFINITIONS

- A. CR: Chlorosulfonated polyethylene synthetic rubber.
- B. EPDM: Ethylene-propylene-diene terpolymer rubber.
- C. FPR: Fiberglass reinforced plastic.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated; include performance curves.
- B. Shop Drawings: Schedule for thermometers and gages indicating manufacturer's number, scale range, and location for each.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.
- B. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," and NSF 372 Drinking Water System Components - Lead Content for potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS

- A. Manufacturers:

1. AMETEK, Inc.; U.S. Gauge Div.
 2. Miljoco Corporation.
 3. REOTEMP Instrument Corporation.
 4. Trerice, H. O. Co.
 5. Weiss Instruments, Inc.
 6. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- B. Case: Die-cast aluminum or Chrome-plated brass, 9 inches long.
- C. Tube: Red, blue, or green reading, organic-liquid filled, with magnifying lens.
- D. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.
- E. Window: Glass or plastic.
- F. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.
- G. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.
- H. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.
- 2.3 THERMOWELLS
- A. Manufacturers: Same as manufacturer of thermometer being used.
- B. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer. Brass for compatible services less than 353 degrees F (178 degrees C); ANSI 18-8 stainless steel for all others to suit service. Furnish extension neck to accommodate insulation where applicable.
- 2.4 PRESSURE GAGES
- A. Manufacturers:
1. AMETEK, Inc.; U.S. Gauge Div.
 2. Cambridge.

3. Dwyer Instruments, Inc.
4. Marsh Bellofram.
5. Miljoco Corporation.
6. Trerice, H. O. Co.
7. Weiss Instruments, Inc.
8. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.

1. Case: Stainless steel, aluminum, or FRP, 4-1/2-inch diameter.
2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Pointer: Red or other dark-color metal.
7. Window: Glass or plastic.
8. Ring: Stainless steel or chrome plated metal.
9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
11. Water: 0-100 PSIG (1 psi divisions to 50 psi; 5 psi divisions above 50 psi), liquid filled.
12. Steam (15 psig and less): 30 inches Hg vacuum-30 PSIG (1 inch divisions below 0 psi; 1 psi divisions above 0 psi), silicone dampened.
13. Steam (16 to 60 psig): 30 inches Hg vacuum-100 PSIG, silicone dampened.
14. Range for Fluids under Pressure: 1-1/2 times expected working pressure. If not a standard scale, select next largest scale.

C. Pressure-Gage Fittings:

1. Valves: NPS 1/4 brass ball type.
2. Syphons: NPS 1/4 coil of brass tubing with threaded ends.

3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.5 TEST PLUGS

A. Manufacturers:

1. Peterson Equipment Co., Inc.
2. Miljoco Corporation.

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F for cold services, and 500 psig at 275 deg F for hot services.

D. Core Inserts: One or two self-sealing rubber valves.

1. Insert material for air, water, oil, or gas service at 20 to 200 deg F shall be Neoprene.
2. Insert material for air or water service at minus 30 to plus 275 deg F shall be Nordel.

E. Test Kit: Furnish test kit(s) containing one pressure gage and adaptor, thermometer(s), and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.

1. Pressure Gage: Small bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be 0 to 200 psig.
2. High-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 0 to 220 deg F.
3. Carrying case shall have formed instrument padding.

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

- #### A. Install liquid-in-glass thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler and chiller.
3. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
4. Inlet and outlet of each hydronic heat exchanger.
5. Inlet and outlet of each hydronic heat-recovery unit.
6. Inlet and outlet of each thermal storage tank.
7. Outside-air, return-air, and mixed-air ducts.

B. Provide the following temperature ranges for thermometers:

1. Domestic Hot Water: 30 to 180 deg F, with 2-degree scale divisions.
2. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale divisions.
3. Heating Hot Water: 30 to 240 deg F, with 2-degree scale divisions.
4. Chilled Water: 0 to 100 deg F, with 2-degree scale divisions.
5. Air Ducts: Minus 40 to plus 110 deg F, with 2-degree scale divisions.

3.2 GAGE APPLICATIONS

- A. Install dry-case-type pressure gages on inlet and outlet of each pressure-reducing valve.
- B. Install liquid-filled-case-type pressure gages at chilled-and condenser-water inlets and outlets of chillers.
- C. Install liquid-filled-case-type pressure gages at suction and discharge of each pump.

3.3 INSTALLATIONS

- A. Install direct-mounting thermometers and adjust vertical and tilted positions.
- B. Install thermowells with socket extending to center of pipe and in vertical position in piping tees where thermometers are indicated.
- C. Duct Thermometer Support Flanges: Install in wall of duct where duct thermometers are indicated. Attach to duct with screws.

- D. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.
- E. Install ball valve and snubber fitting in piping for each pressure gage for fluids (except steam).
- F. Install ball valve and syphon fitting in piping for each pressure gage for steam.
- G. Install test plugs in tees in piping.

3.4 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance for meters, gages, machines, and equipment.
- B. Ground equipment according to Division 16 Section "Grounding and Bonding."
- C. Connect wiring according to Division 16 Section "Conductors and Cables."

3.5 ADJUSTING

- A. Calibrate meters according to manufacturer's written instructions, after installation.
- B. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION 15122

SECTION 15140 - DOMESTIC WATER PIPING

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUMMARY.....2
1.3 DEFINITIONS.....2
1.4 PERFORMANCE REQUIREMENTS.....2
1.5 SYSTEMS DESCRIPTION.....2
1.6 SUBMITTALS.....3
1.7 QUALITY ASSURANCE.....3
1.8 PROJECT CONDITIONS.....3

PART 2 - PRODUCTS.....4
2.1 MANUFACTURERS.....4
2.2 PIPING MATERIALS.....4
2.3 COPPER TUBE AND FITTINGS.....4
2.4 VALVES.....6

PART 3 - EXECUTION.....6
3.1 EXCAVATION.....6
3.2 PIPING SYSTEM INSTALLATION.....6
3.3 JOINT CONSTRUCTION.....7
3.4 HANGER AND SUPPORT INSTALLATION.....7
3.5 CONNECTIONS.....9
3.6 FIELD QUALITY CONTROL.....10
3.7 ADJUSTING.....11
3.8 CLEANING AND DISINFECTION.....11

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 02 Section "Water Distribution" for water-service piping outside the building and for water service entrance piping.
2. Division 15 Section "Mechanical General Requirements."
3. Division 15 Section "Basic Mechanical Materials and Methods" for materials and methods common to mechanical piping systems.
4. Division 15 Section "Hangers and Supports."

5. Division 15 Section "Meters and Gages" for thermometers, pressure gages, and fittings.
6. Division 15 Section "Plumbing Valves" for general duty plumbing valves.
7. Division 15 Section "Domestic Water Piping Specialties" for water distribution piping specialties.

1.2 SUMMARY

- A. This Section includes domestic water piping inside the building.

1.3 DEFINITIONS

- A. PEX: Crosslinked polyethylene plastic.

1.4 PERFORMANCE REQUIREMENTS

- A. Where not indicated on the Drawings, provide components and installation capable of producing domestic water piping systems with 125 psig, unless otherwise indicated.

1. Exception: PEX plastic piping insert fittings specified are limited to 100 psig.

1.5 SYSTEMS DESCRIPTION

- A. Potable and non-potable domestic water piping system materials are scheduled on the Drawing.
- B. Refer to Application Schedules on the Drawings for valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 1. Hot-Water-Piping, Balancing Duty: Calibrated balancing valves.
 2. Drain Duty: Hose-end drain valves.
 3. Isolation Valves at Domestic Water Meters: Gate Valves, NPS 2 and Smaller: Class 150, bronze.
 4. Isolation Valves at Domestic Water Meters: Gate Valves, NPS 2-1/2 and Larger: Class 125, OS&Y, bronze-mounted cast iron.
- C. Transition and special fittings with pressure ratings at least equal to piping rating may be used unless otherwise indicated.

1.6 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Water Samples: Specified in Part 3 "Cleaning" Article.
- C. Coordination Drawings: For piping in equipment rooms and other congested areas, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Fire-suppression-water piping.
 - 2. Domestic water piping.
 - 3. HVAC hydronic piping.
- D. Field quality-control test reports.

1.7 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.
- C. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," and NSF 372 Drinking Water System Components - Lead Content for potable domestic water piping and components.
- D. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be as recommended by the manufacturer of the grooved components.

1.8 PROJECT CONDITIONS

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
 - 1. Notify Construction Manager no fewer than two days in advance of proposed interruption of water service.

2. Do not proceed with interruption of water service without Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

- A. Transition Couplings for Aboveground Pressure Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.3 COPPER TUBE AND FITTINGS

- A. Soft Copper Tube: ASTM B 88, Type K, water tube, annealed temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

- B. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.

2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

C. Grooved-Joint Systems:

1. Manufacturers:
 - a. Anvil International, Inc.; Gruvlok Manufacturing; Model 7401.
 - b. Tyco Fire & Building Products; Grinnell Mechanical Products; Model 672.
 - c. Victaulic Company; Style 606 and Style 607.
2. Grooved-End-Tube Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, gasket suitable for hot water, and bolts and nuts.
3. Copper, Grooved-End Fittings: ASTM B 75 copper tube or ASTM B 584 bronze castings.

D. Copper or Bronze Pressure-Seal Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Viega North America; ProPress System.
 - b. NIBCO Inc.; Press System.
 - c. Elkhart Products Corporation; an Aalberts Industries Company; Xpress.
 - d. Apollo Valves; by Conbraco Industries; ApolloXpress.
2. Housing: Copper.
3. O-Rings and Pipe Stops: EPDM.
4. Tools: Manufacturer's special tools.
5. Maximum 200-psig working-pressure rating at 250 deg F.

E. Copper, Mechanically Formed Tee Option: For forming T-branch on copper water tube. Mechanically formed tee fittings may be used up to half size of main.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. T-DRILL Industries Inc.

2.4 VALVES

- A. General-duty plumbing valves; and drain valves are specified in Division 15 Section "Plumbing Valves."
- B. Balancing valves are specified in Division 15 Section "Domestic Water Piping Specialties."

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Excavating, trenching, and backfilling are specified in Division 02 Section "Earthwork."

3.2 PIPING SYSTEM INSTALLATION

- A. Basic piping installation requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- B. Install sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- C. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Wall penetration systems are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Pressure gages are specified in Division 15 Section "Meters and Gages," and strainers are specified in Division 15 Section "Domestic Water Piping Specialties."

- E. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops.
- F. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping.
 - 1. Install hose-end drain valves at low points in water mains, risers, and branches.
 - 2. Install stop-and-waste drain valves where indicated.
- G. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Calibrated balancing valves are specified in Division 15 Section "Domestic Water Piping Specialties."
- H. Install domestic water piping level without pitch and plumb.

3.3 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- B. PEX Piping Joints: Join according to ASTM F 1807.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Pipe hanger and support devices are specified in Division 15 Section "Hangers and Supports." Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs:
According to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer than 100 Feet: MSS Type 49, spring cushion rolls, if indicated.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Install supports according to Division 15 Section "Hangers and Supports."
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch.
- E. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 3. NPS 2: 10 feet with 3/8-inch rod.
 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 7. NPS 6: 12 feet with 3/4-inch rod.
 8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.
- F. Install supports for vertical steel piping every 15 feet.
- G. Install hangers for drawn-temper copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 3/4 and Smaller: 60-inches with 3/8-inch rod.
 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
 5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 6. NPS 6: 10 feet with 5/8-inch rod.
 7. NPS 8: 10 feet with 3/4-inch rod.
- H. Install supports for vertical copper tubing every 10 feet.
- I. Soft copper tube: Continuous support using v-shaped plastic pipe channel, maximum hanger spacing 8 feet with 3/8-inch rod.

- J. Alternate support for copper tubing NPS 3/4 and smaller:
Continuous support using v-shaped plastic pipe channel,
maximum hanger spacing 8 feet with 3/8-inch rod.
- K. Install hangers for Schedule 10 stainless steel piping
with the following maximum horizontal spacing and minimum
rod diameters:
 - 1. NPS 2: 84 inches with 3/8-inch rod.
 - 2. NPS 2-1/2: 84 inches with 1/2-inch rod.
 - 3. NPS 3: 96 inches with 1/2-inch rod.
 - 4. NPS 4 : 10 feet with 5/8-inch rod.
 - 5. NPS 6: 11 feet with 3/4-inch rod.
 - 6. NPS 8 : 12 feet with 7/8-inch rod.
 - 7. NPS 10 to NPS 12: 14 feet with 7/8-inch rod.
- L. Install supports for vertical Schedule 10 stainless steel
piping every 15 feet.
- M. Support piping and tubing not listed above according to
MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings,
and specialties.
- B. Connect domestic water piping to existing domestic water
distribution piping. Use dielectric fitting if connection
dissimilar metals. Refer to Application Schedule on the
Drawings and Division 15 Section "Basic Mechanical
Materials and Methods" for dielectric fittings.
- C. Install piping adjacent to equipment and machines to allow
service and maintenance.
- D. Connect domestic water piping to the following:
 - 1. Water Heaters: Cold-water supply and hot-water outlet
piping in sizes indicated, but not smaller than sizes
of water heater connections.
 - 2. Plumbing Fixtures: Cold- and hot-water supply piping
in sizes indicated, but not smaller than required by
plumbing code. Refer to Division 15 Section "Plumbing
Fixtures."
 - 3. Equipment: Cold- and hot-water supply piping as
indicated, but not smaller than equipment connections.

Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.6 FIELD QUALITY CONTROL

A. Inspect domestic water piping as follows:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Test domestic water piping as follows:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 150 psig. Isolate test source and allow to stand for four

hours. Leaks and loss in test pressure constitute defects that must be repaired.

5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.7 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.8 CLEANING AND DISINFECTION

A. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

B. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.

2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- C. Prepare and submit reports of purging and disinfecting activities.

END OF SECTION 15140

SECTION 15145 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 PERFORMANCE REQUIREMENTS.....2
1.3 SUBMITTALS.....2
1.4 QUALITY ASSURANCE.....2

PART 2 - PRODUCTS.....3
2.1 VACUUM BREAKERS.....3
2.2 BACKFLOW PREVENTERS.....3
2.3 BALANCING VALVES.....4
2.4 TEMPERATURE-ACTUATED WATER MIXING VALVES.....6
2.5 STRAINERS FOR DOMESTIC WATER PIPING.....7
2.6 OUTLET BOXES.....8
2.7 HOSE BIBBS.....9
2.8 WALL HYDRANTS.....9
2.9 WATER HAMMER ARRESTERS.....10
2.10 AIR VENTS10

PART 3 - EXECUTION.....11
3.1 INSTALLATION.....11
3.2 CONNECTIONS.....12
3.3 LABELING AND IDENTIFYING.....12
3.4 FIELD QUALITY CONTROL.....12
3.5 ADJUSTING.....12

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 15 Section "Mechanical General Requirements."
 - 2. Division 15 Section "Basic Mechanical Materials and Methods."
 - 3. Division 15 Section "Meters and Gages" for thermometers, pressure gages, and flow meters in domestic water piping.
 - 4. Division 15 Section "Domestic Water Piping" for water meters.

5. Division 15 Section "Drinking Fountains and Water Coolers" for water filters for water coolers.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Field quality-control test reports.

C. Flow Reports and Settings: For calibrated balancing valves.

D. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

B. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.

C. NSF Compliance:

1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.

2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

3. Comply with NSF 372, "Drinking Water System Components - Lead Content" for components with wetted surfaces in contact with potable water.

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. FEBCO; a Division of Watts Water Technologies, Inc.
 - c. Watts Water Technologies, Inc.; Watts Regulator Co.
 - d. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1001.
3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
4. Body: Bronze.
5. Inlet and Outlet Connections: Threaded.
6. Finish: Chrome plated.

B. Hose-Connection Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. MIFAB, Inc.
 - c. Watts Water Technologies, Inc.; Watts Regulator Co.
 - d. Woodford Manufacturing Company.
2. Standard: ASSE 1011.
3. Body: Bronze or brass, nonremovable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Chrome or nickel plated.

2.2 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Apollo Valves; Conbraco Industries, Inc.
- b. FEBCO; a Division of Watts Water Technologies, Inc.
- c. Watts Water Technologies, Inc.; Watts Regulator Co.
- d. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1012.

3. Operation: Continuous-pressure applications.

4. Size: NPS 3/4.

5. Body: Bronze.

6. End Connections: Union, solder joint.

7. Finish: Rough bronze.

B. Beverage-Dispensing-Equipment Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Apollo Valves; Conbraco Industries, Inc.
- b. Watts Water Technologies, Inc.; Watts Regulator Co.
- c. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1022.

3. Operation: Continuous-pressure applications.

4. Size: NPS 1/4 or NPS 3/8.

5. Body: Stainless steel or Acetal plastic.

6. End Connections: Threaded.

2.3 BALANCING VALVES

A. Calibrated Balancing Valves NPS 1/2 :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Armstrong International, Inc.
- b. Armstrong Pumps, Inc.
- c. Apollo Valves; by Conbraco Industries, Inc.
- d. Bell & Gossett; Xylem Inc.

- e. Flo Fab Inc.
- f. Flow Design Inc.
- g. Griswold Controls.
- h. NIBCO INC.
- i. IMI Indoor Climate; Tour & Andersson.
- j. Taco, Inc.
- k. Watts Water Technologies, Inc.; Watts Regulator Co.

2. Type: Ball or Y-pattern globe valve with two readout ports and memory setting indicator.
3. Body: Dezincification resistant brass, or bronze.
4. Minimum Flow Rate: 0.3 gpm.

B. Calibrated Balancing Valves NPS 3/4 to NPS 2 :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Armstrong International, Inc.
- b. Armstrong Pumps, Inc.
- c. Apollo Valves; by Conbraco Industries, Inc.
- d. Bell & Gossett; Xylem Inc.
- e. Flo Fab Inc.
- f. Flow Design Inc.
- g. Griswold Controls.
- h. NIBCO INC.
- i. IMI Indoor Climate; Tour & Andersson.
- j. Taco, Inc.
- k. Watts Water Technologies, Inc.; Watts Regulator Co.

2. Type: Ball or Y-pattern globe valve with two readout ports and memory setting indicator.
3. Body: Dezincification resistant brass, or bronze.
4. Size: Same as connected piping, but not larger than NPS 2.

C. Calibrated Balancing Valves NPS 2-1/2 to NPS 4 :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Armstrong International, Inc.
- b. Bell & Gossett; Xylem Inc.

- c. Flo Fab Inc.
- d. Flow Design Inc.
- e. Griswold Controls.
- f. NIBCO INC.
- g. IMI Indoor Climate; Tour & Andersson.
- h. Watts Water Technologies, Inc.; Watts Regulator Co.

2. Type: Adjustable with Y-pattern globe valve, two readout ports, and memory-setting indicator.
3. Size: Same as connected piping, but not smaller than NPS 2-1/2.

- D. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

2.4 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Water-Temperature Limiting Devices:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; Conbraco Industries, Inc.; Model MVD (34D Series).
 - b. Bradley Corporation.
 - c. Lawler Manufacturing Company, Inc.
 - d. Leonard Valve Company; Series 170-LF and 270-LF.
 - e. Watts Water Technologies, Inc.; Powers Division; Hydroguard Series e480 and LM495.
 - f. Watts Water Technologies, Inc.; Watts Regulator Co.
 - g. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1070.
3. Pressure Rating: 125 psig.
4. Type: Thermostatically controlled water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: 1/2-inch union or 3/8-inch compression; with integral check valves.
7. Accessories: Adjustable temperature-control knob.
8. Outlet Temperature Range: Adjustable from 85 deg F to 120 deg F. Set at 105 deg F.
9. Minimum Flow Rate: 0.5 gpm.
10. Valve Finish: Rough bronze.

B. Primary, Thermostatic, Water Mixing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. Armstrong International, Inc. (RADA).
 - c. Bradley Corporation.
 - d. Lawler Manufacturing Company, Inc.
 - e. Leonard Valve Company.
 - f. Symmons Industries, Inc.
 - g. Watts Water Technologies, Inc.; Powers Division.
 - h. Watts Water Technologies, Inc.; Watts Regulator Co.
 - i. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1017.
3. Type: Cabinet-type, thermostatically controlled water mixing valve.
4. Material: Bronze body with corrosion-resistant interior components.
5. Connections: Threaded inlets and outlet.
6. Accessories: Manual temperature control, check stops and strainers on hot- and cold-water supplies, and adjustable, temperature-control handle.
7. Valve Pressure Rating: 125 psig minimum, unless otherwise indicated.
8. Tempered-Water Setting: 130 deg F.
9. Valve Finish: Rough bronze.
10. Piping Finish: Copper.
11. Cabinet: Factory-fabricated, stainless steel, for surface mounting and with hinged, stainless-steel door.

2.5 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Manufacturers:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. Keckley.
 - c. Metraflex.
 - d. Mueller Steam Specialty.
 - e. NIBCO, Inc.
 - f. Spence.

- g. SSI Equipment, Inc.
 - h. Watts Water Technologies, Inc.
 - i. Yarway.
- 2. CWP: 200 psig minimum, unless otherwise indicated.
 - 3. SWP: 125 psig minimum, unless otherwise indicated.
 - 4. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
 - 5. End Connections: Threaded or soldered for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
 - 6. Screen: Stainless steel with round perforations, unless otherwise indicated.
 - 7. Perforation Size:
 - a. Strainers NPS 2 and Smaller: 0.033 inch.
 - b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
 - c. Strainers NPS 5 and Larger: 0.045 inch.
 - 8. Drain: Factory-installed, hose-end drain valve.

2.6 OUTLET BOXES

A. Clothes Washer Outlet Boxes:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Guy Gray Manufacturing Co., Inc.
- 2. Mounting: Recessed.
- 3. Material and Finish: Enameled- or epoxy-painted-steel or Stainless-steel box and faceplate.
- 4. Faucet: Combination, valved fitting or separate hot- and cold-water, valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
- 5. Supply Shutoff Fittings: NPS 1/2 gate, globe, or ball valves and NPS 1/2 copper, water tubing.
- 6. Drain: NPS 1-1/2 standpipe and P-trap for direct waste connection to drainage piping.
- 7. Inlet Hoses: Two 60-inch- long, rubber household clothes washer inlet hoses with female, garden-hose-thread couplings. Include rubber washers.
- 8. Drain Hose: One 48-inch- long, rubber household clothes washer drain hose with hooked end.

2.7 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Chrome or nickel plated.
9. Finish for Service Areas: Chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Operating key.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.8 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Water Technologies, Inc.; Watts Regulator co.
 - f. Woodford Manufacturing Company.
 - g. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.21.3M for self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4 or NPS 1.
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounting with cover.
9. Box and Cover Finish: Polished nickel bronze or chrome plated.
10. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
11. Nozzle and Wall-Plate Finish: Rough bronze.
12. Operating Keys(s): One with each wall hydrant.

2.9 WATER HAMMER ARRESTERS

A. Water Hammer Arresters (Copper Tube Type):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIFAB, Inc.
 - b. PPP Inc.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Watts Water Technologies, Inc.; Watts Regulator Co.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.10 AIR VENTS

A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.
2. Pressure Rating: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.

5. Size: NPS 3/8 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

B. Welded-Construction Automatic Air Vents:

1. Body: Stainless steel.
2. Pressure Rating: 150-psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.
- B. Install balancing valves in locations where they can easily be adjusted.
- C. Install temperature-actuated water mixing valves with strainers, and check stops or shutoff valves on inlets and with shutoff valve on outlet.
 1. Install thermometers and water regulators if specified.
 2. Install cabinet-type units recessed in or surface mounted on wall as specified.
- D. Install Y-pattern strainers for water on supply side of each pump.
- E. Install outlet boxes recessed in wall. Install 2-by-4-inch fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Rough Carpentry."
- F. Install hose stations with check stops or shutoff valves on inlets and with thermometer on outlet.
 1. Install shutoff valve on outlet if specified.
 2. Install cabinet-type units recessed in or surface mounted on wall as specified. Install 2-by-4-inch fire-retardant-treated-wood blocking wall

reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Rough Carpentry."

G. Install water hammer arresters in water piping according to PDI-WH 201.

H. Install air vents at high points of water piping.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping and specialties.

B. Ground equipment according to Division 16 Section "Grounding and Bonding."

C. Connect wiring according to Division 16 Section "Conductors and Cables."

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Calibrated balancing valves.
2. Primary, thermostatic, water mixing valves.
3. Primary water tempering valves.
4. Outlet boxes.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 15 Section "Mechanical Identification."

3.4 FIELD QUALITY CONTROL

A. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.5 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

- B. Set field-adjustable flow set points of balancing valves as follows:
1. Set calibrated balancing valves at calculated presettings.
 2. Measure flow at all stations and adjust where necessary.
 3. Record settings and mark balancing devices.
- C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 15145

SECTION 15150 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 DEFINITIONS.....2
1.3 SYSTEMS DESCRIPTIONS.....2
1.4 SUBMITTALS.....2
1.5 QUALITY ASSURANCE.....2
1.6 PROJECT CONDITIONS.....2

PART 2 - PRODUCTS.....3
2.1 MANUFACTURERS.....3
2.2 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS.....3
2.3 COPPER TUBE AND FITTINGS.....4
2.4 PVC PIPE AND FITTINGS.....5
2.5 SPECIALTY PIPE FITTINGS.....5

PART 3 - EXECUTION.....6
3.1 EXCAVATION.....6
3.2 PIPING SYSTEM INSTALLATION.....6
3.3 JOINT CONSTRUCTION.....8
3.4 SPECIALTY PIPE FITTING INSTALLATION.....8
3.5 VALVE INSTALLATION.....9
3.6 HANGER AND SUPPORT INSTALLATION.....9
3.7 CONNECTIONS.....10
3.8 IDENTIFICATION.....11
3.9 FIELD QUALITY CONTROL.....11
3.10 CLEANING12

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 02 Section "Sanitary Sewage" for piping outside building.
2. Division 15 Section "Mechanical General Requirements".
3. Division 15 Section "Basic Mechanical Materials and Methods".
4. Division 15 Section "Drainage Piping Specialties".

1.2 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. EPDM: Ethylene-propylene-diene terpolymer rubber.
- C. LLDPE: Linear, low-density polyethylene plastic.
- D. NBR: Acrylonitrile-butadiene rubber.
- E. PE: Polyethylene plastic.
- F. PVC: Polyvinyl chloride plastic.
- G. TPE: Thermoplastic elastomer.

1.3 SYSTEMS DESCRIPTIONS

- A. Sanitary waste and vent piping system materials are scheduled on the Drawing.

1.4 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Field quality-control inspection and test reports.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Cast-iron soil pipe shall be marked with the collective trademark of Cast Iron Soil Pipe Institute (CISPI).
- C. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and

then only after arranging to provide temporary service according to requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. CISPI, Hubless-Piping Couplings:

1. Manufacturers:
 - a. ANACO-Husky; McWane Plumbing Group.
 - b. Ferguson Enterprises, Inc.; ProFlo (Private labeled IDEAL-TRIDON).
 - c. IDEAL-TRIDON.
 - d. Mission Rubber Company; a division of MCP Industries, Inc.
 - e. Tyler Pipe; McWane Plumbing Group.
2. Standards: CISPI 310.
3. Description: NSF certified for compliance with CISPI 310. Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers:

- a. ANACO-Husky; McWane Plumbing Group; SD 4000.
 - b. Ferguson Enterprises, Inc.; ProFlo (Private labeled IDEAL-TRIDON).
 - c. IDEAL-TRIDON; Heavy-Duty "HD" No-Hub Couplings.
 - d. Norma Group; Clamp-All Products; HI-TORQ 125.
2. Standards: ASTM C 1277 and ASTM C 1540, or ASTM C 1277 and FM 1680 Class I.
 3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 COPPER TUBE AND FITTINGS

- A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
 1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- B. Hard Copper Tube: ASTM B 88, Types M, water tube, drawn temper.
 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 2. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 3. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- C. Hard Copper Tube: ASTM B 88, Types L, water tube, drawn temper.
 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 2. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 3. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.4 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: Schedule 40, ASTM D 2665, drain, waste, and vent.

1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

2.5 SPECIALTY PIPE FITTINGS

A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:

- a. Dallas Specialty & Mfg. Co.
- b. Fernco, Inc.
- c. Logan Clay Products Company (The).
- d. Mission Rubber Co.
- e. NDS, Inc.
- f. Plastic Oddities, Inc.

2. Sleeve Materials:

- a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
- b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
- c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

B. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:

- a. Cascade Waterworks Mfg. Co.
- b. Mission Rubber Co.

C. Rigid, Unshielded, Nonpressure Pipe Couplings: ASTM C 1461, sleeve-type reducing- or transition-type

mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:

- a. ANACO.

D. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

1. Manufacturers:

- a. SIGMA Corp.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Comply with requirements in Division 02 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING SYSTEM INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Sanitary sewer piping outside the building is specified in Division 02 Section "Sanitary Sewerage."

C. Basic piping installation requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."

D. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

E. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.

- F. Install underground, ductile-iron, special pipe fittings according to AWWA C600.
- G. Install underground, copper, force-main tubing according to Copper Development Association's "Copper Tube Handbook."
- H. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- I. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- K. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- L. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
 - 1. Building Sanitary Drain: 1/8-inch per foot downward in direction of flow, unless otherwise noted.

2. Horizontal Sanitary Drainage Piping: 1/8-inch per foot downward in direction of flow, unless otherwise noted.
3. Vent Piping: 1/8-inch per foot down toward vertical fixture vent or toward vent stack.

- M. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- N. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.
- O. Install underground PVC soil and waste drainage piping according to ASTM D 2321.
- P. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.3 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- B. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
- C. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.4 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
1. Install transition couplings at joints of piping with small differences in OD's.
 2. In Drainage Piping: Shielded, nonpressure transition couplings.
 3. In Aboveground Force Main Piping: Fitting-type transition couplings.
 4. In Underground Force Main Piping:
 - a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
 - b. NPS 2 and Larger: Pressure transition couplings.

3.5 VALVE INSTALLATION

- A. General valve installation requirements are specified in Division 15 Section "Valves."

3.6 HANGER AND SUPPORT INSTALLATION

- A. Pipe hangers and supports are specified in Division 15 Section "Hangers and Supports." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Install individual, straight, horizontal piping runs according to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

- B. Install supports according to Division 15 Section "Hangers and Supports."

- C. Support vertical piping and tubing at base and at each floor.

- D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.

- F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.
8. NPS 10 and NPS 12: 12 feet with 7/8-inch rod.

H. Install supports for vertical steel piping every 15 feet.

I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.
6. NPS 8: 10 feet with 3/4-inch rod.

J. Install supports for vertical copper tubing every 10 feet.

K. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.

3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

3.8 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 15 Section "Mechanical Identification."

3.9 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until

it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.10 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 15150

SECTION 15155 - DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL.....	1
1.1 RELATED DOCUMENTS.....	1
1.2 DEFINITIONS.....	2
1.3 SUBMITTALS.....	2
1.4 QUALITY ASSURANCE.....	2
1.5 COORDINATION.....	3
PART 2 - PRODUCTS.....	3
2.1 CAST-IRON CLEANOUTS.....	3
2.2 FLOOR DRAINS.....	6
2.3 AIR-ADMITTANCE VALVES.....	6
2.4 ROOF FLASHING ASSEMBLIES.....	7
2.5 TRAP SEAL PROTECTION DEVICES.....	8
2.6 THROUGH-PENETRATION FIRESTOP ASSEMBLIES.....	8
2.7 ROOF DRAINS.....	9
2.8 MISCELLANEOUS DRAINAGE PIPING SPECIALTIES.....	9
2.9 FLASHING MATERIALS.....	11
2.10 GREASE INTERCEPTORS	12
2.11 SOLIDS INTERCEPTORS	13
2.12 MOTORS	13
PART 3 - EXECUTION.....	14
3.1 INSTALLATION.....	14
3.2 CONNECTIONS.....	17
3.3 FLASHING INSTALLATION.....	17
3.4 LABELING AND IDENTIFYING.....	18
3.5 PROTECTION.....	18

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 15 Section "Mechanical General Requirements."
2. Division 15 Section "Basic Mechanical Materials and Methods."
3. Division 15 Section "Plumbing Fixtures" for hair interceptors.

1.2 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. FOG: Fats, oils, and greases.
- C. FRP: Fiberglass-reinforced plastic.
- D. HDPE: High-density polyethylene plastic.
- E. PE: Polyethylene plastic.
- F. PP: Polypropylene plastic.
- G. PUR: Polyurethane plastic.
- H. PVC: Polyvinyl chloride plastic.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories.
- B. Shop Drawings:
 - 1. Show fabrication and installation details for frost-resistant vent terminals.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For drainage piping specialties to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary and storm piping specialty components.

1.5 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CAST-IRON CLEANOUTS

- A. Size: Cleanouts shall be same nominal size as the pipe they serve up to 4 inches. For pipes larger than 4 inches nominal size, minimum size of cleanout shall be 4 inches.

- B. Exposed Cast-Iron Cleanouts:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Josam Company; Josam Div.; Series 58910.
- b. MIFAB, Inc.; C1460.
- c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.; 4510 Series.
- d. Tyler Pipe; Wade Div.
- e. Watts Drainage Products Inc.
- f. Zurn Plumbing Products Group; Specification Drainage Operation.

- 2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
- 3. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or hubless, cast-iron soil pipe test tee as required to match connected piping.
- 4. Closure: Countersunk or raised-head, brass or bronze plug with tapered threads.

- C. Cast-Iron Floor Cleanouts (On-Grade Interior Floor Areas):

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Josam Company; Josam Div.
- b. MIFAB, Inc.; C1220-R.

- c. Sioux Chief Manufacturing Company, Inc.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.; Model 4023S-F.
 - e. Tyler Pipe; Wade Div.
 - f. Watts Drainage Products Inc.
 - g. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M.
 3. Type: Adjustable housing.
 4. Body or Ferrule: Cast iron.
 5. Clamping Device: Not required.
 6. Outlet Connection: Spigot.
 7. Closure: Brass, bronze, or plastic plug with tapered threads.
 8. Adjustable Housing Material: Cast iron with threads, set-screws or other device.
 9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy with scoriated cover in service areas, and recessed cover to accept floor finish material in finished floor areas.
 10. Frame and Cover Shape: Round.
 11. Top Loading Classification: Medium Duty.
 12. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
- D. Cast-Iron Floor Cleanouts (Not-On-Grade Interior Floor Areas):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.; C-1100-C-R-34.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.; Model 4333C.
 - e. Tyler Pipe; Wade Div.
 - f. Watts Drainage Products Inc.
 - g. Zurn Plumbing Products Group; Specification Drainage Operation.
 2. Standard: ASME A112.36.2M.
 3. Type: Adjustable housing.
 4. Body or Ferrule: Cast iron.

5. Clamping Device: Required.
6. Outlet Connection: Spigot.
7. Closure: Brass, bronze, or plastic plug with tapered threads.
8. Adjustable Housing Material: Cast iron with threads, set-screws or other device.
9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy with scoriated cover in service areas, and recessed cover to accept floor finish material in finished floor areas.
10. Frame and Cover Shape: Round.
11. Top Loading Classification: Medium Duty.
12. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

E. Cast-Iron Wall Cleanouts (Finished Wall Areas):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.; Model 58790-20.
 - b. MIFAB, Inc.; C1460-RD.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M. Include wall access.
3. Body: Hub-and-spigot, cast-iron soil pipe T-branch or hubless, cast-iron soil pipe test tee as required to match connected piping.
4. Closure: Countersunk or raised-head, drilled-and-threaded bronze or brass plug with tapered threads.
5. Wall Access: Round, deep, chrome-plated bronze flat, chrome-plated brass or stainless-steel cover plate with screw.

F. Exterior Surface Area (Outdoor) Cast-Iron Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.

- b. MIFAB, Inc.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - e. Tyler Pipe; Wade Div.
 - f. Watts Drainage Products Inc.
 - g. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M.
 3. Type: Cast-iron soil pipe with cast-iron ferrule.
 4. Body or Ferrule: Cast iron.
 5. Outlet Connection: Spigot.
 6. Closure: Brass, bronze, or plastic plug with tapered threads.
 7. Access Frame and Cover Material and Finish: Non-skid nickel-bronze, copper alloy.
 8. Frame and Cover Shape: Round.
 9. Top Loading Classification: Heavy Duty.
 10. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
- 2.2 FLOOR DRAINS
- A. Refer to Plumbing and Floor Sinks Fixture Schedule.
- 2.3 AIR-ADMITTANCE VALVES
- A. Fixture Air-Admittance Valves:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ayrlett, LLC.
 - b. Durgo, Inc.
 - c. Oatey.
 - d. ProSet Systems Inc.
 - e. RectorSeal.
 - f. Studor, Inc.
 2. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.
 3. Housing: Plastic.
 4. Operation: Mechanical sealing diaphragm.
 5. Size: Same as connected fixture or branch vent piping.

B. Stack Air-Admittance Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Durgo, Inc.
 - b. Oatey.
 - c. Studor, Inc.
2. Standard: ASSE 1050 for vent stacks.
3. Housing: Plastic.
4. Operation: Mechanical sealing diaphragm.
5. Size: Same as connected stack vent or vent stack.

C. Wall Box:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Durgo, Inc.
 - b. Oatey.
 - c. RectorSeal.
 - d. Studor, Inc.
2. Description: White plastic housing with white plastic grille, made for recessed installation. Include bottom pipe connection and space to contain one air-admittance valve.
3. Size: About 9 inches wide by 8 inches high by 4 inches deep.

2.4 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company; Elmdor/Stoneman Div.
 - b. Thaler Metal Industries Ltd.

- B. Description: Manufactured assembly consisting of metal flashing collar and skirt extending at least 8 inches from pipe, with boot reinforcement and counterflashing fitting.

1. Open-Top Vent Cap: Without cap.
2. Low-Silhouette Vent Cap: With vandal-proof vent cap.
3. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.5 TRAP SEAL PROTECTION DEVICES

A. Barrier Type Trap Seal Protection Devices:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Smith, Jay R. Mfg. Co.; Quad Close Trap Seal Device Fig. 2692.
 - b. SureSeal Manufacturing; Inline Floor Drain Trap Sealer.
2. Standard: ASSE 1072-2007.
3. Sealing Element: Neoprene rubber or chemically resistant elastomer.
4. Size: 2 inch , 3 inch , 3-1/2 inch , or 4 inch.
5. Gravity Drain Outlet Connection: Compression fit sealing gasket 80 durometer.

2.6 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ProSet Systems Inc.
2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
3. Size: Same as connected soil, waste, or vent stack.
4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
6. Special Coating: Corrosion resistant on interior of fittings.

2.7 ROOF DRAINS

A. Metal Roof Drains, RD-5:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Froet Industries LLC.; 100C Series.
2. Standard: ASME A112.6.4 and IAPMO IGC 187-2003.
3. Pattern: Bi-functional roof drain and overflow drain.
4. Body Material: Cast iron.
5. Outlets:
 - a. Bottom overflow outlet.
 - b. Side or angle primary outlet.
6. Dome Material: Cast iron or ductile iron.
7. Overflow Strainer: Debris strainer for overflow pipe
8. Sump Receiver: Required.
9. Extension Collars: Required.
10. Underdeck Clamp: Required.
11. Roof Drain Options:
 - a. Low Profile Roof Drain: 4-inch overflow height
 - b. Finishing Ring: Recessed ring to allow the drain body to be installed in flush configuration, or to be used to install drain with extensions used to adjust for thicker deck sections.
 - c. IRMA Guard: 6-inch high Type 304 stainless steel perforated gravel guard (attaches to drain ring to prevent ballast and debris from entering drain area when installed with an IRMA roofing system.

2.8 MISCELLANEOUS DRAINAGE PIPING SPECIALTIES

A. Hub Outlets:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping.

B. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

C. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

D. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

E. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

F. Frost-Resistant Vent Terminals:

1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

G. Expansion Joints:

1. Standard: ASME A112.21.2M.

2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

H. Conductor Nozzles DNZ-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.; Model 1770-NB-BS.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.; RD-940-83.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Description: Bronze body with threaded inlet, bronze wall flange with mounting holes, and bird screen.
3. Size: Same as connected conductor.

2.9 FLASHING MATERIALS

- A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
 1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
 2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
 3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.
- B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:
 1. General Applications: 12 oz./sq. ft..
 2. Vent Pipe Flashing: 8 oz./sq. ft..
- C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

- D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.
- E. Fasteners: Metal compatible with material and substrate being fastened.
- F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- G. Solder: ASTM B 32, lead-free alloy.
- H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

2.10 GREASE INTERCEPTORS

A. Grease Interceptors:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. Lowe Engineering; a div. of Highland Tank & Manufacturing Co., Inc.
 - c. MIFAB, Inc.
 - d. Schier Products Company.
 - e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - f. Tyler Pipe; Wade Div.
 - g. Watts Drainage Products Inc.
 - h. Zurn Plumbing Products Group.
- 2. Standard: ASME A112.14.3, for intercepting and retaining fats, oils, and greases from food-preparation wastewater.
- 3. Plumbing and Drainage Institute Seal: Required.
- 4. Body Material: Polypropylene.
- 5. Interior Lining: Corrosion-resistant enamel for cast iron or steel bodies. Not required for polypropylene bodies.
- 6. Exterior Coating: Corrosion-resistant enamel for cast iron or steel bodies. Not required for polypropylene bodies.
- 7. Body Dimensions: 27 x 21 x 15

8. Body Extension: Required.
9. Flow Rate: 20 GPM.
10. Grease Retention Capacity: 100 LBS.
11. Inlet and Outlet Size: 3 inches
12. End Connections: No hub.
13. Cleanout: Integral.
14. Mounting: Recessed, flush with floor.
15. Flow-Control Fitting: Required.
16. Operation: Manual cleaning.

2.11 SOLIDS INTERCEPTORS

A. Solids Interceptors:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
 - g. Schier Products Company.
2. Type: Factory-fabricated interceptor made for removing and retaining sediment from wastewater.
3. Body Material: Plastic.
4. Interior Separation Device: Screens.
5. Interior Lining: Not required.
6. Exterior Coating: Not required.
7. Body Dimensions: 11 inches round.
8. Flow Rate: 15 GPM.
9. Inlet and Outlet Size: 1-1/2 inches.
10. End Connections: Plain.
11. Mounting: Above floor Inline.

2.12 MOTORS

A. General requirements for motors are specified in Division 15 Section "Motors."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not

require motor to operate in service factor range above 1.0.

2. Controllers, Electrical Devices, and Wiring:
Electrical devices and connections are specified in Division 16 Sections.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 2. Locate at each change in direction of piping greater than 45 degrees.
 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 4. Locate at base of each vertical soil and waste stack.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 1. Position floor drains for easy access and maintenance.
 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.

- b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- F. Install fixture air-admittance valves on fixture drain piping.
- G. Install stack air-admittance valves at top of stack vent and vent stack piping.
- H. Install air-admittance-valve wall boxes recessed in wall.
- I. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- J. Install through-penetration firestop assemblies in plastic [**stacks**] at floor penetrations.
- K. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 07.
1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
 2. Position roof drains for easy access and maintenance.
- L. Assemble open drain fittings and install with top of hub 1 inch above floor.
- M. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- N. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

- O. Install vent caps on each vent pipe passing through roof.
- P. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- Q. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- R. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.
- S. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- T. Assemble components of FOG disposal systems and install on floor. Install trap, vent, fresh-air inlet, and flow-control fitting according to authorities having jurisdiction. Install shelf fastened to reinforcement in wall construction and adjacent to unit, unless otherwise indicated. Install culture bottle, culture metering pump, timer, and control on shelf. Install tubing between culture bottle, metering pump, and chamber.
- U. Install grease interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.
 - 1. Flush with Floor Installation: Set unit and extension, if required, with cover flush with finished floor.
 - 2. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.
- V. Install solids interceptors with cleanout immediately downstream from interceptors that do not have integral cleanout on outlet. Install trap on interceptors that do not have integral trap and are connected to sanitary drainage and vent systems.
- W. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- X. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Grease Interceptors: Connect inlet and outlet to unit, and connect flow-control fitting and vent to unit inlet piping.
- D. Ground equipment according to Division 16 Section "Grounding and Bonding."
- E. Connect wiring according to Division 16 Section "Conductors and Cables."

3.3 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - 1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
 - 2. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.

- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."
- F. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Grease interceptors.
 - 2. Solids interceptors.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 15 Section "Mechanical Identification."

3.5 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 15155

SECTION 15160 - STORM DRAINAGE PIPING

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 DEFINITIONS.....1
1.3 SYSTEMS DESCRIPTIONS.....2
1.4 SUBMITTALS.....2
1.5 QUALITY ASSURANCE.....2

PART 2 - PRODUCTS.....2
2.1 MANUFACTURERS.....2
2.2 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS.....2
2.3 COPPER TUBE AND FITTINGS.....3
2.4 PVC PIPE AND FITTINGS.....4
2.5 SPECIAL PIPE FITTINGS.....4

PART 3 - EXECUTION.....5
3.1 EXCAVATION.....5
3.2 PIPING SYSTEM INSTALLATION.....5
3.3 JOINT CONSTRUCTION.....6
3.4 HANGER AND SUPPORT INSTALLATION.....6
3.5 CONNECTIONS.....8
3.6 FIELD QUALITY CONTROL.....8
3.7 CLEANING.....9

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 02 Section "Storm Drainage" for piping outside building.
 - 2. Division 15 Section "Mechanical General Requirements."
 - 3. Division 15 Section "Basic Mechanical Materials and Methods."
 - 4. Division 15 Section "Drainage Piping Specialties."
 - 5. Division 15 Section "Sump Pumps."

1.2 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. LLDPE: Linear, low-density polyethylene plastic.

- C. PE: Polyethylene plastic.
- D. PVC: Polyvinyl chloride plastic.
- E. TPE: Thermoplastic elastomer.

1.3 SYSTEMS DESCRIPTIONS

- A. Storm drainage piping system materials are scheduled on the Drawing.

1.4 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Field quality-control inspection and test reports.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Cast-iron soil pipe shall be marked with the collective trademark of Cast Iron Soil Pipe Institute (CISPI).
- C. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. CISPI, Hubless-Piping Couplings:
 - 1. Manufacturers:

- a. ANACO-Husky; McWane Plumbing Group.
 - b. Ferguson Enterprises, Inc.; ProFlo (Private labeled IDEAL-TRIDON).
 - c. IDEAL-TRIDON.
 - d. Mission Rubber Company; a division of MCP Industries, Inc.
 - e. Tyler Pipe; McWane Plumbing Group.
2. Standards: CISPI 310.
 3. Description: NSF certified for compliance with CISPI 310. Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers:
 - a. ANACO-Husky; McWane Plumbing Group; SD 4000.
 - b. Ferguson Enterprises, Inc.; ProFlo (Private labeled IDEAL-TRIDON).
 - c. IDEAL-TRIDON; Heavy-Duty "HD" No-Hub Couplings.
 - d. Norma Group; Clamp-All Products; HI-TORQ 125.
2. Standards: ASTM C 1277 and ASTM C 1540, or ASTM C 1277 and FM 1680 Class I.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 COPPER TUBE AND FITTINGS

- A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
 1. Copper Drainage Fittings: ASME B16.23, cast-copper or ASME B16.29, wrought-copper, solder-joint fittings.
- B. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.
 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 2. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 3. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.4 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: Schedule 40, ASTM D 2665, drain, waste, and vent.
 - 1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

2.5 SPECIAL PIPE FITTINGS

- A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - 1. Manufacturers:
 - a. Dallas Specialty & Mfg. Co.
 - b. Fernco, Inc.
 - c. Logan Clay Products Company (The).
 - d. Mission Rubber Co.
 - e. NDS, Inc.
 - f. Plastic Oddities, Inc.
 - 2. Sleeve Materials:
 - a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- B. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Mission Rubber Co.
- C. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
 - 1. Manufacturers:
 - a. SIGMA Corp.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 02 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING SYSTEM INSTALLATION

- A. Storm sewer and drainage piping outside the building are specified in Division 02 Section "Storm Drainage."
- B. Basic piping installation requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- C. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 15 Section "Drainage Piping Specialties."
- D. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
- E. Install underground, ductile-iron, special pipe fittings according to AWWA C600.
 - 1. Install encasement on piping according to ASTM A 674 or AWWA C105.
- F. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- G. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- H. Make changes in direction for storm piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- I. Lay buried building drain piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use

of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

- J. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:
 - 1. Building Storm Drain: 1/8-inch per foot downward in direction of flow, unless otherwise noted.
 - 2. Horizontal Storm-Drainage Piping: 1/8-inch per foot downward in direction of flow, unless otherwise noted.
- K. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- L. Install PVC storm drainage piping according to ASTM D 2665.
- M. Install underground PVC storm drainage piping according to ASTM D 2321.
- N. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.3 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- B. Hubless Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
- C. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Pipe hangers and supports are specified in Division 15 Section "Hangers and Supports." Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.

- c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Install supports according to Division 15 Section "Hangers and Supports."
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 2. NPS 3: 60 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 4. NPS 6: 60 inches with 3/4-inch rod.
 5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
 6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/4: 84 inches with 3/8-inch rod.
 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 3. NPS 2: 10 feet with 3/8-inch rod.
 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 5. NPS 3: 12 feet with 1/2-inch rod.
 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 7. NPS 6: 12 feet with 3/4-inch rod.
 8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.
- H. Install supports for vertical steel piping every 15 feet.
- I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/4: 72 inches with 3/8-inch rod.
 2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 3. NPS 2-1/2: 108 inches with 1/2-inch rod.

4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.
6. NPS 8: 10 feet with 3/4-inch rod.

J. Install supports for vertical copper tubing every 10 feet.

K. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

3.6 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.

2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or

repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

3.7 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 15160

SECTION 15181 - HYDRONIC PIPING

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 DEFINITIONS.....2
1.3 SYSTEMS DESCRIPTIONS.....2
1.4 SUBMITTALS.....3
1.5 QUALITY ASSURANCE.....3
1.6 EXTRA MATERIALS.....4

PART 2 - PRODUCTS.....4
2.1 COPPER TUBE AND FITTINGS.....4
2.2 STEEL PIPE AND FITTINGS.....5
2.3 JOINING MATERIALS.....7
2.4 VALVES.....7
2.5 SPECIALTY VALVES.....7
2.6 CONTROL VALVES.....10
2.7 AIR CONTROL DEVICES.....10
2.8 HYDRONIC PIPING SPECIALTIES.....11
2.9 HYDRONIC PIPING STRAINERS.....11

PART 3 - EXECUTION.....13
3.1 PIPING SYSTEMS INSTALLATION.....13
3.2 HANGERS AND SUPPORTS.....15
3.3 PIPE JOINT CONSTRUCTION.....17
3.4 HYDRONIC SPECIALTIES INSTALLATION.....17
3.5 TERMINAL EQUIPMENT CONNECTIONS.....18
3.6 FIELD QUALITY CONTROL.....18

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 02 Section "Underground Hydronic Distribution Piping" for preinsulated piping systems.
 - 2. Division 07 Section "Through-Penetration Firestop Systems" for materials and methods for sealing pipe penetrations through fire and smoke barriers.
 - 3. Division 07 Section "Joint Sealants" for materials and methods for sealing pipe penetrations through exterior walls.

4. Division 15 Section "Mechanical General Requirements."
5. Division 15 Section "Basic Mechanical Materials and Methods" for general piping materials and installation requirements.
6. Division 15 Section "Hangers and Supports" for pipe supports, product descriptions, and installation requirements. Hanger and support spacing is specified in this Section.
7. Division 15 Section "Pipe Flexible Connectors, Expansion Fittings and Loops."
8. Division 15 Section "Meters and Gages" for thermometers, flow meters, flow measuring devices, and pressure gages.
9. Division 15 Section "Mechanical Identification" for labeling and identifying hydronic piping.
10. Division 15 Section "General-Duty Valves for HVAC" for general-duty gate, globe, ball, butterfly, and check valves.
11. Division 15 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.
12. Division 15 Section "Temperature Controls" for temperature-control valves and sensors.
13. Division 15 Section "Piping Systems Flushing and Chemical Cleaning."
14. Division 15 Section "HVAC Water Treatment."

1.2 DEFINITIONS

- A. CPVC: Chlorinated polyvinyl chloride.
- B. HDPE: High density polyethylene.
- C. PP: Polypropylene.
- D. PVC: Polyvinyl chloride.
- E. PTFE: Polytetrafluoroethylene.
- F. RTRF: Reinforced thermosetting resin (fiberglass) fittings.
- G. RTRP: Reinforced thermosetting resin (fiberglass) pipe.

1.3 SYSTEMS DESCRIPTIONS

- A. Hydronic piping system materials are scheduled on the Drawings.

- B. Refer to Application Schedule on the Drawings for valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Hot-Water-Piping, Balancing Duty: Calibrated balancing valves.
 - 2. Drain Duty: Hose-end drain valves.

1.4 SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
 - 2. Air control devices.
 - 3. Chemical treatment.
 - 4. Hydronic specialties.
- B. Shop Drawings: Detail, at minimum 1/4scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
- C. Qualification Data: For Installer.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in operation and maintenance manuals.
- F. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.5 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- B. Installer Qualifications:
 - 1. Installers of Pressure-Sealed Joints: Installers shall be certified by pressure-seal joint manufacturer

as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

- C. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be as recommended by the manufacturer of the grooved components.

1.6 EXTRA MATERIALS

- A. Water-Treatment Chemicals: Furnish enough chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.
- B. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
- C. DWV Copper Tubing: ASTM B 306, Type DWV.
- D. Wrought-Copper Socket Fittings: ASME B16.22.
- E. Wrought-Copper Unions: ASME B16.22.
- F. Grooved Mechanical-Joint Fittings and Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.; Gruvlok Manufacturing; Advanced Copper Method.
 - b. Tyco Fire & Building Products; Grinnell Mechanical Products; Model 672.
 - c. Victaulic Company; Style 606 and Style 607.
 - 2. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
 - 3. Grooved-End-Tube Couplings: Rigid pattern, unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, prelubricated EPDM gasket rated for minimum

230 deg F for use with housing, and steel bolts and nuts.

G. Copper or Bronze Pressure-Seal Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Apollo Valves; by Conbraco Industries; ApolloXpress.
 - b. Elkhart Products Corporation; an Aalberts Industries Company; Xpress.
 - c. NIBCO Inc.; Press System.
 - d. Viega North America; ProPress System.
2. Housing: Copper.
3. O-Rings and Pipe Stops: EPDM.
4. Tools: Manufacturer's special tools.
5. Minimum 200-psig working-pressure rating at 250 deg F.

H. Copper, Mechanically Formed Tee Option: For forming T-branch on copper water tube. Mechanically formed tee fittings may be used up to half size of main.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. T-DRILL Industries Inc.

2.2 STEEL PIPE AND FITTINGS

A. Schedule 40 Steel Pipe: ASTM A 53/A 53M or ASTM A 106, Type E or S, Grade A or B. Include ends matching joining method.

1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe. Include ends matching joining method.
2. Malleable-Iron Unions: ASME B16.39, Class 150, hexagonal-stock body, with ball-and-socket, metal-to-metal, bronze seating surface and female threaded ends.
3. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.
4. Cast-Iron Flanges: ASME B16.1, Class 125.
5. Cast-Iron, Flanged Fittings: ASME B16.1, Class 125.
6. Fittings: ASTM A234 ANSI B16.9, steel butt weld to match pipe wall thickness, Class 300.
7. Flanges: Class 300 forged steel welding neck to match pipe wall thickness and valve flanges, ANSI B16.5. Orifice plate flanges shall be raised face welding neck type with ring joint gaskets and flange taps.

Coordinate orifice plate flanges with orifice plate flow elements.

- B. Schedule 80 Steel Pipe: ASTM A 53/A 53M or ASTM A 106, Type E or S, Grade A or B. Include ends matching joining method.
1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 80, seamless steel pipe. Include ends matching joining method.
 2. Screwed Couplings: Extra heavy tapered threaded black carbon steel.
 3. Screwed Unions: 300 pound SWP female screwed malleable iron with ground joint and brass to iron seat.
 4. Screwed Fittings: 300 pound SWP banded malleable iron screwed, ASTM A 197 and ANSI B16.3.
- C. Grooved Mechanical-Joint Fittings and Couplings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.; Gruvlok Manufacturing; Model 7401 Rigid.
 - b. Tyco Fire & Building Products; Grinnell Mechanical Products; Model 772 Rigid Coupling.
 - c. Victaulic Company; Style 07 Rigid Coupling and 107 QuickVic Rigid Coupling.
 2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 234, Grade WPB steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
 3. Gaskets: Synthetic rubber gasket of central cavity pressure-responsive design suitable for temperatures from minus 30 deg F to 250 deg F .
 4. Couplings: Ductile- or malleable-iron housing with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
 - a. Rigid Type: To provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9.

2.3 JOINING MATERIALS

- A. Refer to Division 15 Section "Basic Mechanical Materials and Methods."

2.4 VALVES

- A. General Service Valves: Comply with requirements specified in Division 15 Section "General-Duty Valves for HVAC."

2.5 SPECIALTY VALVES

A. Balance Valves:

1. Balance Valves NPS 6 and Larger: Lug type butterfly valves with aluminum bronze disc, AISI 300 Series stainless steel stem, resilient replaceable seat for service at not less than 250 deg F and memory stops. Refer to Division 15 Section "General-Duty Valves for HVAC" for additional requirements.
 - a. Provide lubricated enclosed screw or worm gear operator with handwheel for sizes 6 inches and larger.
 - b. Pressure rating shall meet or exceed system minimum pressure rating.
2. Flow Measuring: Use Flow Measuring Devices as specified in Division 15 Section "Meters and Gages."
3. Balance Valves for Sizes Less than NPS 6 Combination balance valve and flow measuring device as specified in this Section.

B. Combination, Balancing Valves and Flow Measuring Devices NPS 2 and Smaller:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flow Design Inc.
 - b. Griswold Controls.
 - c. Hydronic Components, Inc. (HCi).
 - d. Nexus Valve.
 - e. PRO Hydronic Specialties, LLC.
2. Manufacturers: Subject to compliance with requirements, use products by one of the following:
 - a. Tour & Andersson; TA Hydraulics Series available through Victaulic Company of America.
 - b. Tyco Fire & Building Products, Grinnell Mechanical Products (formerly marketed by Mepco).

3. Body: Brass or bronze, ball or plug type with calibrated orifice or venturi.
4. Ball: Plated brass, or stainless steel.
5. Plug: Resin.
6. Seat: PTFE.
7. End Connections: Threaded or socket.
8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever, with memory stop to retain set position.
10. WOG Rating: Minimum 400 psig.
11. Maximum Operating Temperature: 250 deg F.

C. Combination, Balancing Valves and Flow Measuring Devices
NPS 2-1/2 through NSP 4 :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flow Design Inc.
 - b. Griswold Controls.
 - c. Hydronic Components, Inc. (HCi).
 - d. Nexus Valve.
 - e. PRO Hydronic Specialties, LLC.
2. Manufacturers: Subject to compliance with requirements, use products by one of the following:
 - a. Tour & Andersson; TA Hydronics Series available through Victaulic Company of America.
 - b. Tyco Fire & Building Products, Grinnell Mechanical Products (formerly marketed by Mepco).
3. Body: Cast-iron or steel body, ball, plug, butterfly, or globe pattern with calibrated orifice or venturi.
4. Stem Seals: EPDM O-rings.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Flanged or grooved.
8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever, with memory stop to retain set position.
10. WOG Rating: Minimum 200 psig.
11. Maximum Operating Temperature: 225 deg F.

D. Combination, Balancing Valves and Flow Measuring Devices
NPS 2-1/2 through NSP 4 :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flow Design Inc.
 - b. Griswold Controls.
 - c. Hydronic Components, Inc. (HCi).
 - d. Nexus Valve.
 - e. PRO Hydronic Specialties, LLC.
 2. Manufacturers: Subject to compliance with requirements, use products by one of the following:
 - a. Tour & Andersson; TA Hydronics Series available through Victaulic Company of America.
 - b. Tyco Fire & Building Products, Grinnell Mechanical Products (formerly marketed by Mepco).
 3. Body: Cast-iron or steel body, ball, plug, butterfly, or globe pattern with calibrated orifice or venturi.
 4. Stem Seals: EPDM O-rings.
 5. Disc: Glass and carbon-filled PTFE.
 6. Seat: PTFE.
 7. End Connections: Flanged or grooved.
 8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
 9. Handle Style: Lever, with memory stop to retain set position.
 10. WOG Rating: Minimum 200 psig.
 11. Maximum Operating Temperature: 225 deg F.
- E. Contractor Option for Combination, Balancing Valves and Flow Measuring Devices NPS 2 and Smaller: Preassembled coil hook up kits may be used.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flow Design Inc.; Complete Coil Hook-Up.
 - b. Griswold Controls.
 - c. Hydronic Components, Inc. (HCi).
 - d. Nexus Valve; Coil Pak.
 - e. PRO Hydronic Specialties, LLC.
 2. Manufacturers: Subject to compliance with requirements, use products by one of the following:
 - a. Tour & Andersson; TA Hydronics Series available through Victaulic Company of America.
 - b. Tyco Fire & Building Products, Grinnell Mechanical Products (formerly marketed by Mepco).

2.6 CONTROL VALVES

- A. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 15 Section "Temperature Controls."
- B. Calibrated orifice balancing valves shall not be required on devices where pressure independent characterized control valves (PICCV's) are installed.

2.7 AIR CONTROL DEVICES

- A. Manual Air Vents: Use ball-valve-type hose-end drain valves, refer to Division 15 Section "Valves."
- B. Automatic Air Vents:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett; Xylem Inc.
 - d. Spirotherm, Inc.
 - e. Taco, Inc.
 - 2. Body: Bronze or cast iron.
 - 3. Internal Parts: Nonferrous.
 - 4. Operator: Noncorrosive metal float.
 - 5. Inlet Connection: NPS 1/2.
 - 6. Discharge Connection: NPS 1/4.
 - 7. Maximum Operating Pressure: 150 psig.
 - 8. Maximum Operating Temperature: 240 deg F.
- C. Bladder-Type Expansion Tanks:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett; Xylem Inc.
 - d. Taco, Inc.
 - 2. Tank: Welded steel, rated for 125-psig working pressure and 240 deg F maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

3. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

D. Combination Air and Dirt Separators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Spirotherm, Inc.; VDN Series.
2. Body: Fabricated steel; constructed for 150-psig maximum working pressure and 250 deg F maximum operating temperature. Separator shall have body extended below pipe connections for dirt separation and include removable lower head.
3. Air and Dirt Separation Mechanism: Internal copper core tube with continuous wound copper medium permanently attached followed by continuous wound copper wire permanently affixed .
4. Venting Chamber: With integral full port, float actuated brass venting mechanism. Include valved side tap to flush floating dirt or liquids and for quick bleeding of air during system fill.
5. Inlet and Outlet Connections: Threaded for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger.
6. Blowdown Connection: Threaded.
7. Size: Match system flow capacity.

2.8 HYDRONIC PIPING SPECIALTIES

- A. Diverting Fittings: 125-psig working pressure; 250 deg F maximum operating temperature; cast-iron body with threaded ends, or wrought copper with soldered ends. Indicate flow direction on fitting.
- B. Flexible connectors and expansion fittings are specified in Division 15 Section "Pipe Flexible Connectors, Expansion Fittings and Loops."

2.9 HYDRONIC PIPING STRAINERS

- A. Manufacturers:
 1. Keckley.
 2. Metraflex.
 3. Mueller Steam Specialty.
 4. Nibco, Inc.

5. Spence.
 6. Sure Flow Equipment Inc.
 7. Watts Water Technologies, Inc.
 8. Yarway.
 9. Anvil International, Inc.; Gruvlok Manufacturing (for grooved piping).
 10. Tyco Fire & Building Products, Grinnell Mechanical Products (for grooved piping)
 11. Victaulic Company; (for grooved piping).
- B. Y-Pattern Strainers, Bronze:
1. CWP: 200 psig minimum, unless otherwise indicated.
 2. SWP: 125 psig minimum, unless otherwise indicated.
 3. Body: Bronze for NPS 2 and smaller.
 4. End Connections: Threaded or soldered.
 5. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
 6. Drain:
 - a. Pipe plug for sizes NPS 2 and smaller.
 - b. Factory-installed, hose-end drain valve for sizes NPS 2-1/2 and larger.
- C. Y-Pattern Strainers, Cast and Ductile Iron:
1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection; or ASTM A 536, Grade 65-45-12, ductile-iron with coupled cover and drain connection.
 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger; grooved ends may be used on grooved piping.
 3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
 4. CWP: 200 psig minimum, unless otherwise indicated.
 5. SWP: 125 psig minimum, unless otherwise indicated.
 6. Drain:
 - a. Pipe plug for sizes NPS 2 and smaller.
 - b. Factory-installed, hose-end drain valve for sizes NPS 2-1/2 and larger.
- D. Basket Strainers, Cast Iron:
1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.

3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP: 200 psig minimum, unless otherwise indicated.
5. SWP: 125 psig minimum, unless otherwise indicated.
6. Drain: Factory-installed, hose-end drain valve.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

- L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- M. Install piping, other than drain piping, at a uniform grade of 0.2 percent upward in direction of flow.
- N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- P. Install valves according to Division 15 Section "General-Duty Valves for HVAC."
- Q. Install shutoff duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, unless only one piece of equipment is connected in the branch line. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.
- R. Install calibrated balancing valves in the return water line of each heating or cooling element and elsewhere as required to facilitate system balancing.
- S. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- T. Install safety valves on hot-water generators and elsewhere as required by the ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to floor. Comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, for installation requirements.
- U. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- V. Install flanges or grooved mechanical couplings in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

- W. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and where indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.
- X. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 15 Section "Pipe Flexible Connectors, Expansion Fittings and Loops."
- Y. Identify piping as specified in Division 15 Section "Mechanical Identification."

3.2 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Division 15 Section "Hangers and Supports." Comply with the following requirements for maximum spacing of supports.
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
 - 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.
 - 5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
 - 2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
 - 3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 - 4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 - 5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
 - 6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.

7. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.
 8. NPS 6: Maximum span, 17 feet; minimum rod size, 1/2 inch.
 9. NPS 8: Maximum span, 19 feet; minimum rod size, 5/8 inch.
 10. NPS 10: Maximum span, 20 feet; minimum rod size, 3/4 inch.
 11. NPS 12: Maximum span, 23 feet; minimum rod size, 7/8 inch.
 12. NPS 14: Maximum span, 25 feet; minimum rod size, 1 inch.
 13. NPS 16: Maximum span, 27 feet; minimum rod size, 1 inch.
 14. NPS 18: Maximum span, 28 feet; minimum rod size, 1-1/4 inches.
 15. NPS 20: Maximum span, 30 feet; minimum rod size, 1-1/4 inches.
- D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 6. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 7. NPS 4 to NPS 5: Maximum span, 10 feet minimum rod size, 1/2-inch.
 8. NPS 6: Maximum span, 10 feet minimum rod size, 5/8-inch.
 9. NPS 8: Maximum span, 10 feet minimum rod size, 3/4-inch.
- E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.3 PIPE JOINT CONSTRUCTION

- A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

3.4 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Manual vents at heat-transfer coils and elsewhere as required for air venting.
- C. Glycol Systems:
 - 1. Install automatic air vents on expansion tanks and install high capacity automatic air vents on air separators. Route vent piping to spill over glycol fill station.
 - 2. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- D. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.
- E. Install combination air/dirt separator in pump suction. Install blowdown piping with ball valve; extend full size to nearest floor drain.
- F. Install expansion tanks as indicated in piping diagrams. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
 - 1. Install tank fittings that are shipped loose.
 - 2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.
 - 3. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements.

3.5 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 15 Section "Meters and Gages."

3.6 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
 - 1. Leave joints, including welds, uninsulated and exposed for examination during test.
 - 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 - 3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
 - 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
 - 5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following tests on hydronic piping:
 - 1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 - 2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
 - 3. Isolate expansion tanks and determine that hydronic system is full of water.
 - 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other

component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for at least 2 hours, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
 6. Prepare written report of testing.
- C. Perform the following before operating the system:
1. Open manual valves fully.
 2. Inspect pumps for proper rotation.
 3. Remove disposal fine-mesh strainers in pump suction diffusers.
 4. Set makeup pressure-reducing valves for required system pressure.
 5. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
 6. Set temperature controls so all coils are calling for full flow.
 7. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
 8. Verify lubrication of motors and bearings.

END OF SECTION 15181

SECTION 15183 - REFRIGERANT PIPING

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 PERFORMANCE REQUIREMENTS.....2
1.3 SYSTEMS DESCRIPTIONS.....2
1.4 SUBMITTALS.....2
1.5 QUALITY ASSURANCE.....3
1.6 PRODUCT STORAGE AND HANDLING.....3
1.7 COORDINATION.....4

PART 2 - PRODUCTS.....4
2.1 COPPER TUBE AND FITTINGS.....4
2.2 VALVES AND SPECIALTIES.....4
2.3 REFRIGERANTS.....8

PART 3 - EXECUTION.....9
3.1 PIPING SYSTEM INSTALLATION.....9
3.2 PIPE JOINT CONSTRUCTION.....11
3.3 VALVE AND SPECIALTY INSTALLATION.....11
3.4 HANGERS AND SUPPORTS.....12
3.5 FIELD QUALITY CONTROL.....13
3.6 SYSTEM CHARGING.....13
3.7 ADJUSTING.....14

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 07 Section "Roof Accessories" for roof curbs, piping supports, and roof penetration boots.
 - 2. Division 07 Section "Through-Penetration Firestop Systems" for materials and methods for sealing pipe penetrations through fire and smoke barriers.
 - 3. Division 07 Section "Joint Sealants" for materials and methods for sealing pipe penetrations through exterior walls.
 - 4. Division 15 Section "Mechanical General Requirements.
 - 5. Division 15 Section "Basic Mechanical Materials and Methods."

6. Division 15 Section "Hangers and Supports" for pipe supports and installation requirements.
7. Division 15 Section "Mechanical Identification" for labeling and identifying refrigerant piping.
8. Division 15 Section "Meters and Gages" for thermometers and pressure gages.
9. Division 15 Section "Temperature Controls" for thermostats, controllers, automatic-control valves, and sensors.

1.2 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant:
 1. Suction Lines for Air-Conditioning Applications: 300 psig.
 2. Suction Lines for Heat-Pump Applications: 535 psig.
 3. Hot-Gas and Liquid Lines: 535 psig.

1.3 SYSTEMS DESCRIPTIONS

- A. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
- B. Suction Lines NPS 4 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.
- C. Hot-Gas and Liquid Lines NPS 1-1/2 and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
- D. Hot-Gas and Liquid Lines NPS 4 and Smaller: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.
- E. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.

1.4 SUBMITTALS

- A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
 1. Thermostatic expansion valves.

2. Solenoid valves.
 3. Hot-gas bypass valves.
 4. Filter dryers.
 5. Strainers.
 6. Pressure-regulating valves.
- B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
1. Shop Drawing Scale: Minimum 1/4 inch equals 1 foot.
 2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.
- 1.5 QUALITY ASSURANCE
- A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
 - B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."
 - C. UL Standard: Provide products complying with UL 207, "Refrigerant-Containing Components and Accessories, Nonelectrical"; or UL 429, "Electrically Operated Valves."
- 1.6 PRODUCT STORAGE AND HANDLING
- A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.7 COORDINATION

- A. Coordinate layout and installation of refrigerant piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate pipe sleeve installations for foundation wall penetrations.
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."
- D. Coordinate pipe sleeve installations for penetrations in exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Division 07 Section "Through-Penetration Firestop Systems" for materials and methods for sealing pipe penetrations through fire and smoke barriers.
- E. Coordinate pipe fitting pressure classes with products specified in related Sections.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 280, Type ACR.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.

2.2 VALVES AND SPECIALTIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Climate & Industrial Controls Group; Parker-Hannifin Corp.; Refrigeration & Air Conditioning Division.
 - 2. Danfoss Electronics, Inc.
 - 3. Emerson Electric Company; Alco Controls Div.
 - 4. Henry Valve Company.
 - 5. Sporlan Valve Company.
- B. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

C. Packed-Angle Valves:

1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

D. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

E. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

- F. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by an NRTL.
1. Body and Bonnet: Plated steel.
 2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
 3. Seat: Polytetrafluoroethylene.
 4. End Connections: Threaded.
 5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.
 6. Working Pressure Rating: 400 psig.
 7. Maximum Operating Temperature: 240 deg F.
 8. Manual operator.
- G. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
 2. Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Seat Disc: Polytetrafluoroethylene.
 4. End Connections: Threaded.
 5. Working Pressure Rating: 400 psig.
 6. Maximum Operating Temperature: 240 deg F.
- H. Thermostatic Expansion Valves: Comply with AHRI 750.
1. Body, Bonnet, and Seal Cap: Forged brass or steel.
 2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Packing and Gaskets: Non-asbestos.
 4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
 5. Suction Temperature: 40 deg F.
 6. Superheat: Adjustable.
 7. Reverse-flow option (for heat-pump applications).
 8. End Connections: Socket, flare, or threaded union.
 9. Working Pressure Rating: 700 psig.
- I. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
 2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Packing and Gaskets: Non-asbestos.
 4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.

5. Seat: Polytetrafluoroethylene.
 6. Equalizer: Internal.
 7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.
 8. End Connections: Socket.
 9. Throttling Range: Maximum 5 psig.
 10. Working Pressure Rating: 500 psig.
 11. Maximum Operating Temperature: 240 deg F.
- J. Straight-Type Strainers:
1. Body: Welded steel with corrosion-resistant coating.
 2. Screen: 100-mesh stainless steel.
 3. End Connections: Socket or flare.
 4. Working Pressure Rating: 500 psig.
 5. Maximum Operating Temperature: 275 deg F.
- K. Angle-Type Strainers:
1. Body: Forged brass or cast bronze.
 2. Drain Plug: Brass hex plug.
 3. Screen: 100-mesh monel.
 4. End Connections: Socket or flare.
 5. Working Pressure Rating: 500 psig.
 6. Maximum Operating Temperature: 275 deg F.
- L. Moisture/Liquid Indicators:
1. Body: Forged brass.
 2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
 3. Indicator: Color coded to show moisture content in ppm.
 4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
 5. End Connections: Socket or flare.
 6. Working Pressure Rating: 500 psig.
 7. Maximum Operating Temperature: 240 deg F.
- M. Replaceable-Core Filter Dryers: Comply with AHRI 730.
1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
 2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
 3. Desiccant Media: Activated alumina.
 4. End Connections: Socket.
 5. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.

6. Maximum Pressure Loss: 2 psig.
7. Rated Flow: See equipment schedules.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 240 deg F.

N. Permanent Filter Dryers: Comply with AHRI 730.

1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina.
4. End Connections: Socket.
5. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
6. Maximum Pressure Loss: 2 psig.
7. Rated Flow: See equipment schedules.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 240 deg F.

O. Mufflers:

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or flare.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

P. Receivers: Comply with AHRI 495.

1. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
2. Comply with UL 207; listed and labeled by an NRTL.
3. Body: Welded steel with corrosion-resistant coating.
4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
5. End Connections: Socket or threaded.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

Q. Liquid Accumulators: Comply with AHRI 495.

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

2.3 REFRIGERANTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Atofina Chemicals, Inc.
2. DuPont Company; Fluorochemicals Div.

3. Honeywell, Inc.; Genetron Refrigerants.
4. INEOS Fluor Americas LLC.

PART 3 - EXECUTION

3.1 PIPING SYSTEM INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Refer to Division 15 Section "Temperature Controls" and Sequence of Operation on the Drawings for solenoid valve controllers, control wiring, and sequence of operation.
- K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in

accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

- M. Install refrigerant piping in protective conduit where installed belowground.
- N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- O. Slope refrigerant piping as follows:
 - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
 - 2. Install horizontal suction lines with a uniform slope downward to compressor.
 - 3. Install traps and double risers to entrain oil in vertical runs.
 - 4. Liquid lines may be installed level.
- P. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- Q. Install pipe sleeves at penetrations in exterior walls and floor assemblies.
- R. Seal penetrations through fire and smoke barriers according to Division 07 Section "Through-Penetration Firestop Systems."
- S. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- T. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.
- U. Seal pipe penetrations through exterior walls according to Division 07 Section "Joint Sealants" for materials and methods.
- V. Identify refrigerant piping and valves according to Division 15 Section "Mechanical Identification."

3.2 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Brazed Joints: Construct joints according to AWS's "Braze Handbook," Chapter "Pipe and Tube." Braze filler metals are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- D. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 VALVE AND SPECIALTY INSTALLATION

- A. Install diaphragm packless valves in suction and discharge lines of compressor.
- B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
- C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
- D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.
- E. Install a full-sized, three-valve bypass around filter dryers.
- F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
- G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
 - 1. Install valve so diaphragm case is warmer than bulb.
 - 2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.

3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
 - H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
 - I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
 - J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
 1. Solenoid valves.
 2. Thermostatic expansion valves.
 3. Hot-gas bypass valves.
 4. Compressor.
 - K. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.
- 3.4 HANGERS AND SUPPORTS
- A. Hanger, support, and anchor products are specified in Division 15 Section "Hangers and Supports."
 - B. Install the following pipe attachments:
 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
 2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 4. Spring hangers to support vertical runs.
 5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
 - C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
 1. NPS 3/4, and soft copper tubing: Continuous support v-shaped plastic pipe channel, maximum hanger spacing 8 feet.

2. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
3. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
4. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
6. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
7. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
8. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.

D. Support multifloor vertical runs at least at each floor.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
 - a. Fill system with nitrogen to the required test pressure.
 - b. System shall maintain test pressure at the manifold gage throughout duration of test.
 - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.6 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.

2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.7 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 1. Open shutoff valves in condenser water circuit.
 2. Verify that compressor oil level is correct.
 3. Open compressor suction and discharge valves.
 4. Open refrigerant valves except bypass valves that are used for other purposes.
 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 15183

SECTION 15185 - HYDRONIC PUMPS

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 DEFINITIONS.....1
1.3 SUBMITTALS.....2
1.4 QUALITY ASSURANCE.....2
1.5 DELIVERY, STORAGE, AND HANDLING.....2
1.6 COORDINATION.....3

PART 2 - PRODUCTS.....3
2.1 GENERAL PUMP REQUIREMENTS.....3
2.2 MANUFACTURERS.....4
2.3 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS (SMALL).....4
2.4 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS.....4
2.5 FLEXIBLY COUPLED, HORIZONTAL, IN-LINE CENTRIFUGAL PUMPS...5
2.6 FLEXIBLY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL
PUMPS.....6
2.7 AUTOMATIC CONDENSATE PUMP UNITS.....8
2.8 AUTOMATIC CONDENSATE PUMP UNITS (PLENUM APPLICATIONS)....8
2.9 PUMP SPECIALTY FITTINGS.....8

PART 3 - EXECUTION.....9
3.1 EXAMINATION.....9
3.2 PUMP INSTALLATION.....9
3.3 ALIGNMENT.....10
3.4 CONNECTIONS.....10
3.5 STARTUP SERVICE.....11
3.6 DEMONSTRATION.....12

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 15 Section "Mechanical General Requirements."
 - 2. Division 15 Section "Basic Mechanical Materials and Methods."

1.2 DEFINITIONS

- A. Buna-N: Nitrile rubber.

- B. EPT: Ethylene propylene terpolymer.

1.3 SUBMITTALS

- A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.
- B. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Operation and Maintenance Data: For all pumps and accessories to include in Operation and Maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.
- C. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
- B. Store pumps in dry location.
- C. Retain protective covers for flanges and protective coatings during storage.
- D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

- E. Comply with pump manufacturer's written rigging instructions.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 GENERAL PUMP REQUIREMENTS

- A. Pump Units: Factory assembled and tested.
- B. Motors: Comply with requirements in Division 15 Section "Motors".
- C. Selection:
 1. Base non-overloading characteristics for pumps upon nameplate horsepower, at any point on performance curve.
 2. Shaft first critical speed shall not be less than 25 percent greater than operating speed.
 3. Maximum impeller diameter shall not be greater than 90 percent of "cut water" diameter for a given casing and no smaller than the smallest published diameter for casing. Do not base acceptable maximum diameter calculation on percentage of impeller diameter range for a given casing.
 4. Pump speed shall be limited to 1800 RPM except as scheduled.
 5. Select at the point of maximum efficiency for a given impeller-casing combination. Deviations shall be within 3 percent of maximum efficiency on the increasing capacity side of the maximum efficiency point and 7 percent on the decreasing capacity side of the maximum efficiency point.
 6. Select pump at a point no greater than 85 percent of end of curve flow.
 7. Maximum pump suction velocity:
 - a. In-line: 12 fps.
 - b. End suction: 13 fps.
 - c. Double suction: 15 fps.

2.2 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.3 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS (SMALL)

A. Manufacturers:

1. Armstrong Pumps Inc.
2. Bell & Gossett; Xylem Inc.; Series PL.
3. Grundfos Pumps Corporation.
4. Taco, Inc.; Series 1400.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; and designed for installation with pump and motor shafts mounted horizontally.

1. Pump Construction: Bronze fitted.
 - a. Casing: Radially split, cast iron, with threaded companion-flange connections.
 - b. Impeller: Glass-reinforced corrosion-resistant material; keyed to shaft.
 - c. Shaft: High-strength alloy steel.
 - d. Seal: Mechanical, carbon/silicon carbide seal.
 - e. Bearings: Permanently oil-lubricated type.
2. Motor-Single speed, with oil-lubricated bearings, unless otherwise indicated; and directly mounted to pump casing. Comply with requirements in Division 15 Section "Motors."

C. Capacities and Characteristics: Refer to Schedule on Drawings.

2.4 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers:

1. Armstrong Pumps Inc.; Series 4360 and 4380.
2. Bell & Gossett; Xylem Inc.; Series 80.
3. Grundfos Pumps Corporation.
4. Taco, Inc.; Series 1900, KV.

B. Description: Factory-assembled and tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined

in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.

C. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, and companion-flange connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
3. Pump Shaft: Steel with copper-alloy shaft sleeve, or stainless steel.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N seal for all glycol systems and all water systems 225 deg F and below; EPT seals for water systems above 225 deg F. Include water slinger on shaft between motor and seal.

D. Motor: Single speed, with permanently or grease lubricated ball bearings, unless otherwise indicated; and rigidly mounted to pump casing. Comply with requirements in Division 15 Section "Motors"

E. Capacities and Characteristics: Refer to Schedule on Drawings.

2.5 FLEXIBLY COUPLED, HORIZONTAL, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers:

1. Armstrong Pumps Inc.; Series S, H, 1050, 1060.
2. Bell & Gossett; Xylem Inc.; Series 60.
3. Grundfos Pumps Corporation.
4. Taco, Inc.; Series 1600.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.

C. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, and threaded companion-flange or flanged connections.
 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, and keyed to shaft. Trim impeller to match specified performance.
 3. Pump Shaft: Hardened alloy steel, with copper-alloy shaft sleeve.
 4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N seal for all glycol systems and all water systems 225 deg F and below; EPT seals for water systems above 225 deg F. Include water slinger on shaft between motor and seal.
 5. Pump Bearings: Permanently lubricated ball bearings.
- D. Flexible Shaft Coupling: Molded rubber insert with interlocking spider or Interlocking frame with interconnecting springs capable of absorbing vibration.
- E. Motor: Single speed, with permanently lubricated ball bearings, unless otherwise indicated; and resiliently mounted to pump casing. Comply with requirements in Division 15 Section "Motors".
- F. Capacities and Characteristics: Refer to Schedule on Drawings.
- 2.6 FLEXIBLY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS
- A. Manufacturers:
1. Armstrong Pumps Inc.; Series 4030.
 2. Aurora Pump; Division of Pentair Pump Group; Series 3340.
 3. Bell & Gossett; Xylem Inc.; Series 1510.
 4. Grundfos Pumps Corporation/PACO.
 5. Taco, Inc.; Series FI.
- B. Description: Factory-assembled and tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.
- C. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections. Provide integral mount on volute to support the casing, and attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft true back pullout. Provide receptacle bronze wear rings for all pumps with pump shaft L/D ratios greater than 6.0.
 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
 3. Pump Shaft: Steel, with copper-alloy shaft sleeve or stainless steel.
 4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N seal for all glycol systems and all water systems 225 deg F and below; EPT seals for water systems above 225 deg F. Include water slinger on shaft between motor and seal.
 5. Pump Bearings: Permanently or grease-lubricated ball bearings contained in cast-iron housing with grease fittings.
- D. Flexible Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be center drop-out type to allow disassembly and removal without removing pump shaft or motor. Provide EPDM coupling sleeve for all motors 40 HP and below and all variable-speed applications.
- E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
- F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.
- G. Motor: Single speed, with permanently lubricated or grease-lubricated ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable

alignment. Comply with requirements in Division 15 Section "Motors".

- H. Capacities and Characteristics: Refer to Schedule on Drawings.

2.7 AUTOMATIC CONDENSATE PUMP UNITS

A. Manufacturers:

1. Little Giant Pump Co.; Subsidiary of Tecumseh Products Co.
2. Hydromatic Pump Company.

- B. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Include factory- or field-installed check valve and a 72-inch-minimum, electrical power cord with plug.

2.8 AUTOMATIC CONDENSATE PUMP UNITS (PLENUM APPLICATIONS)

A. Manufacturers:

1. Hartell Pumps Div.; Milton Roy Co.; Model A2-X-1965.

- B. Description: Packaged units with corrosion-resistant pump, dual-voltage thermally protected motor, cast aluminum tank with cover, and automatic controls. Include auxiliary safety switch and factory- or field-installed check valve.

2.9 PUMP SPECIALTY FITTINGS

- A. Suction Diffuser: Angle pattern, minimum 175-psig pressure rating, cast-iron body and end cap for NPT or flanged connections or ductile iron body and end cap for grooved connections, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and integral locating boss for field-fabricated support.

1. Manufacturers:

- a. Armstrong Pumps, Inc.
- b. Bell & Gossett; Xylem Inc.
- c. Grundfos Pumps Corporation/PACO.
- d. Mueller Steam Specialty Company.
- e. Taco; Fabricated Products Division.
- f. Anvil International, Inc. (grooved only).
- g. Victaulic Co. of America (grooved only).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

- A. Comply with HI 1.4.
- B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
- C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- D. Support in-line centrifugal pumps greater than 1/2 HP independent of piping. Use continuous-thread hanger rods and hangers of sufficient size to support pump weight. Do not support pump from motor housing plate.
- E. Refer to Division 15 Section "Mechanical Vibration Controls" for vibration isolation devices.
- F. Refer to Division 15 Section "Hangers and Supports" for hanger and support materials.
- G. Set base-mounted pumps on concrete bases. Disconnect flexible coupling before setting. Do not reconnect flexible couplings until alignment procedure is complete.
 - 1. Support pump baseplate on rectangular stainless steel blocks and shims, or on wedges with small taper, at points near foundation bolts to provide a gap of 3/4

to 1-1/2 inches between pump base and foundation for grouting.

2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.
3. Install pumps on inertia bases where required. Refer to Division 15 Section "Mechanical Vibration Controls" for vibration isolation devices.

H. Automatic (Cooling Coil) Condensate Pump Units: Install units for collecting condensate and extend to open drain.

3.3 ALIGNMENT

- A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.
- B. Comply with pump and coupling manufacturers' written instructions.
- C. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation." Laser align to a tolerance of 0.0005 inches maximum.
- D. After alignment is correct, tighten foundation bolts evenly but not too firmly.
- E. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

- D. Install check valve and throttling valve on discharge side of pumps. Triple-duty valves are not allowed.
- E. Install Y-type strainer or suction diffuser and shutoff valve on suction side of pumps as indicated on drawings.
- F. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
- G. Install pressure gages on pump suction and discharge or at integral pressure-gage tappings, or install single gage with multiple-input selector valve.
- H. Install check valve and gate or ball valve on each condensate pump unit discharge.
- I. Install electrical connections for power, controls, and devices.
- J. Ground equipment according to Division 16 Section "Grounding and Bonding."
- K. Connect wiring according to Division 16 Section "Conductors and Cables."

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service for each pump supplied. Written report of the start-up shall be provided to the Owner and Engineer upon completion of services.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Clean strainers on suction piping.
 - 4. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.
 - 5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.

6. Start motor.
7. Open discharge valve slowly.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 15185

SECTION 15188 - PIPING SYSTEMS FLUSHING AND CHEMICAL CLEANING

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUMMARY.....1
1.3 DEFINITIONS.....2
1.4 PERFORMANCE REQUIREMENTS.....2
1.5 SUBMITTALS.....2
1.6 QUALITY ASSURANCE.....2
1.7 COORDINATION.....3

PART 2 - PRODUCTS.....3
2.1 MANUFACTURERS.....3
2.2 MATERIALS.....4

PART 3 - EXECUTION.....4
3.1 ACCEPTABLE SERVICE PROVIDER.....4
3.2 PREPARATION.....4
3.3 INITIAL FLUSHING.....5
3.4 FLUSHING AND CHEMICAL CLEANING PROCEDURES.....5
3.5 PLACING INTO OPERATION.....7
3.6 FIELD QUALITY CONTROL.....7

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 15 Section "Mechanical General Requirements."
 - 2. Division 15 Section "Basic Mechanical Materials and Methods."

1.2 SUMMARY

- A. This Section includes chemical cleaning for the following piping systems:
 - 1. Heating hot water.
 - 2. Chilled water.

1.3 DEFINITIONS

- A. Cleaning: Recirculating water containing chemical cleaning and passivation compounds.
- B. Flushing: Using approved water on a once through basis.

1.4 PERFORMANCE REQUIREMENTS

- A. Furnish the services of a firm specializing in piping system chemical cleaning and water treatment work.
 - 1. For chemical cleaning: This firm shall select the required type and quantity, based on system volume, of cleaning compound, and method of application.
- B. Passivation for Galvanized Steel: Open loop only, for the first two weeks of operation.

1.5 SUBMITTALS

- A. Product Data:
 - 1. Proposed cleaning chemicals and quantities.
 - 2. Proposed passivation chemicals and quantities.
 - 3. Analyses and reports of all chemical items concerning safety and compliance with government regulations.
- B. Shop Drawings: Reduced scale plans indicating locations of velocity measurements.
- C. Field quality-control test reports.
- D. Other Informational Submittals:
 - 1. Proposed, step-by-step, chemical cleaning procedure.
 - 2. Circulation pump suction and discharge pressure at start and completion of chemical cleaning operations.
 - 3. Passivation Confirmation Report: Verify passivation of galvanized-steel surfaces, and confirm this observation in a letter to Architect.

1.6 QUALITY ASSURANCE

- A. Service Provider Qualifications: An experienced piping systems cleaning service provider capable of applying cleaning compounds as specified in this Section.
- B. Conduct safety meetings with Owner's Representative and personnel involved in the cleaning process.

- C. Assume responsibility for damage, necessary subsequent cleaning, flushing, and inspection of Work under the Contract which results from improper flushing and cleaning operations including failure to flush all dead-ends.

1.7 COORDINATION

- A. Schedule flushing and chemical cleaning activities immediately after piping system pressure testing and immediately prior to piping system chemical treatment work to minimize internal oxidization or flash corrosion of piping systems.
- B. Coordinate chemical cleaning work with other work to avoid accidental chemical discharge, spillage, or spray out, and electrolytically originated system damage resulting from concurrent chemical cleaning and arc welding.
- C. Coordinate with work performed under other Sections to provide in-place temporary strainers, spool pieces, flushing hose connections, cross-over piping, and isolation and drain valves.
- D. Chillers shall not be cleaned with any chloride component.
- E. Boilers shall be flushed and cleaned to remove rust and oil deposits.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. System Cleaning Chemicals: Subject to compliance with requirements, provide products by:
 - 1. Base Bid Manufacturer:
 - a. Chemtex Corporation.
 - 2. Alternate Manufacturers:
 - a. PVS-Nolwood Chemicals, Inc.; PVS CHILL CLP Cleaner.
 - b. Nalco, an Ecolab Company.
 - c. Mitco Custom Water Treatment.
 - d. H-O-H Chemicals, Inc.
 - e. GE Power & Water; Water & Process Technologies.
 - f. Enerco Corporation.

2.2 MATERIALS

- A. Cleaning chemicals shall be as recommended by manufacturer and compatible with piping system components and connected equipment.
- B. Cleaning and passivation chemical shall consist of an inorganic phosphate, yellow metal corrosion inhibitor (Tolytriazole), dispersant, and oil emulsifier.
- C. Provide additional temporary and permanent piping, equipment, and materials required for chemical cleaning work.
- D. Use potable water for flushing and cleaning operations, unless directed otherwise by the Architect.

PART 3 - EXECUTION

3.1 ACCEPTABLE SERVICE PROVIDER

- A. Subject to compliance with requirements, provide chemical cleaning service by:
 - 1. Base Bid Provider:
 - a. Chemtex Corporation (Glenn Martin, 248-880-4547).
 - 2. Alternate Providers:
 - a. Eldon Water (Patrick Racine, Christa Blades, or Pierre Beausoleil, 888-712-4000).
 - b. Enerco Corporation (Doug White 517-627-8444 or 800-292-5908).
 - c. GE Power & Water; Water & Process Technologies.
 - d. Mitco Custom Water Treatment (Gordon Chapin, 800-516-2175).
 - e. Nalco, an Ecolab Company (Brian Irwin or Tony Mackovski, 248-344-7564).
 - f. H-O-H Chemicals, Inc./H.V. Burton Co.

3.2 PREPARATION

- A. Prior to flushing and cleaning activities, drain the system of all water used for hydrostatic testing.
- B. Temporarily connect dead-end supply and return piping as necessary to result in recirculating system in which no lines are left static for purposes of flushing and cleaning. Refer to System Piping Diagrams on the Drawings

for suggested locations of temporary connections for flushing and cleaning purposes.

- C. Select three locations for monitoring flow rates.

3.3 INITIAL FLUSHING

- A. Remove loose dirt, mill scale, metal chips, weld beads, rust and other deleterious substances without damage to system components.
- B. Bypass factory cleaned equipment, unless acceptable means of protection are provided and subsequent inspection of water boxes and other "hide-out" areas takes place.
- C. Isolate or protect clean system components including pumps and pressure vessels and remove components which may be damaged.
- D. Open valves, drains, vents and strainers at all system levels.
- E. Remove plugs, caps, spool pieces and components to facilitate early discharge from system.
- F. Sectionalize system if possible to obtain debris carrying velocity of 6 FPS.
- G. Connect dead-end supply and return headers as necessary or provide terminal drains in end caps.
- H. Install temporary strainers where necessary to protect down-stream equipment.
- I. Supply and remove flushing water and drainage by fire hoses, garden hoses, temporary and permanent piping and Contractor's booster pumps.
- J. Flush for not less than one hour.
- K. Inspect system including basins to determine if debris accumulation requires dewatering and cleaning prior to next phase work.

3.4 FLUSHING AND CHEMICAL CLEANING PROCEDURES

- A. Remove without chemical or mechanical damage to system components adherent dirt (organic soil), oil and grease

(hydrocarbons), welding and soldering flux, mill varnish, pipe compounds, rust (iron oxide), and other deleterious substances not removed by initial flushing. Removal of tightly adherent mill scale is not required.

- B. Fill system with fresh water and add manufacturer's recommended volume of system cleaner to remove grease and petroleum products from piping. Circulate solution for 48 hours at a minimum velocity of 6 fps.
 - 1. Utilize defoamers to preclude damage to existing work and adjacent electrical equipment.
 - 2. Utilize heat to maximize effectiveness of compounds or use live steam injection where practical and safe. Do not raise cleaning water temperature in excess of controlled limits.
- C. Monitor flow rates and clean strainers as required to maintain minimum specified velocity during the entire circulation and chemical cleaning period.
- D. Cleaning of new piping systems shall be completed prior to connection of systems to existing services.
- E. Install temporary strainer screens between pipe flange faces where necessary to protect primary system from branch connections during chemical cleaning procedures.
- F. Following chemical cleaning:
 - 1. Remove, clean, and reinstall strainer baskets.
 - 2. Blow down and clean low points, dirt legs, and traps.
- G. Drain systems:
 - 1. Check with local authorities concerning discharge requirements and submit copies of letters or reports.
 - 2. If acceptable, drain system to sanitary drainage system.
 - 3. Do not under any circumstances drain to storm drainage system or open drainage ditch.
 - 4. If discharge requirements do not allow discharge to sanitary sewer, secure the services of a licensed disposal Contractor.
 - 5. Disposal Contractors:
 - a. Dynecol.
 - b. SQS Environmental.
- H. Perform final flush to remove any remaining debris and chemical from the system:

1. Flush dead ends and isolated pre-cleaned equipment.
2. Operate valves to dislodge debris in valve body.
3. Flush for not less than 1 hour.

3.5 PLACING INTO OPERATION

- A. Clean strainers.
- B. Dewater and clean new sumps, basins, storage vessels and pressure vessels.
- C. Disassemble, inspect, clean, repair, replace and reassemble any critical component or questionable item. Bellows style, and hose and braid flexible connectors left in place shall be removed and cleaned.
- D. Preliminarily adjust control valves.
- E. Install clean primary filter elements, if necessary, as determined by both pressure differential across filter and visual inspection of filter elements.
- F. Close-up and fill system as soon as possible to minimize corrosion of untreated surfaces.
- G. Vent air from system and adjust fill valve.
- H. Immediately after completion of flushing and chemical cleaning, fill systems with potable water and make ready for chemical treatment as specified in Division 15 Section "HVAC Water Treatment."

3.6 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 1. Withdraw, inspect, and test samples of water from each system after flushing and chemical cleaning is completed, to ensure system is free of contaminants.
 2. If loose debris or contaminants are still present, repeat final flushing procedures until test samples and strainers remain free of debris and contaminants.

END OF SECTION 15188

SECTION 15189 - HVAC WATER TREATMENT

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 DEFINITIONS.....1
1.3 PERFORMANCE REQUIREMENTS.....2
1.4 SUBMITTALS.....3
1.5 QUALITY ASSURANCE.....6
1.6 OWNER'S INSTRUCTIONS.....6
1.7 MAINTENANCE SERVICE.....7

PART 2 - PRODUCTS.....7
2.1 MANUFACTURERS.....7
2.2 CHEMICAL FEED PIPE AND FITTINGS.....8
2.3 CHEMICAL TREATMENT TEST EQUIPMENT.....8
2.4 CHEMICALS.....9

PART 3 - EXECUTION.....11
3.1 WATER ANALYSIS.....11
3.2 INSTALLATION.....11
3.3 GLYCOL INSTALLATION.....12
3.4 CONNECTIONS.....12
3.5 FIELD QUALITY CONTROL.....13
3.6 DEMONSTRATION.....15

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 15 Section "Mechanical General Requirements."
 - 2. Division 15 Section "Basic Mechanical Materials and Methods."
 - 3. Division 15 Section "Piping Systems Flushing and Chemical Cleaning."

1.2 DEFINITIONS

- A. CPVC: Chlorinated Polyvinyl Chloride.
- B. EEPROM: Electrically erasable, programmable read-only memory.

- C. EPDM: Ethylene-propylene-diene monomer.
- D. FMP: Fluoroelastomer.
- E. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- F. MDA: Michigan Department of Agriculture.
- G. RO: Reverse osmosis.
- H. TDS: Total dissolved solids.
- I. PTFE: Polytetrafluoroethylene.
- J. UV: Ultraviolet.

1.3 PERFORMANCE REQUIREMENTS

- A. Furnish the services of a firm specializing in hydronic piping system water treatment work.
 - 1. This firm shall furnish and administer glycol for systems using glycol/water mix.
- B. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.
- C. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
- D. Closed hydronic systems, including hot-water heating with non-aluminum boilers and chilled water, shall have the following water qualities:
 - 1. pH: Maintain a value within 9.0 to 10.5.
 - 2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
 - 3. Boron: Maintain a value within 100 to 200 ppm.
 - 4. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.

5. Soluble Copper: Maintain a maximum value of 0.20
Insert number ppm.
6. TDS: Maintain a maximum value of 5000 mmhos.
7. Free Caustic Alkalinity: Maintain a maximum value of
20 ppm.
8. Microbiological Limits:
 - a. Total Aerobic Plate Count: Maintain a maximum
value of 1000 organisms/ml.
 - b. Total Anaerobic Plate Count: Maintain a maximum
value of 100 organisms/ml.
 - c. Ammonia: Maintain a maximum value of 20 ppm.
 - d. Nitrate Reducers: Maintain a maximum value of 100
organisms/ml.
 - e. Sulfate Reducers: Maintain a maximum value of 0
organisms/ml.
 - f. Iron Bacteria: Maintain a maximum value of 0
organisms/ml.

1.4 SUBMITTALS

- A. Product Data: Include rated capacities, operating
characteristics, furnished specialties, and accessories
for the following products:
 1. Bypass feeders.
 2. Water meters.
 3. Inhibitor injection timers.
 4. pH controllers.
 5. TDS controllers.
 6. Biocide feeder timers.
 7. Chemical solution tanks.
 8. Injection pumps.
 9. Ozone generators.
 10. UV-irradiation units.
 11. Chemical test equipment.
 12. Chemical material safety data sheets.
 13. Water softeners.
 14. RO units.
- B. Shop Drawings: Pretreatment and chemical treatment
equipment showing tanks, maintenance space required, and
piping connections to HVAC systems. Include plans,
elevations, sections, details, and attachments to other
work.
 1. Wiring Diagrams: Power and control wiring.
- C. Field quality-control test reports.

- D. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in operation and maintenance manuals.
1. Submit under provisions of Division 15 Section "Mechanical General Requirements" and as supplemented in this Section.
 2. Submit following operation and maintenance data as minimum for purified water system.
 - a. Furnish complete instruction manuals for installation, operation, maintenance, and lubrication requirements for each component of mechanical and electrical equipment or system.
 - b. Each instruction manual shall include, but not be limited to, the following:
 - 1) Diagrams and illustrations.
 - 2) Detailed description of the function of each principal component of the system.
 - 3) Performance and nameplate data.
 - 4) Installation instructions.
 - 5) Procedures for starting.
 - 6) Proper adjustment.
 - 7) Test procedures and recording of operation data.
 - 8) Procedures for operating.
 - 9) Shutdown and restart instructions.
 - 10) Emergency operating instructions and trouble-shooting guide.
 - 11) Safety precautions.
 - 12) Maintenance and overhaul instructions which shall include detailed assembly drawings with part numbers, recommended spare parts list, instructions for ordering spare parts (including suppliers names), and complete preventive maintenance instructions required to ensure satisfactory performance and longevity of the equipment.
 - 13) Lubrication instructions, which shall list points to be greased or oiled, shall recommend type, grade, and temperature range of lubricants, and shall recommend frequency of lubrication.
 - 14) List of electrical relay settings and control and alarm contact settings.
 - 15) Electrical interconnection wiring diagram for equipment furnished, including all control.

- c. Manual shall be complete in all respects for all equipment, controls, accessories, and associated appurtenances.
- d. Each O&M Manual shall be transmitted to the Owner's representative and Architect prior to installation of the equipment and all equipment shall be serviced by the manufacturer in accordance with the manufacturer's recommendations prior to operation. A service record shall be maintained on each item of equipment and shall be delivered to the Owner's representative and Architect prior to final acceptance of the project.

E. Other Informational Submittals:

1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" Article above.
2. An analytical review of make-up water characteristics for each treated system operating conditions, including such items as Langlier/Ryzner Indexes. Based on this review, provide a definitive description of treatment system developed to achieve specified objectives and include generic terms to describe product formulation content and function. Detailed proprietary formulation data is not required. However, manufacturer's standard published literature is not usually acceptable.
3. A step-by-step procedure to be followed by the Contractor during flushing, purging, disinfecting, draining, disposal, pretreatment and treatment operations. The intent of the step-by-step procedure is two-fold.
 - a. To assure that all essential permanent provisions to accomplish the above work are included during the course of construction.
 - b. To allow the Owner to accomplish the source procedures as subsequent maintenance operations.

F. Provide OSHA equivalent materials form for hazardous substances.

1.5 QUALITY ASSURANCE

- A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.
- C. Regulatory Requirements: Conform to applicable codes for addition of non-potable chemicals to building mechanical systems, and for delivery to public sewage systems.

1.6 OWNER'S INSTRUCTIONS

- A. Provide a coordinated water treatment training program oriented to the needs common to operating personnel and maintenance personnel and to the needs of maintenance personnel only, sufficiently prior to acceptance of the work, upon mutually satisfactory arrangement with the Architect.
- B. Provide a total of not less than eight "field" hours encompassing mechanical, electrical, chemical, pollution and safety aspects, sufficient for personnel to operate and maintain systems and consistently achieve specified objectives, with subsequently scheduled guidance by the water treatment laboratory.
- C. Water treatment laboratory chemical engineer, complemented by instrument engineer, supplemented by Contractor's staff, shall comprise the training staff.
- D. Training materials shall include "survey," limits control program, shop drawings, operating and maintenance manuals, safe handling of chemicals, chemical testing, use of log sheets and demonstrations of installed and functioning systems.
- E. On completion of the installation of the entire purified water system, conduct a thorough check and test of all components in the system. During this period, instruct the Owner's personnel in the theory, operation, and

maintenance of the system. When this work is finished, start up the system and operate it for as long as necessary to complete two consecutive days of operation at the specified performance levels. During this period, continue to instruct the Owner's personnel.

1.7 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion, scale formation, and biological growth for cooling, chilled-water piping heating, hot-water piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion, and shall include the following:

1. Provide piping/plumbing recommendation to optimize chemical program results.
2. Initial water analysis and HVAC water-treatment recommendations.
3. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
4. Quarterly field service and consultation.
5. Customer report charts and log sheets.
6. Laboratory technical analysis.
7. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

B. Glycol manufacturer shall provide testing services every six months of samples submitted by the Owner. Fluid shall be tested at no charge for: glycol percent, pH, reserve alkalinity, dissolved metals, magnesium, calcium, chlorides, acidity, and inhibitor components. Testing service shall be for the life of the fluid.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers/Suppliers: Unless otherwise specified, and subject to compliance with requirements, provide products by one of the following:

1. Base Bid Manufacturer:
 - a. Chemtex Corporation, (Glenn Martin, 248-880-4547).
2. Alternate Manufacturers:

- a. Ashland Specialty Chemical Company; Drew Industrial Div.
- b. Eldon Water (Patrick Racine, Christa Blades, or Pierre Beausoleil, 888-712-4000).
- c. Enerco Corporation (Doug White 517-627-8444 or 800-292-5908).
- d. GE Power & Water; Water & Process Technologies.
- e. Mitco Custom Water Treatment (Gordon Chapin, 800-516-2175).
- f. Nalco, an Ecolab Company (734-751-2387).
- g. H-O-H Chemicals, Inc.(H.V. Burton Co., 734-261-4220)

2.2 CHEMICAL FEED PIPE AND FITTINGS

A. CPVC Piping:

1. CPVC Schedule 80 Pipe: ASTM F 441/ F 441M.
2. CPVC Schedule 80 Fittings: ASTM F 439, socket type or ASTM F 437, threaded type.
3. Isolation Valves: Three-piece true union style ball valve constructed of CPVC with TFE seats, and FPM or EPDM o-ring seals.

B. Stainless-Steel Pipes And Fittings:

1. Stainless-Steel Tubing: Comply with ASTM A 269, Type 316.
2. Stainless-Steel Fittings: Complying with ASTM A 815/A 815M, Type 316, Grade WP-S.
3. Two-Piece, Full-Port, Stainless-Steel Ball Valves: ASTM A 351, Type 316 stainless-steel body; ASTM A 276, Type 316 stainless-steel stem and vented ball, carbon-filled TFE seats, threaded body design with adjustable stem packing, threaded ends, and 250-psig SWP and 600-psig CWP ratings.

2.3 CHEMICAL TREATMENT TEST EQUIPMENT

- ### A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounting cabinet for testing pH, TDS, inhibitor, chloride, alkalinity, and hardness; sulfite and testable polymer tests for high-pressure boilers, and oxidizing biocide test for open cooling systems.

B. Sample Cooler:

1. Tube: Sample.
 - a. Size: NPS 1/4 tubing.
 - b. Material: ASTM A 666, Type 316 stainless steel.

- c. Pressure Rating: Minimum 2000 psig.
- d. Temperature Rating: Minimum 850 deg F.
- 2. Shell: Cooling water.
 - a. Material: ASTM A 666, Type 304 stainless steel.
 - b. Pressure Rating: Minimum 250 psig.
 - c. Temperature Rating: Minimum 450 deg F.
- 3. Capacities and Characteristics:
 - a. Tube: Sample.
 - 1) Flow Rate: 0.25 gpm.
 - 2) Entering Temperature: 400 deg F.
 - 3) Leaving Temperature: 88 deg F.
 - 4) Pressure Loss: 6.5 psig.
 - b. Shell: Cooling water.
 - 1) Flow Rate: 3 gpm.
 - 2) Entering Temperature: 70 deg F.
 - 3) Pressure Loss: 1.0 psig.

- C. Corrosion Test-Coupon Assembly (Corrosion Racks):
Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.
 - 1. Two-station rack for closed-loop systems.
 - 2. Four-station rack for open systems.
 - 3. Include 1-inch diameter, chemical resistant acrylic flowmeter suitable for 1 to 20 gpm at exit of coupon rack.

2.4 CHEMICALS

- A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment, and that can attain water quality specified in Part 1 "Performance Requirements" Article.
- B. Water Softener Chemicals:
 - 1. Mineral: High-capacity, sulfonated-polystyrene ion-exchange resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock. Resin exchange capacity minimum 30,000 grains/cu. ft. of calcium carbonate of resin when regenerated with 15 lb of salt.
 - 2. Salt for Brine Tanks: High-purity sodium chloride, free of dirt and foreign material. Rock and granulated forms are not acceptable.

- C. Inhibited Ethylene Glycol: Industrially inhibited ethylene glycol, easily analyzed for glycol concentration and inhibitor level, and easily re-inhibited using replacement inhibitor readily available from fluid manufacturer. Premix inhibited glycol solution and deionized water to specified concentration. Automotive anti-freeze is unacceptable. Premixed solution shall be supplied in 55 gallon drums complete with manual transfer pumps.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Dow Chemical; Dowtherm SR-1.
 - b. Eldon Water.
 - c. Houghton Chemical Corporation.
 - d. Interstate Chemical Company; Intercool OP100.
 - e. Nalco, an Ecolab Company.
 - f. PVS-Nolwood Chemicals, Inc.; Chill EGHD.
- A. Inhibited Propylene Glycol: Single nationally marketed brand of propylene glycol, inhibited for industrial applications, and readily available in bulk quantities from a firm offering free testing and advisory service to bulk users as to inhibitor replenishment needs. Premix inhibited glycol solution and deionized water to specified concentration. Automotive anti-freeze is unacceptable. Premixed solution shall be supplied in 55 gallon drums complete with manual transfer pumps.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Dow Chemical; Dowfrost HD.
 - b. Eldon Water.
 - c. Houghton Chemical Corporation.
 - d. Interstate Chemical Company; Intercool P300.
 - e. Nalco, an Ecolab Company.
 - f. PVS-Nolwood Chemicals, Inc.; Chill PGHD.
- B. For Aluminum Boilers: Use one of the following:
1. Uninhibited Virgin Propylene Glycol: Single nationally marketed brand of propylene glycol readily available in bulk quantities from a firm offering free testing and advisory service to bulk users. Premix glycol solution and deionized water to specified concentration and add multi-metal corrosion inhibitor as recommended by boiler manufacturer. Automotive anti-freeze is unacceptable.

- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Dow Chemical.
 - 2) Eldon Water.
 - 3) Interstate Chemical Company.
 - 4) Nalco, an Ecolab Company.
 - 5) PVS-Nolwood Chemicals, Inc.
2. Multi-Metal Corrosion Inhibitor and Dispersant: Neutral pH formulation designed to provide corrosion inhibition of ferrous, stainless, copper, and aluminum alloys in closed recirculating water systems, and also containing polymeric dispersants and sequestrants to aid in maintaining clean internal surfaces.
 - a. Dispersant Package: Quadpolymer/phosphonate blend.
 - b. Molybdenum Tracer: For ease of testing and control.
 - c. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Fernox USA.
 - 2) H-O-H Water Technology, Inc.
 - 3) Rhomar Water Management, Inc.; Pro-Tek AL.
 - 4) Sentinel Performance Solutions Ltd.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

- A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

- A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.
- B. Install water testing equipment on wall near water chemical application equipment.
- C. Install meters and equipment requiring service at a maximum 60 inches above finished floor.

- D. Install interconnecting control wiring for chemical treatment controls and sensors.
- E. Mount sensors and injectors in piping circuits.
- F. Bypass Feeders: Install in closed hydronic systems, including hot-water heating, and equipped with the following:
 - 1. Install bypass feeder in a bypass circuit on main header having pressure differential greater than or equal to 20 psig, unless otherwise indicated on Drawings.
 - 2. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
 - 3. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.
 - 4. Install a swing check on inlet after the isolation valve.
- G. Install glycol feed system in accordance with manufacturers instructions.

3.3 GLYCOL INSTALLATION

- A. Clean and flush glycol system before adding premixed glycol solution.
- B. Fill systems indicated to have antifreeze or glycol solutions with the following premixed concentrations. Batch feeding of glycol is prohibited.
 - 1. Hot-Water Heating Piping: Minimum 30 percent propylene glycol.
 - 2. Chilled-Water Piping: Minimum 30 percent propylene glycol.
- C. Perform tests determining strength of glycol and water solution and submit written test results.

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

- C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- D. Install make-up water meters where indicated on the drawings.
- E. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Division 15 Section "Valves."
- F. Refer to Division 15 Section "Domestic Water Piping Specialties" for backflow preventers required in makeup water connections to potable-water systems.
- G. Confirm applicable electrical requirements in Division 16 Sections for connecting electrical equipment.
- H. Ground equipment according to Division 16 Section "Grounding and Bonding."
- I. Connect wiring according to Division 16 Section "Conductors and Cables."

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Tests and Inspections:
 - 1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
 - 2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
 - 3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
 - 4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.

5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
 7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
 8. Repair leaks and defects with new materials and retest piping until no leaks exist.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Sample boiler water at one-week intervals after boiler startup for a period of five weeks, and prepare test report advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" Article for each required characteristic. Sample boiler water at four -week intervals following the testing noted above to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section.
- E. At four -week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" Article.
- F. Comply with ASTM D 3370 and with the following standards:
1. Silica: ASTM D 859.
 2. Steam System: ASTM D 1066.
 3. Acidity and Alkalinity: ASTM D 1067.
 4. Iron: ASTM D 1068.
 5. Water Hardness: ASTM D 1126.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment. Refer to Division 15 Section "Mechanical General Requirements."

END OF SECTION 15189

SECTION 15410 - PLUMBING FIXTURES

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 DEFINITIONS.....2
1.3 SUBMITTALS.....3
1.4 QUALITY ASSURANCE.....3

PART 2 - PRODUCTS.....4
2.1 WATER CLOSETS.....4
2.2 WATER CLOSET FLUSHOMETERS.....4
2.3 URINALS.....4
2.4 URINAL FLUSHOMETERS.....4
2.5 TOILET SEATS.....4
2.6 LAVATORIES.....4
2.7 LAVATORY FAUCETS.....4
2.8 COUNTER-MOUNTING SINKS.....4
2.9 SERVICE SINKS.....5
2.10 SINK FAUCETS5
2.11 WASH FOUNTAINS5
2.12 SHOWER FAUCETS5
2.13 FIXTURE SUPPLIES5
2.14 PROTECTIVE SHIELDING GUARDS5
2.15 FIXTURE SUPPORTS6
2.16 DISPOSERS7

PART 3 - EXECUTION.....7
3.1 EXAMINATION.....7
3.2 INSTALLATION.....7
3.3 CONNECTIONS.....9
3.4 FIELD QUALITY CONTROL.....10
3.5 ADJUSTING.....10
3.6 CLEANING.....11
3.7 PROTECTION.....11

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 02 Section "Water Distribution" for exterior plumbing fixtures and hydrants.
 - 2. Division 10 Section "Toilet and Bath Accessories."

3. Division 15 Section "Mechanical General Requirements."
4. Division 15 Section "Basic Mechanical Materials and Methods."
5. Division 15 Section "Drinking Fountains and Water Coolers."
6. Division 15 Section "Domestic Water Piping Specialties" for backflow preventers; individual-fixture, water tempering valves; and specialty fixtures not included in this Section.
7. Division 15 Section "Drainage Piping Specialties" for floor drains, and specialty fixtures not included in this Section.

1.2 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.
- D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.
- E. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.
- F. FRP: Fiberglass-reinforced plastic.
- G. PMMA: Polymethyl methacrylate (acrylic) plastic.
- H. PVC: Polyvinyl chloride plastic.
- I. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.3 SUBMITTALS

- A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Coordination Drawings: Counter cutout templates for mounting of counter-mounted plumbing fixtures.
- D. Operation and Maintenance Data: For plumbing fixtures and trim to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
 - 1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.
- C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.
- D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- E. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.

- F. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," and NSF 372 Drinking Water System Components - Lead Content for potable domestic water piping and components.
- G. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- H. Comply with applicable ANSI, ASME, ASSE, ASTM, ICC, NSF, and UL standards and other requirements specified for plumbing fixtures, trim, fittings, components, and features.

PART 2 - PRODUCTS

2.1 WATER CLOSETS

- A. Refer to Plumbing Fixture Schedule.

2.2 WATER CLOSET FLUSHOMETERS

- A. Refer to Plumbing Fixture Schedule.

2.3 URINALS

- A. Refer to Plumbing Fixture Schedule.

2.4 URINAL FLUSHOMETERS

- A. Refer to Plumbing Fixture Schedule.

2.5 TOILET SEATS

- A. Refer to Plumbing Fixture Schedule.

2.6 LAVATORIES

- A. Refer to Plumbing Fixture Schedule.

2.7 LAVATORY FAUCETS

- A. Refer to Plumbing Fixture Schedule.

2.8 COUNTER-MOUNTING SINKS

- A. Refer to Plumbing Fixture Schedule.

2.9 SERVICE SINKS

- A. Refer to Plumbing Fixture Schedule.

2.10 SINK FAUCETS

- A. Refer to Plumbing Fixture Schedule.

2.11 WASH FOUNTAINS

- A. Refer to Plumbing Fixture Schedule.

2.12 SHOWER FAUCETS

- A. Refer to Plumbing Fixture Schedule.

2.13 FIXTURE SUPPLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. BrassCraft; a Masco Company.
 - 2. McGuire Mfg. Co., Inc.
 - 3. Any of the approved plumbing fixture manufacturers.

- B. Description: Chrome-plated brass, loose-key or screwdriver angle stops with brass stems; rigid, chrome-plated copper risers; and chrome-plated wall flanges.

2.14 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe Covers (PSG-1):
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Engineered Brass Co.
 - b. Insul-Tect Products Co.; a Subsidiary of MVG Molded Products.
 - c. McGuire Manufacturing Co., Inc.
 - d. Plumberex Specialty Products Inc.
 - e. TCI Products; SG-200BV.
 - f. TRUEBRO, Inc.
 - g. Zurn Plumbing Products Group; Z8946-3-NT.
 - 2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

2.15 FIXTURE SUPPORTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Josam Company.
 2. MIFAB Manufacturing Inc.
 3. Smith, Jay R. Mfg. Co.
 4. Tyler Pipe; Wade Div.
 5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
 6. Zurn Plumbing Products Group; Specification Drainage Operation.
- B. Water-Closet Supports:
1. Description: Combination carrier designed for wall-mounting, water-closet-type fixture. Include:
 - a. Single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement.
 - b. Faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture.
 - c. Cast iron nipple and coupling kit.
 - d. Additional extension coupling, faceplate, and feet for installation in wide pipe space.
- C. Urinal Supports:
1. Description: For wall-mounting, urinal-type fixture. Include steel uprights with feet.
 2. Accessible-Fixture Support: Include rectangular steel uprights.
- D. Lavatory Supports:
1. Description: Lavatory carrier with concealed arms and tie rods for wall-mounting, lavatory-type fixture. Include steel uprights with feet.
 2. Accessible-Fixture Support: Include rectangular steel uprights.
- E. Sink Supports:
1. Description: For wall-mounting sink-type fixture. Include steel uprights with feet.
 - a. Type I, sink carrier with exposed arms and tie rods.
 - b. Type II, sink carrier with hanger plate, bear studs, and tie rod.

- c. Type III, sink carrier with hanger plate and exposed arms.

2.16 DISPOSERS

A. Disposers, D-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. In-Sink-Erator; a div. of Emerson Electric Co.
2. Description: Continuous-feed, household type food-waste disposer. Include reset button; wall switch; corrosion-resistant chamber with jam-resistant, cutlery- or stainless-steel grinder or shredder; NPS 1-1/2 outlet; quick-mounting, stainless-steel sink flange; antisplash guard; and combination cover/stopper.
 - a. Motor: 115-V ac, 1725 rpm, 3/4 hp with overload protection.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.
- B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
 1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
 2. Use carrier supports without waste fitting for fixtures with tubular waste piping.

3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.
- D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
- E. Install wall-mounting fixtures with tubular waste piping attached to supports.
- F. Install counter-mounting fixtures in and attached to casework.
- G. Install fixtures level and plumb according to roughing-in drawings. Install accessible fixtures at heights required by local codes.
- H. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
 1. Exception: Fixtures with flushometer valves, and faucets or valves with integral stops.
- I. Install ASSE 1070 water-temperature limiting devices on supplies for lavatories and sinks that will be used for handwashing, and where specified. Refer to Division 15 Section "Domestic Water Piping Specialties."
- J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
- L. Install protective shielding guards PSG-1 on exposed traps and supplies of lavatories, and sinks used for hand washing.
- M. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.
- N. Install toilet seats on water closets.

- O. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- P. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
- Q. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- R. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- S. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
 - 2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
- T. Install disposer in outlet of each sink indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.
- U. Install dishwasher air-gap fitting at each sink indicated to have air-gap fitting. Connect inlet hose to dishwasher and outlet hose to disposer.
- V. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- W. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 7 Section "Joint Sealants."

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- C. Individual water line branches, waste lines, vents, and traps for connection to individual fixtures, fixture fittings and specialties shall be in accordance with the schedule on the Drawings.
- D. Ground equipment according to Division 16 Section "Grounding and Bonding."
- E. Connect wiring according to Division 16 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
- B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.5 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Operate and adjust disposers. Replace damaged and malfunctioning units.
- C. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.
- D. Replace washers and seals, or cartridges of leaking and dripping faucets and stops.
- E. Install fresh batteries in sensor-operated mechanisms.

3.6 CLEANING

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
 - 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
 - 2. Remove sediment and debris from drains.
- B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 15410

SECTION 15415 - DRINKING FOUNTAINS, WATER COOLERS, AND CUSPIDORS

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 DEFINITIONS.....1
1.3 SUBMITTALS.....2
1.4 QUALITY ASSURANCE.....2

PART 2 - PRODUCTS.....3
2.1 PRESSURE (ELECTRIC) WATER COOLERS.....3
2.2 DRINKING FOUNTAINS.....3
2.3 FIXTURE SUPPORTS.....3

PART 3 - EXECUTION.....4
3.1 EXAMINATION.....4
3.2 APPLICATIONS.....4
3.3 INSTALLATION.....4
3.4 CONNECTIONS.....5
3.5 FIELD QUALITY CONTROL.....5
3.6 ADJUSTING.....5
3.7 CLEANING.....6

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 15 Section "Mechanical General Requirements."
 - 2. Division 15 Section "Basic Mechanical Materials and Methods."

1.2 DEFINITIONS

- A. Accessible Drinking Fountain or Water Cooler: Fixture that can be approached and used by people with disabilities.
- B. Cast Polymer: Dense, cast-filled-polymer plastic.
- C. Drinking Fountain: Fixture with nozzle for delivering stream of water for drinking.

- D. Fitting: Device that controls flow of water into or out of fixture.
- E. Fixture: Drinking fountain or water cooler.
- F. Remote Water Cooler: Electrically powered equipment for generating cooled drinking water.
- G. TDS: Total dissolved solids.
- H. Water Cooler: Electrically powered fixture for generating and delivering cooled drinking water.

1.3 SUBMITTALS

- A. Product Data: For each fixture indicated. Include rated capacities, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For fixtures to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a NRTL acceptable to authorities having jurisdiction, and marked for intended use.
- B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for fixtures for people with disabilities.
- C. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- D. AHRI Standard: Comply with AHRI's "Directory of Certified Drinking Water Coolers" for style classifications.
- E. AHRI Standard: Comply with AHRI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with AHRI's "Directory of Certified

Drinking Water Coolers" for type and style classifications.

- F. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant, unless otherwise indicated.

PART 2 - PRODUCTS

2.1 PRESSURE (ELECTRIC) WATER COOLERS

- A. Refer to Plumbing Fixture Schedule.

2.2 DRINKING FOUNTAINS

- A. Refer to Plumbing Fixture Schedule.

2.3 FIXTURE SUPPORTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Josam Co.
 2. MIFAB Manufacturing, Inc.
 3. Smith, Jay R. Mfg. Co.
 4. Tyler Pipe; Wade Div.
 5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
 6. Zurn Plumbing Products Group; Specification Drainage Operation.
- B. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.
1. Type I: Hanger-type carrier with two vertical uprights.
 2. Type II: Bilevel, hanger-type carrier with three vertical uprights.
 3. Supports for Accessible Fixtures: Include rectangular, vertical, steel uprights instead of steel pipe uprights.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before fixture installation. Verify that sizes and locations of piping and types of supports match those indicated.
- B. Examine walls and floors for suitable conditions where fixtures are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.
- B. Use mounting frames for recessed water coolers, unless otherwise indicated.
- C. Set freestanding and pedestal drinking fountains on floor.
- D. Set remote water coolers on floor, unless otherwise indicated.
- E. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

3.3 INSTALLATION

- A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.
- B. Install mounting frames affixed to building construction and attach recessed water coolers to mounting frames, unless otherwise indicated.
- C. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.
- D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution

pipng. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Division 15 Section "Valves."

- E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- F. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings. Escutcheons are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- G. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 7 Section "Joint Sealants."

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- C. Ground equipment according to Division 16 Section "Grounding and Bonding."
- D. Connect wiring according to Division 16 Section "Conductors and Cables."

3.5 FIELD QUALITY CONTROL

- A. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.
 - 1. Remove and replace malfunctioning units and retest as specified above.
 - 2. Report test results in writing.

3.6 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.

- B. Adjust water cooler temperature settings.

3.7 CLEANING

- A. After completing fixture installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

END OF SECTION 15415

SCROLL WATER CHILLERS

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 DEFINITIONS.....1
1.3 SUBMITTALS.....2
1.4 QUALITY ASSURANCE.....3
1.5 DELIVERY, STORAGE, AND HANDLING.....4
1.6 COORDINATION.....4

PART 2 - PRODUCTS.....4
2.1 PACKAGED AIR-COOLED WATER CHILLERS.....4
2.2 SOURCE QUALITY CONTROL.....10

PART 3 - EXECUTION.....10
3.1 EXAMINATION.....10
3.2 WATER CHILLER INSTALLATION.....10
3.3 CONNECTIONS.....11
3.4 STARTUP SERVICE.....12
3.5 DEMONSTRATION.....12

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections:
 - 1. Division 15 Section "Mechanical General Requirements."
 - 2. Division 15 Section "Basic Mechanical Materials and Methods."
 - 3. Division 15 Section "Hydronic Piping."

1.2 DEFINITIONS

- A. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.
- B. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.

- C. IPLV: Integrated part-load value. A single number part-load efficiency figure of merit calculated per the method defined by AHRI 550/590 and referenced to AHRI standard rating conditions.
- D. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.
- E. NPLV: Nonstandard part-load value. A single number part-load efficiency figure of merit calculated per the method defined by AHRI 550/590 and intended for operating conditions other than the AHRI standard rating conditions.
- F. SCCR: Short circuit current rating.

1.3 SUBMITTALS

- A. Product Data: Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
 - 1. Performance at AHRI standard conditions and at conditions indicated.
 - 2. Performance at AHRI standard unloading conditions.
 - 3. Minimum evaporator flow rate.
 - 4. Refrigerant capacity of water chiller.
 - 5. Oil capacity of water chiller.
 - 6. Fluid capacity of evaporator.
 - 7. Characteristics of safety relief valves.
 - 8. Minimum entering condenser-air temperature
 - 9. Performance at varying capacity with constant design entering condenser-air temperature. Repeat performance at varying capacity for different entering condenser-air temperatures from design to minimum in 10 deg F increments.
- B. Shop Drawings: Complete set of manufacturer's prints of water chiller assemblies, control panels, sections and elevations, and unit isolation. Include the following:
 - 1. Assembled unit dimensions.
 - 2. Weight and load distribution.
 - 3. Required clearances for maintenance and operation.
 - 4. Size and location of piping and wiring connections.
 - 5. Wiring Diagrams: For power, signal, and control wiring.

- C. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Structural supports.
 - 2. Piping roughing-in requirements.
 - 3. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
 - 4. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.
 - D. Certificates: For certification required in "Quality Assurance" Article.
 - E. Source quality-control test reports.
 - F. Startup service reports.
 - G. Operation and Maintenance Data: For each water chiller to include in operation and maintenance manuals.
- 1.4 QUALITY ASSURANCE
- A. AHRI Certification: Certify chiller according to AHRI 590 certification program.
 - B. ASHRAE Compliance:
 - 1. ASHRAE 15 for safety code for mechanical refrigeration.
 - 2. ASHRAE Guideline 3 for refrigerant leaks, recovery, and handling and storage requirements.
 - C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
 - D. ASME Compliance: Fabricate and stamp water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code.
 - E. Comply with NFPA 70.
 - F. Comply with requirements of UL and UL Canada, and include label by an NRTL showing compliance.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Ship water chillers from the factory fully charged with refrigerant and filled with oil.

1.6 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.
- C. Coordinate sizes and locations of roof curbs and rails, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 PACKAGED AIR-COOLED WATER CHILLERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Daikin Applied; a member of Daikin Industries, Ltd.
 - 2. Johnson Controls, Inc.; York Chillers.
 - 3. Trane Inc.; a Division of Ingersoll Rand.
- B. Description: Factory-assembled and run-tested water chiller complete with base and frame, cabinet, compressors, compressor motors and motor controllers, evaporator, condenser coils, condenser fans and motors, electrical power, controls, and accessories.
- C. Cabinet:
 - 1. Base: Galvanized-steel base extending the perimeter of water chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.
 - 2. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported from base.
 - 3. Casing: Galvanized steel.
 - 4. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstanding a 500-hour salt-spray test according to ASTM B 117.
- D. Compressors:

1. Description: Positive-displacement direct drive with hermetically sealed casing.
2. Each compressor provided with suction and discharge service valves, crankcase oil heater, and suction strainer.
3. Operating Speed: Nominal 3600 rpm for 60-Hz applications.
4. Capacity Control: On-off compressor cycling, plus hot-gas bypass on at least one circuit.
5. Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug, and initial oil charge.
6. Vibration Isolation: Mount individual compressors on vibration isolators.

E. Compressor Motors:

1. Hermetically sealed and cooled by refrigerant suction gas.
2. High-torque, two-pole induction type with inherent thermal-overload protection on each phase.

F. Compressor Motor Controllers:

1. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.

G. Refrigeration:

1. Refrigerant: R-410A.
2. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
3. Refrigerant Circuit: Each circuit shall include a thermal-expansion valve or electronic-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.
4. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor discharge line and the refrigerant liquid-line to allow the isolation and storage of the refrigerant charge in the chiller condenser.
5. Minimum Ambient Start and Operation: 35 deg F.
6. Maximum Ambient Operation: 125 deg F.

H. Evaporator:

1. Shell-and-Tube:

- a. Description: Direct-expansion, shell-and-tube design with fluid flowing through the shell and refrigerant flowing through the tubes within the shell.
- b. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
- c. Shell Material: Carbon steel.
- d. Shell Heads: Removable carbon-steel heads with multipass baffles designed to ensure positive oil return and located at each end of the tube bundle.
- e. Shell Nozzles: Fluid nozzles located along the side of the shell and terminated with mechanical-coupling end connections for connection to field piping.
- f. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.
- g. Remote Mounting: Designed for remote field mounting where indicated. Provide kit for field installation.

I. Air-Cooled Condenser:

1. Plate-fin coil with integral subcooling on each circuit, rated at 450 psig.
 - a. Construct coils of copper tubes mechanically bonded to aluminum fins.
 - b. Coat coils with a baked epoxy corrosion-resistant coating after fabrication.
 - c. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.
2. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.
3. Fan Motors: Totally enclosed non-ventilated (TENV) or totally enclosed air over (TEAO) enclosure, with permanently lubricated bearings, and having built-in overcurrent- and thermal-overload protection.
4. Fan Guards: Steel safety guards with corrosion-resistant coating.

J. Electrical:

1. Factory installed and wired, and functionally tested at factory before shipment.
2. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.

3. House in a unit-mounted, NEMA 250, Type 3R enclosure with hinged access door with lock and key or padlock and key.
4. Wiring shall be numbered and color-coded to match wiring diagram.
5. Factory wiring located outside of an enclosure shall be installed in a raceway. Terminal connections shall be made with not more than a 24-inch length of liquidtight or flexible metallic conduit.
6. Field power interface shall be to wire lugs. Minimum SCCR according to UL 508 shall be as required by electrical power distribution system, but not less than 42,000 A.
7. Each motor shall have branch power circuit and controls with one of the following disconnecting means having SCCR to match main disconnecting means:
 - a. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
 - b. NEMA KS 1, heavy-duty, nonfusible switch.
 - c. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
8. Each motor shall have overcurrent protection.
9. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.
10. Phase-Failure and Undervoltage: Solid-state sensing with adjustable settings.
11. Power Factor Correction: Capacitors to correct power factor to 0.90 at full load.
12. Controls Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
13. Control Relays: Auxiliary and adjustable time-delay relays, or an integral to water chiller microprocessor.
14. Service Receptacle:
 - a. Unit-mounted, 120-V GFI duplex receptacle.
 - b. Power receptacle from chiller internal electrical power wiring.
15. Indicate the following for water chiller electrical power supply:
 - a. Current, phase to phase, for all three phases.
 - b. Voltage, phase to phase and phase to neutral for all three phases.

- c. Three-phase real power (kilowatts).
- d. Three-phase reactive power (kilovolt amperes reactive).
- e. Power factor.
- f. Running log of total power versus time (kilowatt hours).
- g. Fault log, with time and date of each.

K. Controls:

- 1. Factory installed and wired, and functionally tested at factory before shipment.
- 2. Stand-alone, microprocessor based.
- 3. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.
- 4. Operator Interface: Keypad or pressure-sensitive touch screen. Multiple-character, backlit, liquid-crystal display or light-emitting diodes. Display the following:
 - a. Date and time.
 - b. Operating or alarm status.
 - c. Operating hours.
 - d. Outside-air temperature if required for chilled-water reset.
 - e. Temperature and pressure of operating set points.
 - f. Entering and leaving temperatures of chilled water.
 - g. Refrigerant pressures in evaporator and condenser.
 - h. Saturation temperature in evaporator and condenser.
 - i. No cooling load condition.
 - j. Elapsed time meter (compressor run status).
 - k. Pump status.
 - l. Antirecycling timer status.
 - m. Percent of maximum motor amperage.
 - n. Current-limit set point.
 - o. Number of compressor starts.
- 5. Control Functions:
 - a. Manual or automatic startup and shutdown time schedule.
 - b. Entering and leaving chilled-water temperatures, control set points, and motor load limit. Chilled-water leaving temperature shall be reset based on return-water temperature.
 - c. Current limit and demand limit.
 - d. External water chiller emergency stop.
 - e. Antirecycling timer.
 - f. Automatic lead-lag switching.

- g. Start and run during a temperature of 35 deg F ambient.
- 6. Manual-Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:
 - a. Low evaporator pressure or high condenser pressure.
 - b. Low chilled-water temperature.
 - c. Refrigerant high pressure.
 - d. High or low oil pressure.
 - e. High oil temperature.
 - f. Loss of chilled-water flow.
 - g. Control device failure.
 - h. Compressor motor current-overload.
 - i. Starter fault.
- 7. Building Automation System Interface: Factory-installed hardware and software to enable building automation system to monitor, control, and display water chiller status and alarms.
 - a. Hardwired Points:
 - 1) Monitoring: On/off status, common trouble alarm.
 - 2) Control: On/off operation, chilled-water discharge temperature set-point adjustment.
 - b. BACNET translator or gateway with building management system shall enable building management system operator to remotely control and monitor the water chiller from an operator workstation. Control features and monitoring points displayed locally at water chiller control panel shall be available through building management system.
- L. Insulation:
 - 1. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type I, for tubular materials and Type II, for sheet materials.
 - 2. Thickness: 3/4 inch.
 - 3. Factory-applied insulation over cold surfaces of water chiller components.
 - a. Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.
 - 4. Apply protective coating to exposed surfaces of insulation.

M. Accessories:

1. Factory-furnished, chilled-water flow switches or differential pressure switches for field installation.
2. Individual compressor suction and discharge pressure readout at the control panel for each refrigeration circuit.
3. Factory-furnished spring isolators for field installation.

N. Capacities and Characteristics:

1. Refer to schedule on Drawings.
2. Noise Rating: 70 dBA at 30 feet when measured according to AHRI 370.

2.2 SOURCE QUALITY CONTROL

- A. Factory test and inspect evaporator according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.
- B. For water chillers located outdoors, rate sound power level according to AHRI 370 procedure.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Before water chiller installation, examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting water chiller performance, maintenance, and operations.
 1. Water chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 WATER CHILLER INSTALLATION

- A. Equipment Mounting: Install water chiller on concrete bases. Concrete bases shall comply with requirements in Division 03. Vibration isolation devices and minimum deflection are specified in Division 15 Section "Mechanical Vibration Controls."

1. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 3. Install anchor bolts to elevations required for proper attachment to supported equipment.
- B. Equipment Mounting: Install water chiller using vibration isolation devices specified in Division 15 Section "Mechanical Vibration Controls."
1. Minimum Deflection: Refer to Division 15 Section "Mechanical Vibration Controls."
- C. Equipment Mounting: Install water chiller on vibration isolation inertia bases. Comply with requirements specified in Division 15 Section "Mechanical Vibration Controls."
- D. Maintain manufacturer's recommended clearances for service and maintenance.
- E. Charge water chiller with refrigerant if not factory charged and fill with oil if not factory installed.
- F. Install and wire separate devices furnished by manufacturer and not factory installed.

3.3 CONNECTIONS

- A. Comply with requirements in Division 15 Section "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Comply with requirements in Division 15 Section "Refrigerant Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- C. Install piping adjacent to chiller to allow service and maintenance.
- D. Evaporator Fluid Connections: Connect to evaporator inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gage. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee

with pressure gage, and drain connection with valve. Make connections to water chiller with a mechanical coupling.

- E. Connect each drain connection with a union and drain pipe and extend pipe, full size of connection, to floor drain. Provide a shutoff valve at each connection if required.

3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.
- C. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
 - 1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
 - 2. Verify that pumps are installed and functional.
 - 3. Verify that thermometers and gages are installed.
 - 4. Operate water chiller for run-in period.
 - 5. Check bearing lubrication and oil levels.
 - 6. Verify that refrigerant pressure relief device for chillers installed indoors is vented outside.
 - 7. Verify proper motor rotation.
 - 8. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.
 - 9. Verify and record performance of chilled-water flow and low-temperature interlocks.
 - 10. Verify and record performance of water chiller protection devices.
 - 11. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
- D. Prepare a written startup report that records results of tests and inspections.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water chillers.

END OF SECTION 15629

SECTION 15730 - UNITARY ROOFTOP AIR CONDITIONERS

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUMMARY.....1
1.3 DEFINITIONS.....2
1.4 SUBMITTALS.....2
1.5 QUALITY ASSURANCE.....2
1.6 COORDINATION.....3

PART 2 - PRODUCTS.....3
2.1 MANUFACTURERS.....3
2.2 UNITARY ROOFTOP AIR CONDITIONERS.....3
2.3 UNITARY ROOFTOP AIR CONDITIONERS (INVERTER COMPRESSOR
UNITS).....6
2.4 MOTORS.....9

PART 3 - EXECUTION.....9
3.1 INSTALLATION.....9
3.2 CONNECTIONS.....9
3.3 FIELD QUALITY CONTROL.....10
3.4 STARTUP SERVICE.....10
3.5 ADJUSTING.....12
3.6 DEMONSTRATION.....12

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 15 Section "Mechanical General Requirements."
 - 2. Division 15 Section "Basic Mechanical Materials and Methods."
 - 3. Division 15 Section "Common Work Results for HVAC" for common mechanical drive requirements for fans and air handling equipment.

1.2 SUMMARY

- A. This Section includes outdoor-mounted unitary air conditioning units smaller than 20 tons.

- B. Products supplied but not installed under this Section:
 - 1. Roof curbs and equipment rails.

1.3 DEFINITIONS

- A. DDC: Direct-digital controls.
- B. BAS: Building Automation System.

1.4 SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
 - 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For rooftop air conditioners to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. AHRI Compliance:
 - 1. Comply with AHRI 210/240 and AHRI 340/360 for testing and rating energy efficiencies for RTUs.
 - 2. Comply with AHRI 270 for testing and rating sound performance for RTUs.
- B. ASHRAE Compliance:
 - 1. Comply with ASHRAE 15 for refrigeration system safety.
 - 2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
- C. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.
- D. UL Compliance: Comply with UL 1995.

- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 COORDINATION

- A. Coordinate size and locations of roof curbs, equipment supports, and roof penetrations. Framing, flashing, and attachment to roof structure are specified under Division 07.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 UNITARY ROOFTOP AIR CONDITIONERS

- A. Manufacturers:
 - 1. Lennox Industries Inc.
 - 2. Johnson Controls Incorporated/YORK; Engineered Systems Group.
 - 3. Carrier Corp.
 - 4. Trane Company; a Division of Ingersoll Rand.
 - 5. Daikin.
- B. Description: Factory assembled and tested; designed for exterior installation; consisting of compressor, condenser coil, direct expansion cooling coil, supply-air fan, condenser coil fan, refrigeration controls, filters, dampers, and temperature controls or interface specified for unit controls.
- C. Maximum Temperature Distribution Across Supply Air Outlet:
 - 1. 10 deg F Heating.
 - 2. 5 deg F Cooling.
- D. Casing: Galvanized-steel single-wall construction with enamel paint finish, hinged access doors with neoprene gaskets for inspection and access to internal parts,

minimum 1/2-inch- thick thermal insulation, knockouts for electrical and piping connections, exterior condensate drain connection, and lifting lugs.

- E. Condensate Drain Pans: Formed sections of galvanized-steel sheet, a minimum of 2 inches deep.
 - 1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
 - 2. Drain Connections: Threaded nipple.
- F. Supply-Air Fan: Forward curved, centrifugal, belt driven with adjustable motor sheaves, grease-lubricated ball bearings, and motor.
- G. Condenser Coil Fan: Propeller type, directly driven by permanently lubricated motor.
- H. Direct Expansion Cooling Coils: Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
- I. Compressor(s): Number as scheduled. Hermetic reciprocating or scroll compressors with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief, and crankcase heater(s).
- J. Refrigeration System:
 - 1. Compressor(s).
 - 2. Condenser coil and fan.
 - 3. Direct expansion cooling coil and supply-air fan.
 - 4. Expansion valves with replaceable thermostatic elements.
 - 5. Check valves.
 - 6. Refrigerant dryers.
 - 7. High-pressure switches.
 - 8. Low-pressure switches.
 - 9. Thermostats for coil freeze-up protection during low-ambient temperature operation or loss of air.
 - 10. Low ambient switch.
 - 11. Brass service valves installed in discharge and liquid lines.
 - 12. Refrigerant: R-407C or R-410A.
 - 13. Compressor Motor Overload Protection: Manual reset.
 - 14. Anti-recycling Timing Device: Prevents compressor restart for five minutes after shutdown.
 - 15. Oil-Pressure Switch: Designed to shut down compressors on low oil pressure.

- K. Filters: 2-inch- thick, fiberglass, pleated, throwaway filters in filter rack.
- L. Heat Exchanger: Aluminized-steel or stainless-steel construction for natural-gas-fired burners. Units utilizing 50 percent or greater outside air must be stainless steel construction. Include the following controls:
 - 1. Redundant single or dual gas valve with manual shutoff.
 - 2. Direct-spark pilot ignition.
 - 3. Electronic flame sensor.
 - 4. Induced-draft blower.
 - 5. Flame rollout switch.
- M. Economizer: Return- and outside-air dampers with neoprene seals, bird screen, and hood.
 - 1. Damper Motor: Fully modulating spring return with adjustable minimum position.
 - 2. Control: Electronic-control system uses return-air and outside-air temperature to adjust mixing dampers.
 - 3. Relief Damper (Horizontal Duct Connections Only): Gravity actuated with bird screen and hood sized for economizer mode.
- N. Power Connection: Provide for single connection of power to unit with unit-mounted and wired disconnect switch accessible from outside unit and control-circuit transformer with built-in circuit breaker.
- O. Unit Controls: Solid-state control board and components contain at least the following features:
 - 1. Supply-air fan control relay.
 - 2. Default control to ensure proper operation after power interruption.
 - 3. Field-adjustable control parameters.
 - 4. Economizer control.
 - 5. Gas valve delay between first- and second-stage firing.
 - 6. Night setback mode (outside air damper lockout relay).
 - 7. Low-refrigerant pressure control.
 - 8. Control interface for BAS communication link.
- P. Thermostat: Wall-mounted, programmable, electronic; with heating setback and cooling setup with seven-day programming; and the following:
 - 1. Touch sensitive keypad.

2. Deg F space temperature readout.
3. LED indicators.
4. Hour/day programming.
5. Manual override capability.
6. Time and operational mode readout.
7. Status indicator.
8. Battery backup.
9. Subbase with manual system switch (on-heat-auto-cool) and fan switch (auto-on).
10. Dirty-filter indication.
11. Refer to M3.1 Rooftop Unit RTU-1 & RTU-2 control diagram for additional thermostat requirements.

Q. Accessories:

1. Cold-Weather Kit: Electric heater maintains temperature in gas burner compartment.
2. Service Outlets: 115-V, ground-fault, circuit-interrupter type. Provided by unit manufacturer, to be wired in field.
3. Dirty-filter switch.
4. Hail guards of steel, painted to match casing.
5. Hot gas reheat coil.

R. Roof Curb: Steel with corrosion-protection coating, gasketing, and factory-installed wood nailer; complying with NRCA standards. Top of curb shall be level and height shall be as scheduled.

2.3 UNITARY ROOFTOP AIR CONDITIONERS (INVERTER COMPRESSOR UNITS)

A. Manufacturers:

1. Daikin McQuay; Rebel.
2. Aeon.

B. Description: Factory assembled and tested; designed for exterior installation; consisting of compressor, condenser coil, direct expansion cooling coil, variable volume supply-air fan, variable volume exhaust fan, condenser coil fan, refrigeration controls, filters, dampers, and temperature controls or interface specified for unit controls.

C. Maximum Temperature Distribution Across Supply Air Outlet:

1. 10 deg F Heating.
2. 5 deg F Cooling.

- D. Casing: Galvanized-steel double-wall construction with enamel paint finish, hinged access doors with neoprene gaskets for inspection and access to internal parts, minimum 1/2-inch-thick thermal insulation, knockouts for electrical and piping connections, exterior condensate drain connection, and lifting lugs.
- E. Condensate Drain Pans: Formed sections of stainless steel, a minimum of 2 inches deep.
 - 1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
 - 2. Drain Connections: Threaded nipple.
- F. Supply and Exhaust-Air Fans: Variable speed airfoil (SWSI), aluminum, class II, direct drive, and motor.
- G. Condenser Coil Fan: Propeller type, directly driven by permanently lubricated motor.
- H. Direct Expansion Cooling Coils: Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
- I. Compressor(s): Number as scheduled. Inverter scroll, with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief, and crankcase heater(s). Digital scroll compressors are not acceptable.
- J. Refrigeration System:
 - 1. Compressor(s).
 - 2. Condenser coil and fan.
 - 3. Direct expansion cooling coil and supply-air fan.
 - 4. Expansion valves with replaceable thermostatic elements.
 - 5. Check valves.
 - 6. Refrigerant dryers.
 - 7. High-pressure switches.
 - 8. Low-pressure switches.
 - 9. Thermostats for coil freeze-up protection during low-ambient temperature operation or loss of air.
 - 10. Low ambient switch.
 - 11. Brass service valves installed in discharge and liquid lines.
 - 12. Refrigerant: R-410A.
 - 13. Compressor Motor Overload Protection: Manual reset.

14. Anti-recycling Timing Device: Prevents compressor restart for five minutes after shutdown.
 15. Oil-Pressure Switch: Designed to shut down compressors on low oil pressure.
- K. Filters: 2-inch- thick, fiberglass, pleated, MERV-8 filters in filter rack.
- L. Heat Exchanger: Aluminized-steel or stainless-steel construction for natural-gas-fired burners. Units utilizing 50 percent or greater outside air must be stainless steel construction. Include the following controls:
1. Redundant dual gas valve with manual shutoff.
 2. Direct-spark pilot ignition.
 3. Electronic flame sensor.
 4. Induced-draft blower.
 5. Flame rollout switch.
- M. Economizer: Return- and outside-air dampers with neoprene seals, bird screen, and hood.
1. Damper Motor: Fully modulating spring return with adjustable minimum position.
 2. Control: Electronic-control system uses return-air and outside-air temperature to adjust mixing dampers.
 3. Relief Damper: Gravity actuated with bird screen and hood.
- N. Power Connection: Provide for single connection of power to unit with unit-mounted and wired disconnect switch accessible from outside unit and control-circuit transformer with built-in circuit breaker.
- O. Control devices and operational sequences are specified in Division 15 Section "Temperature Controls" and indicated on "Sequence of Operation" on the Drawings.
- P. Accessories:
1. Service Outlets: 115-V, ground-fault, circuit-interrupter type. Provided by unit.
 2. Dirty-filter switch.
 3. Hail guards of steel, painted to match casing.
 4. Power Exhaust Fan with static pressure transmitter. Fan shall be controlled off building pressure.
 5. Hot gas reheat coil.

- Q. Isolation Curb: Refer to Division 15 Section "Mechanical Vibration Controls."

2.4 MOTORS

- A. Comply with requirements in Division 15 Section "Motors."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Hoist, transport, and rig air conditioning units or their shipping sections into position following procedures recommended by the manufacturer.
- B. Install units level and plumb, maintaining manufacturer's recommended clearances. Install according to AHRI Guideline B.
- C. Deliver roof curbs and equipment supports to site for installation under Division 07. Install rooftop air conditioners on equipment curbs and supports specified and as scheduled. Secure units to curb support with anchor bolts.

3.2 CONNECTIONS

- A. Duct installation requirements are specified in other Division 15 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
 1. Install ducts to termination in roof curb.
 2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
 3. Connect supply ducts to rooftop unit with flexible duct connectors specified in Division 15 Section "Duct Accessories."
 4. Terminate return-air duct through roof structure and insulate space between roof and bottom of unit with 2-inch-thick, acoustic duct liner.
- B. Electrical System Connections: Comply with applicable requirements in Division 16 Sections for power wiring, switches, and motor controls.
- C. Ground equipment according to Division 16 Section "Grounding and Bonding."

- D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.
- B. Perform the following field quality-control tests and inspections and prepare test reports:
 - 1. After installing rooftop air conditioners and after electrical circuitry has been energized, test units for compliance with requirements.
 - 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Repair malfunctioning units and retest as specified above; or remove malfunctioning units, replace with new units and retest as specified.

3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Complete installation and startup checks according to manufacturer's written instructions and do the following:
 - 1. Inspect for visible damage to unit casing.
 - 2. Inspect for visible damage to compressor, air-cooled outside coil, and fans.
 - 3. Inspect internal insulation.
 - 4. Verify that labels are clearly visible.
 - 5. Verify that clearances have been provided for servicing.
 - 6. Verify that controls are connected and operable.
 - 7. Verify that filters are installed.
 - 8. Clean outside coil and inspect for construction debris.

9. Adjust vibration isolators.
10. Inspect operation of barometric dampers.
11. Lubricate bearings on fan.
12. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
13. Adjust fan belts to proper alignment and tension.
14. Start unit according to manufacturer's written instructions.
 - a. Start refrigeration system in summer only.
 - b. Complete startup sheets and attach copy with Contractor's startup report.
15. Inspect and record performance of interlocks and protective devices; verify sequences.
16. Operate unit for an initial period as recommended or required by manufacturer.
17. Check control interface wiring.
18. Adjust and inspect high-temperature limits.
19. Inspect outside-air dampers for proper stroke and interlock with return-air dampers.
20. Start refrigeration system and measure and record the following:
 - a. Coil leaving-air, dry- and wet-bulb temperatures.
 - b. Coil entering-air, dry- and wet-bulb temperatures.
 - c. Outside-air, dry-bulb temperature.
 - d. Outside-air-coil, discharge-air, dry-bulb temperature.
21. Inspect and verify operation of controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
22. Measure and record the following minimum and maximum airflows.
 - a. Supply-air volume.
 - b. Return-air volume.
 - c. Relief-air volume.
 - d. Outside-air intake volume.
23. Simulate maximum cooling demand and inspect the following:
 - a. Compressor refrigerant suction and hot-gas pressures.
 - b. Short circuiting of air through outside coil or from outside coil to outside-air intake.
24. Record all final adjustment and control settings.
25. After startup and performance testing, change filters, vacuum heat exchanger and cooling and outside coils, lubricate bearings, adjust belt tension, and inspect operation of power vents.

3.5 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain rooftop air conditioners. Refer to Division 15 Section "Mechanical General Requirements."

END OF SECTION 15730

SECTION 15738 - SPLIT-SYSTEM AIR-CONDITIONING UNITS

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUMMARY.....1
1.3 SUBMITTALS.....2
1.4 QUALITY ASSURANCE.....2
1.5 COORDINATION.....2
1.6 EXTRA MATERIALS.....3

PART 2 - PRODUCTS.....3
2.1 MANUFACTURERS.....3
2.2 SINGLE-ZONE DUCTLESS SPLIT SYSTEM AIR CONDITIONER.....3
2.3 ACCESSORIES.....5

PART 3 - EXECUTION.....6
3.1 INSTALLATION.....6
3.2 CONNECTIONS.....7
3.3 FIELD QUALITY CONTROL.....7
3.4 DEMONSTRATION.....7

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 15 Section "Mechanical General Requirements."
 - 2. Division 15 Section "Basic Mechanical Materials and Methods."

1.2 SUMMARY

- A. This Section includes ductless split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components.
- B. Products supplied but not installed under this Section:
 - 1. Roof curbs and equipment rails.

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For split-system air-conditioning units to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.
- C. ASHRAE Compliance:
 - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
- E. Seasonal Energy-Efficiency Ratio (SEER): Minimum 13.

1.5 COORDINATION

- A. Coordinate size and location of concrete or plastic pads for units.
- B. Coordinate delivery and placement of roof curbs, and equipment supports. Installation of roof curbs, equipment supports, and roof penetrations is specified in Division

07 Section "Roof Accessories." Pipe Roof Penetration Enclosures are specified in Division 15 Section "Basic Mechanical Materials and Methods."

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One set of filters for each unit.
 - 2. Infrared remotes where applicable.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Single-Zone Split-System Air-Conditioning Units:
 - a. Airedale North America, Inc.
 - b. Daikin Applied; a member of Daikin Industries, Ltd.; Daikin AC.
 - c. Samsung Electronics.
 - d. LG Electronics, HVAC Division.
 - e. Mitsubishi Electric & Electronics America, Inc.; HVAC Advanced Products Division.
 - f. Sanyo North America Corporation; a member of the Panasonic Group.
 - 2. Roof Curbs and Equipment Rails:
 - a. Pate Company (The).
 - b. Roof Products and Systems Corp.
 - c. ThyCurb; a division of THYBAR Corporation.

2.2 SINGLE-ZONE DUCTLESS SPLIT SYSTEM AIR CONDITIONER

- A. Complete packaged air conditioning unit factory fabricated and tested.
- B. Indoor Evaporator Section: Complete with fan section, motor, washable filter, condensate drain pan, built in factory installed or field installed condensate pump, and direct expansion evaporator section.
- C. Air Cooled Condensing Section: Completely factory piped for single point connection of refrigerant lines. Condensing unit with propeller fan shall be matched to

evaporator section to provide cooling capacity as scheduled on drawings.

- D. Controls: Unit furnished with factory installed microprocessor controls. Provide wireless remote or unit mounted control or wall thermostat, which shall provide selection of all functions and control of room temperature set points. Furnish and install one mounting bracket for each wireless remote control.
- E. Provide complete refrigerant piping circuit (including all piping specialties) sized in accordance with manufacturer's requirements to interconnect evaporator and condenser sections.
- F. Wall-Mounting, Evaporator-Fan Components:
1. Cabinet: With removable panels for servicing, and discharge drain pans with drain connection.
 2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with AHRI 210/240, and with thermal-expansion valve.
 3. Fan: Direct drive, centrifugal fan.
 4. Fan Motors: Comply with requirements in Division 15 Section "Motors."
 - a. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.
 5. Filters: Permanent, cleanable.
- G. Ceiling-Mounting, Evaporator-Fan Components:
1. Cabinet: Enameled steel chassis with removable panels on front and ends, and discharge drain pans with drain connection.
 2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with AHRI 210/240, and with thermal-expansion valve.
 3. Fan: Direct drive, centrifugal fan, with outside air intake, and integral factory or field installed condensate pump.
 4. Fan Motors: Comply with requirements in Division 15 Section "Motors."
 - a. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.
 5. Filters: Permanent, cleanable.

H. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - a. Compressor Type: Reciprocating or Scroll.
 - b. Include refrigerant charge.
 - c. Refrigerant: R-410A.
3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with AHRI 210/240, and with liquid subcooler.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kit: Permits operation down to 0 deg F. Include wind manufacturer's wind baffle accessory.

I. Control equipment is specified in Division 15 Section "Temperature Controls," and sequence of operation is indicated on the Drawings.

J. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:

1. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
2. Fan-speed selection, including auto setting.

K. Automatic-reset timer to prevent rapid/short cycling of compressor.

2.3 ACCESSORIES

A. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized with nitrogen, and sealed; factory-insulated suction line with flared fittings at both ends.

B. Roof Curbs and Equipment Rails:

1. Minimum 18 gage welded galvanized steel construction.

2. Integral base flange or plate.
 3. Built-in fully mitered raised cant with step matching insulation thickness.
 4. Factory installed insect and decay resistant wood nailer.
 5. Top of curb or equipment support shall be level and extend a minimum of 8 inches above the top of the roof insulation.
- C. Automatic Condensate Pump Units (Field Installed)
1. Manufacturers:
 - a. Little Giant Pump Co.; Subsidiary of Tecumseh Products Co.
 - b. Beckett Corporation.
 - c. Hartell Pumps Div.; Milton Roy Co.
 - d. Hydromatic Pump Company; Division of Pentair Pump Group.
 2. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls.
- D. Automatic Condensate Pump Units (Field Installed Above Ceiling Applications)
1. Manufacturers:
 - a. Hartell Pumps Div.; Milton Roy Co.; Model A2-X-1965.
 2. Description: Packaged units with corrosion-resistant pump, dual-voltage thermally protected motor, cast aluminum tank with cover, and automatic controls. Include auxiliary safety switch; junction box wire connections, with 3/4-inch knock out for conduit; and factory- or field-installed check valve.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install grade-mounting, compressor-condenser components on 2-inch thick reinforced precast concrete, or plastic pad; extending 2 inches beyond unit perimeter.

- D. Deliver roof curbs and equipment support to site for installation under Division 07. Install roof-mounting compressor-condenser components on equipment supports specified. Anchor units to supports with removable, cadmium-plated fasteners. Install wind baffle according to manufacturer's installation instructions.
- E. Install and connect refrigerant tubing to components. Install tubing to allow access to unit. Evacuate and charge with refrigerant in accordance with manufacturers instructions.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to unit to allow service and maintenance.
- C. Electrical Connections: Comply with requirements in Division 16 Sections for power wiring, switches, and motor controls.

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace malfunctioning units and retest as specified above.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 15738

SECTION 15761 - HEATING AND COOLING COILS

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUMMARY.....1
1.3 SUBMITTALS.....1
1.4 QUALITY ASSURANCE.....2
PART 2 - PRODUCTS.....2
2.1 WATER COILS.....2
2.2 REFRIGERANT COILS.....3
2.3 DRAIN PANS.....4
PART 3 - EXECUTION.....4
3.1 EXAMINATION.....4
3.2 INSTALLATION.....5
3.3 CONNECTIONS.....5

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 15 Section "Mechanical General Requirements."
 - 2. Division 15 Section "Basic Mechanical Materials and Methods."
 - 3. Division 15 Sections for coils that are integral to air-handling units.

1.2 SUMMARY

- A. This Section includes duct-mounted heating and cooling coils, and heating and cooling coils that are an integral part of air-handling units.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each

coil. Include rated capacity and pressure drop for each coil.

- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which coil location and ceiling-mounted access panels are shown and coordinated with each other.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASHRAE Compliance:
 - 1. Comply with ASHRAE 15 for refrigeration system safety.
 - 2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.

PART 2 - PRODUCTS

2.1 WATER COILS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Aerofin Corporation.
 - 2. Carrier; a United Technologies Company.
 - 3. Daikin Applied; a member of Daikin Industries, Ltd.
 - 4. JCI/York International.
 - 5. Luvata/Heatcraft Commercial/Industrial Products.
 - 6. Precision Coils; a business of Unison Comfort Technologies.
 - 7. Trane Inc.; a Division of Ingersoll Rand.
- B. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.

- C. Minimum Working-Pressure/Temperature Ratings: 200 psig, 325 deg F.
- D. Source Quality Control: Factory tested to 300 psig.
- E. Tubes: ASTM B 743 copper, minimum 0.020 inch wall thickness, and minimum 0.50 inch diameter.
- F. Fins: Aluminum, minimum 0.010 inch thick.
- G. Headers: Cast iron with cleaning plugs, and drain and air vent tappings or seamless copper tube with brazed joints, prime coated.
- H. Frames, Hot Water Coils: Galvanized-steel channel frame, minimum 0.0625 inch thick for flanged mounting.
- I. Frames, Chilled Water Coils: ASTM A 666, Type 304 stainless steel, minimum 0.0625 inch thick for flanged mounting.

2.2 REFRIGERANT COILS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Aerofin Corporation.
 - 2. Carrier; a United Technologies Company.
 - 3. Daikin Applied; a member of Daikin Industries, Ltd.
 - 4. JCI/York International.
 - 5. Luvata/Heatcraft Commercial/Industrial Products.
 - 6. Precision Coils; a business of Unison Comfort Technologies.
 - 7. Trane Inc.; a Division of Ingersoll Rand.
- B. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.
- C. Minimum Working-Pressure Rating: 300 psig.
- D. Source Quality Control: Factory tested to 450 psig.
- E. Tubes: ASTM B 743 copper, minimum 0.020 inch wall thickness, and minimum 0.50 inch diameter.
- F. Fins: Aluminum, minimum 0.010 inch thick.

- G. Suction and Distributor Piping: ASTM B 88, Type L copper tube with brazed joints.
- H. Frames: ASTM A 666, Type 304 stainless steel, minimum 0.0625 inch thick for slip-in mounting.

2.3 DRAIN PANS

- A. Description: For cooling coils, IAQ compliant formed to slope from all directions to the drain connection as required by ASHRAE 62.
- B. Construction: Minimum 22 gage, Type 304 stainless steel with welded joints, positively sloped a minimum of 1/8 inch per foot, with threaded drain connection at lowest point of pan. Intermediate pans piped to the primary drain pan are required for all stacked cooling coils.
- C. Provide intermediate coils with 3 inch deep pans for each tiered coil bank. Top pan shall extend 6 inches beyond face of coil and bottom pan shall extend not less than 12 inches beyond face of coil. Where more than two panes are used, pan extension shall be proportional.
- D. Supports: Same material as pans.
- E. Pipe pan drain to floor drain. A deep seal trap shall be installed on the drain pipe from the pans.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install coils level and plumb.
- B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."
- C. Laboratory Terminal Unit Hot Water Coils: Caulk and seal frame and all housing tube openings in the field with a non-hardening sealant. Sealant type shall be approved by the coil manufacturer.
- D. Install minimum 22 gage, Type 304 stainless-steel drain pan under each cooling coil.
 - 1. Construct drain pans with connection for drain; insulated.
 - 2. Construct drain pans to extend beyond coil length and width and to connect to condensate trap and drainage.
 - 3. Extend drain pan upstream and downstream from coil face.
 - 4. Extend drain pan under coil headers and exposed supply piping.
- E. Install moisture eliminators for cooling coils. Extend drain pan under moisture eliminator.
- F. Straighten bent fins on air coils.
- G. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to coils to allow service and maintenance.
- C. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Control valves are specified in Division 15 Section

"Temperature Controls," and other piping specialties are specified in Division 15 Section "Hydronic Piping."

- D. Connect refrigerant piping according to Division 15 Section "Refrigerant Piping."

END OF SECTION 15761

SECTION 15764 - CONVECTION HEATING UNITS

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUBMITTALS.....1
1.3 QUALITY ASSURANCE.....2

PART 2 - PRODUCTS.....2
2.1 HOT-WATER OR STEAM FINNED-TUBE RADIATORS (WALL MOUNTED)...2

PART 3 - EXECUTION.....4
3.1 EXAMINATION.....4
3.2 FINNED-TUBE RADIATOR INSTALLATION.....4
3.3 CONNECTIONS.....5
3.4 FIELD QUALITY CONTROL.....5

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 15 Section "Mechanical General Requirements."
 - 2. Division 15 Section "Basic Mechanical Materials and Methods."

1.2 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Plans, elevations, sections, and details.
 - 2. Details of custom-fabricated enclosures indicating dimensions.
 - 3. Location and size of each field connection.

4. Location and arrangement of piping valves and specialties.
 5. Location and arrangement of integral controls.
 6. Enclosure joints, corner pieces, access doors, and other accessories.
 7. Wiring Diagrams: Power, signal, and control wiring.
- C. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
1. Structural members, including wall construction, to which convection units will be attached.
 2. Method of attaching convection units to building structure.
 3. Penetrations of fire-rated wall and floor assemblies.
- D. Color Samples for Initial Selection: For units with factory-applied color finishes.
- E. Color Samples for Verification: For each type of exposed finish required.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For convection heating units to include in emergency, operation, and maintenance manuals.
- 1.3 QUALITY ASSURANCE
- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a NRTL acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 HOT-WATER OR STEAM FINNED-TUBE RADIATORS (WALL MOUNTED)

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Rittling; A Zehnder Group Company.
 2. Sterling Hydronics; a Mestek Company.
 3. Trane.

4. Vulcan Radiator; a Mestek Company.
 - B. Performance Ratings: Rate finned-tube radiators according to Hydronics Institute's "I=B=R Testing and Rating Standard for Finned-Tube (Commercial) Radiation."
 - C. Heating Elements: Copper tubing mechanically expanded into flanged collars of evenly spaced aluminum fins resting on element supports, ends suitable for solder fittings.
 - D. Element Supports: Ball-bearing cradle type to permit longitudinal movement on enclosure brackets.
 - E. Front Panel: Minimum 0.062-inch- thick steel.
 - F. Wall-Mounting Back Panel: Minimum 0.0329-inch- thick steel, full height, with full-length channel support for front panel without exposed fasteners.
 - G. Support Brackets: Locate at maximum 36-inch spacing to support front panel and element.
 - H. Finish: Baked powder coat finish in manufacturer's standard [**custom**] color as selected by Architect.
 - I. Damper: Knob-operated internal damper at enclosure outlet.
 - J. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, minimum size 6 by 7 inches, integral with enclosure.
 - K. Enclosure Style: Sloped top.
 1. Top Outlet Grille: Punched louver; painted to match enclosure.
 2. Top Outlet Grille: Extruded-aluminum linear bar grille; pencil-proof bar spacing.
 - a. Stainless Steel.
 - b. Anodized finish, color as selected by Architect from manufacturer's standard [**custom**] colors.
 - c. Painted to match enclosure.
 3. Enclosure Height: <8 inches.>
 4. Enclosure Depth: <3-15/16 inches.>

- L. Accessories: Filler sections, corners, relay sections, and splice plates all matching the enclosure and grille finishes.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive convection heating units for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for hydronic-piping connections to verify actual locations before convection heating unit installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FINNED-TUBE RADIATOR INSTALLATION

- A. Install units level and plumb.
- B. Install enclosure continuously around corners, using outside and inside corner fittings.
- C. Join sections with splice plates and filler pieces to provide continuous enclosure.
- D. Install access doors for access to valves.
- E. Install enclosure continuously from wall to wall.
- F. Terminate enclosures with manufacturer's end caps, except where enclosures are indicated to extend to adjoining walls.
- G. Install valves within reach of access door provided in enclosure.
- H. Install air-seal gasket between wall and recessing flanges or front cover of fully recessed unit.
- I. Install piping within pedestals for freestanding units.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in Division 15 Section "Hydronic Piping" Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Hot Water Piping: Unless otherwise indicated:
 - 1. Install union and isolation valve on supply-water connection.
 - 2. Install union and calibrated balancing valve or PICCV as indicated on the Drawings on return-water connection.
 - 3. Hydronic specialties are specified in Division 15 Section "Hydronic Piping."
- C. Install control valves as required by Division 15 Section "Temperature Controls."
- D. Install piping adjacent to convection heating units to allow service and maintenance.

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper convection heating unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace convection heating units that do not pass tests and inspections and retest as specified above.

END OF SECTION 15764

SECTION 15768 - CONSOLE STYLE UNIT VENTILATORS

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUMMARY.....2
1.3 DEFINITIONS.....2
1.4 SUBMITTALS.....2
1.5 QUALITY ASSURANCE.....2
1.6 COORDINATION.....3
1.7 EXTRA MATERIALS.....3

PART 2 - PRODUCTS.....3
2.1 MANUFACTURERS.....3
2.2 MANUFACTURED UNITS.....3
2.3 CABINETS.....4
2.4 INDOOR FAN.....5
2.5 DAMPERS.....5
2.6 COILS.....5
2.7 FACTORY HYDRONIC PIPING PACKAGE.....5
2.8 ACCESSORIES.....6
2.9 BASIC UNIT CONTROLS.....6
2.10 CAPACITIES AND CHARACTERISTICS6

PART 3 - EXECUTION.....7
3.1 EXAMINATION.....7
3.2 INSTALLATION.....7
3.3 CONNECTIONS.....7
3.4 FIELD QUALITY CONTROL.....8
3.5 ADJUSTING.....8
3.6 DEMONSTRATION.....8

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 15 Section "Mechanical General Requirements."
 - 2. Division 15 Section "Basic Mechanical Materials and Methods."
 - 3. Division 15 Section "Hydronic Piping."
 - 4. Division 15 Section "Refrigerant Piping."
 - 5. Division 15 Section "Vertical Unit Ventilators."

6. Division 15 Section "Water-to-Air Heat Pumps" for water-source heat-pump-type unit ventilators.

1.2 SUMMARY

- A. This Section includes vertical-discharge, floor-mounted console style unit ventilators and accessories with the following heating and cooling features:
1. Hydronic heating coil.
 2. Hydronic cooling coil.

1.3 DEFINITIONS

- A. BAS: Building automation system.
- B. HGBP: Hot-gas bypass.

1.4 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for each unit type and configuration.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Plans, elevations, sections, and details.
 2. Details of anchorages and attachments to structure and to supported equipment.
 3. Wiring Diagrams: Power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For unit ventilators to include in operation and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

1.5 QUALITY ASSURANCE

- A. Comply with NFPA 70.

- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.6 COORDINATION

- A. Coordinate size and location of wall sleeves for outdoor-air intake and relief dampers.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Unit Ventilator Filters: Furnish spare filter for each filter installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Airedale North America, Inc.; a Modine Company.
 - 2. Daikin Applied; a member of Daikin Industries, Ltd.; AAF-HermanNelson.
 - 3. Trane; a brand of Ingersoll Rand.

2.2 MANUFACTURED UNITS

- A. Factory-packaged and -tested vertical discharge, floor mounting units rated according to AHRI 840, ASHRAE 33, and UL 1995, including finished cabinet, filter, cooling coil, drain pan, supply-air fan and motor in blow- or draw-through configuration, heating coil, welded continuous bar type discharge grille with round edged steel bars and multiple direction discharge. Include 14 inch painted galvanized mesh located beneath discharge grille on blow-through units.

2.3 CABINETS

- A. Insulation: Minimum 1-inch- thick, coated glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
 - 1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84 by a qualified testing agency.
- B. Drain Pans: Insulated stainless steel or corrosion resistant material, formed to slope from all directions to the drain connection as required by ASHRAE 62.1.
- C. Cabinet Frame and Access Panels: Welded-steel frame with removable panels fastened with hex-head tamperproof fasteners.
 - 1. Steel components exposed to moisture shall be hot-dip galvanized after fabrication.
- D. Cabinet Finish: Powder coat or baked enamel, in manufacturer's standard [**custom**] paint color as selected by Architect.
- E. Indoor-Supply-Air Grille: Steel, double deflection, adjustable.
- F. Return-Air Inlet: Front toe space.
- G. End Pockets: For service access to controls, piping connections, and drain pan.
 - 1. Minimum 12 inches wide.
 - 2. Where scheduled on the Drawings furnish additional cabinet extensions or end-pockets.
- H. End Panels: Matching material and finish of unit ventilator.
- I. Outdoor-Air Wall Box: Minimum 0.1265-inch- thick, aluminum, rain-resistant louver and box with integral eliminators and bird screen.
 - 1. Louver Configuration: Horizontal, rain-resistant louver.
 - 2. Louver Material: Aluminum.
 - 3. Bird Screen: 1/2-inch mesh screen on interior side of louver.

4. Decorative Grille: On outside of intake.
5. Finish: Baked enamel, color as selected by Architect from manufacturer's standard colors.

2.4 INDOOR FAN

- A. Fan and Motor Board: Removable.
 1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels; and aluminum, painted-steel, or galvanized-steel fan scrolls.
 2. Fan Shaft and Bearings: Hollow steel shaft with permanently lubricated, resiliently mounted bearings.
 3. Motor: Permanently lubricated, multispeed, permanent split-capacitor type resiliently mounted on motor board. Comply with requirements in Division 15 Section "Motors."
 4. Wiring Termination: Connect motor to chassis wiring with plug connection.

2.5 DAMPERS

- A. Mixing Dampers: Galvanized-steel blades with edge and end seals and nylon bearings; with electric actuator.
- B. Outdoor-Air Dampers: Galvanized-steel blades with edge and end seals and nylon bearings; with electric actuator.

2.6 COILS

- A. Test and rate unit ventilator coils according to ASHRAE 33.
- B. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

2.7 FACTORY HYDRONIC PIPING PACKAGE

- A. Piping: ASTM B 88, Type L copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet. Crossover piping, [NPS 1-1/2] [NPS 2] with shutoff valves.

- B. Control Valves: As specified in Division 15 Section "Temperature Controls" and as indicated on Sequence of Operation Drawings.
- C. Hose Kits: As specified in Division 15 Section "Hydronic Piping." Tag hose kits to equipment designations.

2.8 ACCESSORIES

- A. Subbase: Sheet metal floor-mounting base with leveling screws and black enamel finish.
- B. Insulated false back with gasket seals on wall and outdoor-air plenum.
 - 1. Insulation: Minimum 1-inch-thick, coated glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
 - a. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84 by a qualified testing agency.
- C. Duct flanges for supply-, return-, and outdoor-air connections (where applicable, refer to schedules).
- D. Filters: Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 and all addendums.
 - 1. Glass Fiber Treated with Adhesive: 80 percent arrestance and MERV 5.

2.9 BASIC UNIT CONTROLS

- A. Control devices and operational sequences are specified in Division 15 Section "Temperature Controls," and "Sequence of Operation" on the Drawings.
- B. Electrical Connection: Factory wire motors and controls for a single electrical connection.

2.10 CAPACITIES AND CHARACTERISTICS

- A. Refer to schedule on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive unit ventilators for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before unit ventilator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install unit ventilators to comply with NFPA 90A.
- B. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above finished floor.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
 - 1. Install piping adjacent to machine to allow service and maintenance.
 - 2. Connect piping to unit ventilator factory hydronic piping package. Install piping package if shipped loose.
 - 3. Connect condensate drain to indirect waste.
- B. Connect supply and return ducts to unit ventilators with flexible duct connectors specified in Division 15 Section "Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.
- C. Ground equipment according to Division 16 Section "Grounding and Bonding."
- D. Connect wiring according to Division 16 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.

3.5 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain unit ventilators.

END OF SECTION 15768

SECTION 15770 - VERTICAL UNIT VENTILATORS

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUMMARY.....1
1.3 DEFINITIONS.....2
1.4 SUBMITTALS.....2
1.5 QUALITY ASSURANCE.....2
1.6 WARRANTY.....3
1.7 EXTRA MATERIALS.....3

PART 2 - PRODUCTS.....3
2.1 UNIT VENTILATOR.....3
2.2 BASIC UNIT CONTROLS.....5
2.3 CAPACITIES AND CHARACTERISTICS.....7

PART 3 - EXECUTION.....7
3.1 EXAMINATION.....7
3.2 INSTALLATION.....7
3.3 CONNECTIONS.....7
3.4 FIELD QUALITY CONTROL.....8
3.5 ADJUSTING.....8
3.6 DEMONSTRATION.....9

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 15 Section "Mechanical General Requirements."
 - 2. Division 15 Section "Basic Mechanical Materials and Methods."

1.2 SUMMARY

- A. This Section includes vertical style unit ventilators and accessories with the following heating and cooling features:
 - 1. Hydronic heating coil.
 - 2. Hydronic cooling coil.

1.3 DEFINITIONS

- A. BAS: Building automation system.
- B. DDC: Direct digital controller.

1.4 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for each unit type and configuration.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Plans, elevations, sections, and details.
 - 2. Details of anchorages and attachments to structure and to supported equipment.
 - 3. Wiring Diagrams: Power, signal, and control wiring.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For unit ventilators to include in operation and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
 - 1. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.
- F. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.
- C. Comply with minimum COP/efficiency levels according to ASHRAE/IESNA 90.1.

- D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- E. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Compressor failure.
 - b. Condenser coil leak.
 - 2. Warranty Period: Five years from date of Substantial Completion.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Unit Ventilator Filters: Furnish spare filter for each filter installed.
 - 2. Spare Cooling Chassis: Furnish spare integral cooling chassis for each size unit installed.
 - 3. Spare fan assembly: Furnish spare fan assembly for each size unit installed.

PART 2 - PRODUCTS

2.1 UNIT VENTILATOR

- A. Manufacturers:
 - 1. Airedale North America, Inc.
 - 2. Change' Air Products & Services Ltd.
- B. Unit Casing: Constructed of galvanized sheet steel, braced and reinforced for rigidity, covered with baked dry powder epoxy resin paint in manufacturer's standard color as selected by Architect.

1. Cabinet front containing low level return air grille integral to door front and sound attenuating inlet plenum.
 2. Removable panels or hinged door with spring loaded pins for access to cooling coil, supply and evaporator fan/motor assemblies, electronic controls, filters, and dampers.
 3. Furnish matching outside air back plenum where indicated for field mounting to rear of unit to allow louver installation above existing window sill heights.
 4. Furnish matching blank-off panels where required to conceal back of unit. Coordinate with architectural casework.
 5. Unit shall be fitted with power disconnect switch located on control panel, sized for full load amperage. Switch lockable in off position.
 6. VUV-1 Only: Furnish matching duct shroud to conceal supply duct from unit discharge to above finished ceiling.
- C. Insulation: Minimum 1-inch thick, foil-covered, closed-cell foam complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
- D. Modulating Damper: Spring return type, designed to mix outside air with return air.
1. Capable of permitting 100 percent outside air into the conditioned space, or recycling return air and allowing minimum outside air into the conditioned space.
 2. Fully modulating allowing any mixture of outside air and return air with minimum damper position setting to continuously maintain outside air ventilation requirements dependent on control via the unit's DDC controls.
 3. Blade seals shall overlap for minimum leakage.
- E. Louver Blades: Aluminum, storm-proof, mounted at 45 degree angle in heavy gage extruded aluminum frames.
1. Blade profile and louver size designed to prevent water penetration during full economizer operation.
 2. 1/2 inch mesh bird screen shall be attached to louver frame.

- F. Supply Fan: Double inlet, forward curved, centrifugal fan with integral direct drive motor.
 - 1. Indoor fan assembly: Consisting of two blowers and one common-shafted electronically commutated motor (ECM).
 - a. ECM having a wide range of programmable speed and torque characteristics.
 - b. ECM fully programmable to compensate for wide variety of static pressures as well as lack of maintenance
 - G. Powered Exhaust:
 - 1. Fully modulating from minimum outside air to full economizer prevents over pressurization of the conditioned space.
 - 2. Exhaust/condenser fan integral to the unit.
 - H. Cooling:
 - 1. First stage: Fully modulating economizer.
 - 2. Second stage: Unit mounted chilled water coil.
 - I. Drain Pans: Insulated galvanized steel with plastic liner.
 - J. Filters: Accessible from front of unit and positioned to filter mixed air prior to conditioning. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
 - 1. Pleated Cotton-Polyester Media: 90 percent arrestance and 7 MERV.
 - K. Heating and cooling coils: Factory piped and complete with isolation valves, balance valve, strainer, and manual air vent.
 - L. Furnish unit having factory wired and tested 3-speed motor switch. Unit shall be set to provide design airflow at specified static pressure on medium speed.
 - M. Manufacturer shall factory install DDC based controls as furnished by Temperature Controls Contractor. Refer to Temperature Control Drawings for scope of work.
- 2.2 BASIC UNIT CONTROLS
- A. Control devices are specified in Division 15 Section "HVAC Instrumentation and Controls," and operational sequences are indicated on the Drawings.
 - B. Basic Unit Controls:

1. Control voltage transformer.
 2. Unit-mounted thermostat with the following features.
 - a. Adjustable setpoint.
 - b. Automatic changeover.
 - c. Adjustable deadband.
 - d. Exposed set point.
 - e. Exposed indication.
 - f. Degree F indication.
 3. Unit-mounted temperature sensor.
 4. Unoccupied-period-override push button.
 5. Data entry and access port.
 - a. Input data includes room temperature set points, and occupied and unoccupied periods.
 - b. Output data includes room temperature supply-air temperature, entering-water temperature, operating mode, and status.
- C. DDC Terminal Controller:
1. Safety Controls Operation: Freezestat shall stop fan and close outdoor-air damper if air less than 38 deg F enters coils.
 2. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
 3. Unoccupied Period Override Operation: Two hours.
 4. Heating-Coil Operation:
 - a. Occupied Periods: Modulate control valve to provide heating if room temperature falls below thermostat set point.
 - b. Unoccupied Periods: Start fan and modulate control valve if room temperature falls below setback temperature.
 - c. Switch refrigerant-reversing valve to operate supplemental coil for heating when outdoor temperature is below 25 deg F adjustable.
 5. Outdoor-Air Damper Operation: Open to percent fixed minimum intake as scheduled, and maximum 100 percent of the fan capacity to comply with ASHRAE Cycle II during occupied periods, and close during unoccupied periods. Microprocessor controller shall permit air-side economizer operation when outdoor air is less than 60 deg F adjustable.
 6. Cooling Lockout: During economizer cycle operation, block out cooling.
 7. Controller shall have volatile-memory backup.

- D. BAS Interface Requirements:
 - 1. Interface relay for scheduled operation.
 - 2. Interface relay to provide indication of fault at the central workstation.
 - 3. Provide BACnet or LonWorks interface for central BAS workstation for the following functions:
 - a. Adjust set points.
 - b. Unit ventilator start, stop, and operating status.
 - c. Data inquiry to include outdoor-air damper position, supply- and room-air temperature.
 - d. Occupied and unoccupied schedules.

- E. Electrical Connection: Factory wire motors and controls for a single electrical connection.

2.3 CAPACITIES AND CHARACTERISTICS

- A. Refer to Schedule on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive unit ventilators for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before unit ventilator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install unit ventilators to comply with NFPA 90A.
- B. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above finished floor.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:

1. Install piping adjacent to machine to allow service and maintenance.
2. Connect piping to unit ventilator factory hydronic piping package. Install piping package if shipped loose.
3. Connect condensate drain to indirect waste.

B. Connect supply and return ducts to unit ventilators with flexible duct connectors specified in Division 15 Section "Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.

C. Ground equipment according to Division 16 Section "Grounding and Bonding."

D. Connect wiring according to Division 16 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
3. Record temperatures entering and leaving energy recovery wheel when outdoor-air temperature is a minimum of 15 deg F higher, or 20 deg F lower, than room temperature.

C. Remove and replace malfunctioning units and retest as specified above.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide

up to two visits to Project during other than normal
occupancy hours for this purpose.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain unit ventilators. Refer to Division 15 Section "Mechanical General Requirements."

END OF SECTION 15770

SECTION 15790 - CENTRIFUGAL FAN CABINET UNIT HEATERS (HOT WATER)

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUBMITTALS.....1
1.3 QUALITY ASSURANCE.....2
1.4 EXTRA MATERIALS.....2

PART 2 - PRODUCTS.....3
2.1 MANUFACTURED UNITS.....3
2.2 UNIT CONTROLS.....4

PART 3 - EXECUTION.....4
3.1 EXAMINATION.....4
3.2 INSTALLATION.....5
3.3 CONNECTIONS.....5
3.4 FIELD QUALITY CONTROL.....5
3.5 DEMONSTRATION.....6

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 15 Section "Mechanical General Requirements."
 - 2. Division 15 Section "Basic Mechanical Materials and Methods."

1.2 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Plans, elevations, sections, and details.
 - 2. Location and size of each field connection.
 - 3. Location and arrangement of piping valves and specialties.

4. Location and arrangement of integral controls.
 5. Wiring Diagrams: Power, signal, and control wiring.
- C. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
1. Suspended ceiling components.
 2. Structural members to which cabinet unit heaters will be attached.
 3. Method of attaching hangers to building structure.
 4. Size and location of initial access modules for acoustical tile.
 5. Items penetrating finished ceiling, including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 6. Perimeter moldings for exposed or partially exposed cabinets.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For cabinet unit heaters to include in operation and maintenance manuals.
- 1.3 QUALITY ASSURANCE
- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- 1.4 EXTRA MATERIALS
- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Filters: Furnish spare filter for each filter installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERED UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Daikin Applied; a member of Daikin Industries, Ltd.
 2. Hydro-Air Components Inc.; Rittling.
 3. Modine Manufacturing Co.
 4. Sterling Radiator; a Mestek Company.
 5. Trane; a business of Ingersoll Rand.
 6. Vulcan Radiator; a Mestek Company.
- B. Description: A factory-assembled and -tested unit complying with AHRI 440.
- C. Coil Section Insulation: ASTM C 1071; surfaces exposed to airstream shall have erosion-resistant coating to prevent erosion of glass fibers.
1. Thickness: Minimum 1/2 inch.
 2. Thermal Conductivity (k-Value): 0.26 Btu x in./h x sq. ft. at 75 deg F mean temperature.
 3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
 4. Adhesive: Comply with ASTM C 916 and with NFPA 90A or NFPA 90B.
 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Cabinet: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect.
1. Horizontal Unit, Exposed Bottom Panels: Minimum 0.0528-inch- thick, sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.
 2. Vertical Unit, Exposed Front Panels: Minimum 0.0528-inch- thick, sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
 3. Recessing Flanges for Units That Are Semirecessed or Fully Recessed: Steel, finished to match cabinet.
 4. Control Access Door: Key operated.

5. Base for Surface, Vertical, Wall-Mounting Units: Minimum 0.0528-inch- thick steel, finished to match cabinet, 6 inches high with leveling bolts.
- E. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
 1. Glass Fiber Treated with Adhesive: Throw-away type 80 percent arrestance and 5 MERV.
- F. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.
- G. Fan and Motor Board: Removable.
 1. Fan: Forward curved, double-width centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
 2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 15 Section "Motors."
 3. Wiring Terminations: Connect motor to chassis wiring with plug connection.
- H. Electrical Connection: Factory wire motors and controls for a single field connection.
- I. Capacities and Characteristics: Refer to Schedule on Drawings.

2.2 UNIT CONTROLS

- A. Control devices are specified in Division 15 Section "Temperature Controls," and operational sequences are indicated on the Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive cabinet unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.

- B. Examine roughing-in for piping and electrical connections to verify actual locations before cabinet unit heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install cabinet unit heaters to comply with NFPA 90A.
- B. Suspend cabinet unit heaters from structure with elastomeric hangers. Vibration isolators are specified in Division 15 Section "Mechanical Vibration and Controls."
- C. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.
- D. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect supply and return ducts to cabinet unit heaters with flexible duct connectors specified in Division 15 Section "Duct Accessories."
- D. Comply with safety requirements in UL 1995.
- E. Ground equipment according to Division 16 Section "Grounding and Bonding."
- F. Connect wiring according to Division 16 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-

assembled components and equipment installation, including connections. Report results in writing.

- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters.

END OF SECTION 15790

SECTION 15815 - METAL DUCTS

PART 1 - GENERAL.....	1
1.1 RELATED DOCUMENTS.....	1
1.2 SUMMARY.....	2
1.3 DEFINITIONS.....	2
1.4 SYSTEM DESCRIPTION.....	2
1.5 PERFORMANCE REQUIREMENTS.....	3
1.6 SUBMITTALS.....	3
1.7 QUALITY ASSURANCE.....	4
1.8 COORDINATION.....	4
PART 2 - PRODUCTS.....	5
2.1 MANUFACTURERS.....	5
2.2 SHEET METAL MATERIALS.....	5
2.3 ZERO-CLEARANCE PREFABRICATED RANGE HOOD EXHAUST DUCT.....	6
2.4 DUCT LINER.....	7
2.5 SEALANTS AND GASKETS.....	8
2.6 HANGERS AND SUPPORTS.....	10
2.7 ROOF MOUNTED DUCT SUPPORTS.....	12
2.8 RECTANGULAR DUCT FABRICATION.....	12
2.9 APPLICATION OF LINER IN RECTANGULAR DUCTS.....	13
2.10 ROUND AND FLAT-OVAL DUCT AND FITTING FABRICATION.....	14
2.11 DOUBLE-WALL DUCT AND FITTING FABRICATION.....	18
PART 3 - EXECUTION.....	19
3.1 DUCTWORK APPLICATION SCHEDULE.....	19
3.2 DUCTWORK APPLICATION SCHEDULE.....	19
3.3 DUCT INSTALLATION.....	19
3.4 INSTALLATION OF EXPOSED DUCTWORK.....	21
3.5 RANGE HOOD EXHAUST DUCTS, SPECIAL INSTALLATION REQUIREMENTS.....	21
3.6 DUCT SEALING.....	22
3.7 HANGING AND SUPPORTING.....	22
3.8 CONNECTIONS.....	23
3.9 PAINTING.....	23
3.10 FIELD QUALITY CONTROL.....	23
3.11 START UP.....	23

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

- B. Related Sections include the following:
1. Division 15 Section "Mechanical General Requirements."
 2. Division 15 Section "Nonmetal Ducts" for fabric ducts, fibrous-glass ducts, thermoset FRP ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
 3. Division 15 Section "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
 4. Division 15 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 SUMMARY

- A. This Section includes metal ducts for supply, return, outside, relief air, and exhaust air-distribution systems in pressure classes from minus 6- to plus 6-inch wg.

1.3 DEFINITIONS

- A. Duct Sizes: Inside clear dimensions. For lined ducts, maintain sizes inside lining.
- B. Low Pressure: Up to 2 inch WG and velocities less than 1,500 fpm. Construct for 2 inch WG positive or negative static pressure.
- C. Medium Pressure: Greater than 2 inch WG to 6 inch WG and velocities greater than 1,500 fpm and less than 2,500 fpm. Construct for 6 inch WG positive or negative static pressure.
- D. High Pressure: Greater than 6 inch WG to 12 inch WG and velocities greater than 2,500 fpm. Construct for 12 inch WG positive or negative static pressure.
- E. FRP: Fiberglass-reinforced plastic.
- F. PVC: Polyvinyl Chloride.

1.4 SYSTEM DESCRIPTION

- A. Duct system design, as indicated, has been used to select size and type of air-moving and -distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by Architect. Accompany requests for layout modifications with calculations showing that proposed

layout will provide original design results without increasing system total pressure.

1.5 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Application Schedule" Article.

1.6 SUBMITTALS

- A. Shop Drawings: CAD-generated and drawn to 1/8 inch equals 1 foot scale. Show fabrication and installation details for metal ducts. Shop drawings shall be reviewed and approved by the Architect prior to any fabrication.
1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 2. Duct layout indicating sizes and pressure classes.
 3. Elevations of top and bottom of ducts.
 4. Dimensions of main duct runs from building grid lines.
 5. Fittings.
 6. Reinforcement and spacing.
 7. Seam and joint construction.
 8. Penetrations through fire-rated and other partitions.
 9. Equipment installation based on equipment being used on Project.
 10. Duct accessories, including access doors and panels.
 11. Hangers and supports, including methods for duct and building attachment, vibration isolation.
- B. Delegated-Design Submittal:
1. Sheet metal thicknesses.
 2. Joint and seam construction and sealing.
 3. Reinforcement details and spacing.
 4. Materials, fabrication, assembly, and spacing of hangers and supports.
- C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
1. Ceiling suspension assembly members.
 2. Other systems installed in same space as ducts.

3. Ceiling- and wall-mounting access doors and panels required to provide access to dampers and other operating devices.
4. Ceiling-mounting items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

D. Welding certificates.

E. Field quality-control test reports.

1.7 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. NFPA Compliance:

1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

C. Comply with NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operations," Ch. 3, "Duct System," for range hood ducts, unless otherwise indicated.

1.8 COORDINATION

A. Sheet metal trades shall cooperate fully with the Laboratory Airflow Controls Trades and shall attend all field installation training sessions.

B. Sheet metal trades shall cooperate fully with the Test and Balance Contractor and provide all miscellaneous caps and any other materials required for structural integrity and leakage testing of the complete duct system in whole or in part. Refer to Division 15 Section "Testing, Adjusting and Balancing."

1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

- C. Sheet metal trades shall participate in the above ceiling coordination program. Refer to Division 01 requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SHEET METAL MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
- C. PVC-Coated Galvanized Steel: Acceptable by authorities having jurisdiction for use in fabricating ducts with UL 181, Class 1 listing. Lock-forming-quality, galvanized sheet steel complying with ASTM A 653/A 653M and having G60 coating designation. Factory-applied PVC coatings shall be 4 mils thick on exterior sheet metal surfaces of ducts and fittings exposed to corrosive conditions and minimum 1 mil thick on interior surfaces.
- D. PVC-Coated Galvanized Steel: Acceptable by authorities having jurisdiction for use in fabricating ducts with UL 181, Class 1 listing. Lock-forming-quality, galvanized sheet steel complying with ASTM A 653/A 653M and having G60 coating designation. Factory-applied PVC coatings shall be 4 mils thick on sheet metal surfaces of ducts and fittings exposed to corrosive conditions and 4 mils thick on opposite surfaces.

- E. PVC-Coated Galvanized Steel: Acceptable by authorities having jurisdiction for use in fabricating ducts with UL 181, Class 1 listing. Lock-forming-quality, galvanized sheet steel complying with ASTM A 653/A 653M and having G60 coating designation. Factory-applied PVC coatings shall be 4 mils thick on interior sheet metal surfaces of ducts and fittings exposed to corrosive conditions and minimum 1 mil thick on exterior surfaces.
- F. Carbon-Steel Sheets: ASTM A 366/A 366M, cold-rolled sheets; commercial quality; with oiled, matte finish for exposed ducts.
- G. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- H. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.
- I. Tie Rods: For rectangular ducts having a side dimension of 48 inches or greater. Galvanized steel, 3/8-inch minimum diameter.

2.3 ZERO-CLEARANCE PREFABRICATED RANGE HOOD EXHAUST DUCT

- A. Manufacturers:
 - 1. AMPCO; American Metal Products; Model IVSI-4ZC.
 - 2. Metal-Fab Inc.; Model IPIC-3G/4G.
 - 3. Schebler Chimney Systems; FyreGuard.
 - 4. Selkirk Inc.; Selkirk Metalbestos; ZeroClear Z3.
- B. Description: Factory-fabricated, -listed, and -labeled, double-wall ducts tested according to UL 1978 and rated for 500 deg F continuously, or 2000 deg F for 30 minutes; with positive or negative duct pressure and complying with NFPA 211, and suitable for zero-clearance installations.
- C. Construction: Inner shell and outer jacket separated by a 3-inch to 4-inch annular space filled with high-temperature, ceramic-fiber insulation.
 - 1. Inner Shell: ASTM A 666, Type 304 stainless steel.
 - 2. Outer Jacket: Aluminized steel indoors and Type 304 stainless steel outdoors. Seams shall be fully welded.

- D. Gaskets and Flanges: Ensure that gaskets and sealing materials are rated at 1500 deg F minimum.
- E. Hood Connectors: Constructed from same material as grease duct with internal or external continuously welded or brazed joints.
- F. Accessories: Tees, elbows, increasers, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly. Include unique components required to comply with NFPA 96 including cleanouts, transitions, adapters, and drain fittings.
 - 1. Termination: Suitable for connection to kitchen exhaust fan.
- G. Grease Duct Supports: Construct duct bracing and supports from non-combustible material.
 - 1. Design bracing and supports to carry static and seismic loads within stress limitations of the International Building Code.
 - 2. Ensure that bolts, screws, rivets and other mechanical fasteners do not penetrate duct walls.

2.4 DUCT LINER

- A. Fibrous-Glass Liner: Comply with NFPA 90A or NFPA 90B and with NAIMA AH124.
 - 1. Manufacturers:
 - a. CertainTeed Corp.; Insulation Group.
 - b. Johns Manville International, Inc.
 - c. Knauf Fiber Glass GmbH.
 - 2. Materials: ASTM C 1071, Type I, flexible; surfaces exposed to airstream shall be coated to prevent erosion of glass fibers.
 - a. Thickness: 1 inch.
 - b. Density: 1-1/2 pounds per cubic foot.
 - c. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.
 - d. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
 - e. Maximum Operating Temperature: 250 deg F when tested according to ASTM C 411.

- f. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
- g. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in duct.
 - 1) Tensile Strength: Indefinitely sustain a 50-lb- tensile, dead-load test perpendicular to duct wall.
 - 2) Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8 inch into airstream.
 - 3) Adhesive for Attaching Mechanical Fasteners: Comply with fire-hazard classification of duct liner system.
- 3. Noise reduction coefficient (NRC): Sound absorption coefficients shall not be less than those in the table below as tested by ASTM C423 using an ASTM E795 Type A mounting.

Sound absorption coefficients at
 octave band center frequencies, Hz

Thickness Inches (mm)	125	250	500	1000	2000	4000	NRC
1 (25)	.08	.31	.59	.84	.91	.90	.70
1-1/2 (38)	.10	.47	.83	.93	.97	.96	.80
2 (51)	.24	.64	.96	1.03	1.00	.99	.90

2.5 SEALANTS AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Elastomeric Sealant Tape: 3 inches wide; modified butyl adhesive backed.
 - 1. Manufacturers:
 - a. Hardcast; Foil-Grip 1402 and Foil-Grip 1402-181BFX.

- C. Water-Based Joint and Seam Sealant:
1. Manufacturers:
 - a. Hardcast; Flex-Grip 550 and Versa-Grip 181.
 - b. Polymer Adhesives; No. 11.
 - c. United McGill.
 2. Application Method: Brush on.
 3. Solids Content: Minimum 65 percent.
 4. Shore A Hardness: Minimum 20.
 5. Water resistant.
 6. Mold and mildew resistant.
 7. VOC: Maximum 75 g/L (less water).
 8. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 9. Service: Indoor or outdoor.
 10. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- D. Solvent-Based Joint and Seam Sealant:
1. Manufacturers:
 - a. Hardcast; Sure-Grip 404.
 - b. United McGill.
 2. Application Method: Brush on.
 3. Base: Synthetic rubber resin.
 4. Solvent: Toluene and heptane.
 5. Solids Content: Minimum 60 percent.
 6. Shore A Hardness: Minimum 60.
 7. Water resistant.
 8. Mold and mildew resistant.
 9. VOC: Maximum 395 g/L.
 10. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
 11. Service: Indoor or outdoor.
 12. Substrate: Compatible with galvanized sheet steel, stainless steel, or aluminum sheets.
- E. Flanged Joint Sealant: Comply with ASTM C 920.
1. General: Single-component, acid-curing, silicone, elastomeric.
 2. Type: S.
 3. Grade: NS.
 4. Class: 25.
 5. Use: O.

- F. Gaskets: Chloroprene elastomer, 40 durometer, 1/8 inch thick, full face, one piece vulcanized or dovetailed at joints.
- G. Round Duct Joint O-Ring Seals:
 - 1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
 - 2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
 - 3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.6 HANGERS AND SUPPORTS

- A. Building Attachments: Concrete inserts, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
- B. Hanger Materials: Galvanized sheet steel or threaded steel rod.
 - 1. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
 - 2. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
 - 3. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."
 - 4. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.
- C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials. Attachments for stainless steel and PVC-coated duct shall be stainless steel.
- D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.

3. Supports for Aluminum Ducts: Aluminum support materials unless materials are electrolytically separated from ducts.
- E. Load Rated Cable Suspension System for Noncorrosive Environments: Tested to five times the Safe Working Loads and verified by the SMACNA Testing and Research Institute.
1. Cable: Aircraft quality 7 x 7 and 7 x 19 wire rope.
 - a. Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
 - b. Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
 2. Fastener: One-piece, die-cast zinc housing with Type 302 S26 stainless steel hardened and tempered springs, and oil impregnated, sintered, hardened and tempered steel locking wedges.
 3. End Fixings: Loop, stud or toggle; or plain end suitable for wire rope beam clamp.
 4. Manufacturers:
 - a. Ductmate Industries, Inc.; Clutcher and EZ-Lock.
 - b. Duro Dyne Corp.; Dyna-Tite System.
 - c. Gripple Inc.; Hang-Fast System.
- F. Stainless Steel Load Rated Cable Suspension System for Corrosive Environments: Tested to five times the Safe Working Loads and verified by the SMACNA Testing and Research Institute.
1. Cable: Aircraft quality stainless steel 7 x 7 and 7 x 19 wire rope.
 - a. Stainless steel complying with ASTM A 492.
 2. Fastener: One-piece, stainless steel housing with Type 302 S26 stainless steel hardened and tempered springs, and ceramic locking wedges.
 3. End Fixings:
 - a. Loop End: Type 316L/A4 stainless steel.
 - b. Stud or Toggle End: Type 304L/A2 stainless steel.
 - c. Plain end suitable for stainless steel wire rope beam clamp.
 4. Manufacturers:
 - a. Ductmate Industries, Inc.; Clutcher and EZ-Lock.
 - b. Duro Dyne Corp.; Dyna-Tite System.
 - c. Gripple Inc.; Hang-Fast System.
- G. Welded Supports: Structural steel shapes with zinc rich paint. Equivalent, proprietary design, rolled steel

structural support systems may be used in lieu of mill rolled structural steel.

2.7 ROOF MOUNTED DUCT SUPPORTS

- A. General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted duct.
- B. Support: Assembly of bases, and vertical and horizontal members, for roof installation without membrane penetration.
 - 1. Manufacturer:
 - a. B-Line Systems, Inc.; a division of Cooper Industries.
 - b. Eco Support Products.
 - c. ERICO/Michigan Hanger Co.
 - d. MIRO Industries.
 - e. Portable Pipe Hangers.
 - 2. Bases: Two or more plastic, stainless steel, or recycled rubber.
 - 3. Vertical Members: Two or more protective-coated-steel channels.
 - 4. Horizontal Member: Protective-coated-steel channel.

2.8 RECTANGULAR DUCT FABRICATION

- A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
 - 1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
 - 2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
 - 3. Internal Tie Rod: Ducts having a side dimension of 48 inches or greater only.
- B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's and SMACNA guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.
 - 1. Manufacturers:

- a. Ductmate Industries, Inc.
- b. Nexus Inc.
- c. Ward Industries, Inc.

C. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of nonbraced panel area unless ducts are lined.

2.9 APPLICATION OF LINER IN RECTANGULAR DUCTS

- A. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
- B. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
- C. Butt transverse joints without gaps and coat joint with adhesive.
- D. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
- E. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.
- F. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm or greater.
- G. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
- H. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 1. Fan discharges.
 2. Intervals of lined duct preceding unlined duct.
 3. Upstream edges of transverse joints in ducts where air velocities are greater than 2500 fpm or where indicated.

- I. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
 1. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
- J. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.10 ROUND AND FLAT-OVAL DUCT AND FITTING FABRICATION

- A. Diameter as applied to flat-oval ducts in this Article is the diameter of a round duct with a circumference equal to the perimeter of a given size of flat-oval duct.
- B. Round and Flat-Oval, Spiral Lock-Seam Ducts:
 1. Manufacturers:
 - a. Eastern Sheet Metal (ESM).
 - b. LaPine Metal Products.
 - c. Lindab Inc.
 - d. McGill AirFlow Corporation.
 - e. SEMCO Incorporated.
 - f. SET Duct Manufacturing, Inc.
 - g. Tangent Air, Inc.
 - h. Universal Spiral Air.
- C. Round, Spiral Lock-Seam Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" or SMACNA "Industrial Duct Construction Standards" as required based on pressure class.
 1. Round fittings shall be factory fabricated welded design. Use of field fabricated fittings (welded design) shall only be permitted when factory fabricated fittings are unavailable.
- D. Flat-Oval, Spiral Lock-Seam Ducts: Fabricate supply ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" or SMACNA "Industrial Duct Construction Standards" as required based on pressure class.

1. Flat-oval fittings shall be factory fabricated welded design. Use of field fabricated fittings (welded design) shall only be permitted when factory fabricated fittings are unavailable.

E. Duct Joints:

1. Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
2. Ducts 21 to 72 Inches in Diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.
3. Ducts Larger Than 72 Inches in Diameter: Companion angle flanged joints per SMACNA "HVAC Duct Construction Standards--Metal and Flexible," Figure 3-2.
4. Bolts and fasteners for galvanized steel duct shall be carbon steel, zinc coated per ASTM A153. Bolts and fasteners for stainless steel and polyvinyl chloride coated steel duct shall be stainless steel.
5. Round Ducts: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.
 - a. Manufacturers:
 - 1) AccuDuct Mfg. Inc.
 - 2) Ductmate Industries, Inc.
 - 3) Eastern Sheet Metal (ESM).
 - 4) Lindab Inc.
 - 5) Universal Spiral Air.
6. Flat-Oval Ducts: Prefabricated connection system consisting of two flanges and one synthetic rubber gasket.
 - a. Manufacturers:
 - 1) AccuDuct Mfg. Inc.
 - 2) Ductmate Industries, Inc.
 - 3) Eastern Sheet Metal (ESM).
 - 4) McGill AirFlow Corporation.
 - 5) SEMCO Incorporated.
 - 6) Universal Spiral Air.

- F. Low Pressure Ductwork (plus or minus 2 inches W.G. Static Pressure Class)

1. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible provide single thickness turning vanes.
 2. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.
- G. Medium and High Pressure Ductwork (For Static Pressure Class Greater than plus or minus 2 inches W.G.)
1. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible provide single thickness turning vanes.
 2. Transform duct sizes gradually, not exceeding 15 degrees divergence and 30 degrees convergence.
 3. Fabricate continuously welded medium and high pressure round and oval duct fittings two gauges heavier than duct gauges indicated in SMACNA Standard. Joints shall be minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.
 4. Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.
- H. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.
- I. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.
- J. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:
1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.

2. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from minus 2- to plus 2-inch wg:
 - a. Ducts 3 to 36 Inches in Diameter: 0.034 inch.
 - b. Ducts 37 to 50 Inches in Diameter: 0.040 inch.
 - c. Ducts 52 to 60 Inches in Diameter: 0.052 inch.
 - d. Ducts 62 to 84 Inches in Diameter: 0.064 inch.
3. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from 2- to 10-inch wg:
 - a. Ducts 3 to 26 Inches in Diameter: 0.034 inch.
 - b. Ducts 27 to 50 Inches in Diameter: 0.040 inch.
 - c. Ducts 52 to 60 Inches in Diameter: 0.052 inch.
 - d. Ducts 62 to 84 Inches in Diameter: 0.064 inch.
4. Flat-Oval Mitered Elbows: Welded construction with same metal thickness as longitudinal-seam flat-oval duct.
5. 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems or for material-handling Class A or B exhaust systems and only where space restrictions do not permit using radius elbows. Fabricate with single-thickness turning vanes.
6. Round Elbows 8 Inches and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
7. Round Elbows 9 through 14 Inches in Diameter: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
8. Round Elbows Larger Than 14 Inches in Diameter and All Flat-Oval Elbows: Fabricate gored elbows unless space restrictions require mitered elbows.
9. Die-Formed Elbows for Sizes through 8 Inches in Diameter and All Pressures 0.040 inch thick with 2-piece welded construction.
10. Round Gored-Elbow Metal Thickness: Same as non-elbow fittings specified above.
11. Flat-Oval Elbow Metal Thickness: Same as longitudinal-seam flat-oval duct specified above.
12. Pleated Elbows for Sizes through 14 Inches in Diameter and Pressures through 10-Inch wg: 0.022 inch.

- K. PVC-Coated Elbows and Fittings: Fabricate elbows and fittings as follows:
1. Round Elbows 4 to 8 Inches in Diameter: Two piece, die stamped, with longitudinal seams spot welded, bonded, and painted with PVC aerosol spray.
 2. Round Elbows 9 to 26 Inches in Diameter: Standing-seam construction.
 3. Round Elbows 28 to 60 Inches in Diameter: Standard gored construction, riveted and bonded.
 4. Other Fittings: Riveted and bonded joints.
 5. Couplings: Slip-joint construction with a minimum 2-inch insertion length.

2.11 DOUBLE-WALL DUCT AND FITTING FABRICATION

A. Manufacturers:

1. Eastern Sheet Metal (ESM).
2. LaPine Metal Products.
3. Lindab Inc.
4. McGill AirFlow Corporation.
5. SEMCO Incorporated.
6. SET Duct Manufacturing, Inc.
7. Tangent Air Inc.
8. Universal Spiral Air.

B. Ducts: Fabricate double-wall (insulated) ducts with an outer shell and an inner duct. Dimensions indicated are for inner ducts.

1. Outer Shell: Base metal thickness on outer-shell dimensions. Fabricate outer-shell lengths 2 inches longer than inner duct and insulation and in metal thickness specified for single-wall duct.
2. Insulation: 1-inch-thick fibrous glass, unless otherwise indicated. Terminate insulation where double-wall duct connects to single-wall duct or uninsulated components, and reduce outer shell diameter to inner duct diameter.
 - a. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.
3. Solid Inner Ducts: Use the following sheet metal thicknesses and seam construction:
 - a. Ducts 3 to 8 Inches in Diameter: 0.019 inch with standard spiral-seam construction.
 - b. Ducts 9 to 42 Inches in Diameter: 0.019 inch with single-rib spiral-seam construction.

- c. Ducts 44 to 60 Inches in Diameter: 0.022 inch with single-rib spiral-seam construction.
 - d. Ducts 62 to 88 Inches in Diameter: 0.034 inch with standard spiral-seam construction.
 - 4. Perforated Inner Ducts: Fabricate with 0.028-inch-thick sheet metal having 3/32-inch-diameter perforations, with overall open area of 23 percent.
 - a. Provide 1 mil mylar liner between acoustical insulation and perforated inner liner.
 - 5. Maintain concentricity of inner duct to outer shell by mechanical means. Prevent dislocation of insulation by mechanical means.
- C. Fittings: Fabricate double-wall (insulated) fittings with an outer shell and an inner duct.
- 1. Solid Inner Ducts: Use the following sheet metal thicknesses:
 - a. Ducts 3 to 34 Inches in Diameter: 0.028 inch.
 - b. Ducts 35 to 58 Inches in Diameter: 0.034 inch.
 - c. Ducts 60 to 88 Inches in Diameter: 0.040 inch.
 - 2. Perforated Inner Ducts: Fabricate with 0.028-inch-thick sheet metal having 3/32-inch-diameter perforations, with overall open area of 23 percent.

PART 3 - EXECUTION

3.1 DUCTWORK APPLICATION SCHEDULE

- A. Ductwork materials and performance requirements are scheduled on the Drawing.

3.2 DUCTWORK APPLICATION SCHEDULE

- A. Ductwork materials and performance requirements are scheduled on the Drawing.

3.3 DUCT INSTALLATION

- A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
- B. Install round and flat-oval ducts in lengths not less than 12 feet unless interrupted by fittings.
- C. Install ducts with fewest possible joints.

- D. Install fabricated fittings for changes in directions, size, and shape and for connections.
- E. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.
- F. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.
- J. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.
- K. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.
- L. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- M. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.
- N. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, and sleeves. Fire and smoke dampers are specified in Division 15 Section "Duct Accessories."

- O. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.
- P. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."
 - 1. Intermediate level.

3.4 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.5 RANGE HOOD EXHAUST DUCTS, SPECIAL INSTALLATION REQUIREMENTS

- A. Install ducts to allow for thermal expansion through 2000 deg F temperature range.
- B. Install ducts without dips or traps that may collect residues unless traps have continuous or automatic residue removal.
- C. Install access openings at each change in direction and at intervals defined by NFPA 96; locate on sides of duct a minimum of 1-1/2 inches from bottom; and fit with grease-tight covers of same material as duct.
- D. Install welded test ports or prefabricated test port section in the exhaust duct for the duct Pitot-tube

traverse. Install each test port with a threaded cap that is liquid tight.

- E. Do not penetrate fire-rated assemblies except as permitted by applicable building codes.
- F. Field Quality Control:
 - 1. Prior to use or concealment of any portion of grease duct system, perform leakage test in presence of Code Official.
 - 2. Light test or approved equivalent test method shall be performed to determine that welded and brazed joints are liquid tight.
 - 3. Lamp shall be not less than 100 watts and shall be open to emit light equally in all directions perpendicular to duct walls.

3.6 DUCT SEALING

- A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated. Ducts must be properly cleaned and sealed in strict accordance with sealant manufacturer's instructions.
 - 1. Seal Class: Refer to Application Schedule on the Drawings.
 - 2. Seal ducts before external insulation is applied.
 - 3. After pressure testing, remake leaking joints until leakage is equal to or less than maximum allowable. Refer to Application Schedule on the Drawings for allowable leakage rates.

3.7 HANGING AND SUPPORTING

- A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.
- B. Support vertical ducts at maximum intervals of 16 feet and at each floor.
- C. Install concrete inserts before placing concrete.
- D. Support ductwork from building structure, not from roof deck, floor slab, pipe, other ducts, or equipment.

- E. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.
- F. Install roof mounted duct supports in accordance with manufacturer's instructions. Provide additional membrane layer or walkpads under support bases as required.
- G. Use load rated cable suspension system for round duct in exposed locations.

3.8 CONNECTIONS

- A. Make connections to equipment with flexible connectors according to Division 15 Section "Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards-- Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.9 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

3.10 FIELD QUALITY CONTROL

- A. Duct System Cleanliness Tests:
 - 1. Visually inspect duct system to ensure that no visible contaminants are present.
- B. Duct system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.11 START UP

- A. Air Balance: Comply with requirements in Division 15 Section "Testing, Adjusting, and Balancing."

END OF SECTION 15815

SECTION 15816 - NONMETAL DUCTS

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 PERFORMANCE REQUIREMENTS.....1
1.3 DEFINITIONS.....2
1.4 SUBMITTALS.....2
1.5 QUALITY ASSURANCE.....3

PART 2 - PRODUCTS.....3
2.1 MANUFACTURERS.....3
2.2 FABRIC DUCTS.....3

PART 3 - EXECUTION.....6
3.1 APPLICATION AND INSTALLATION.....6
3.2 HANGER AND SUPPORT INSTALLATION.....7
3.3 FIELD QUALITY CONTROL.....7
3.4 START UP.....8

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 15 Section "Mechanical General Requirements."
 - 2. Division 15 Section "Duct Accessories" for dampers, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including duct closure, reinforcements, and hangers and supports, shall comply with SMACNA's "Fibrous Glass Duct Construction Standards" and performance requirements and design criteria indicated.
 - 1. Static-Pressure Classes:
 - a. Supply Ducts (except in Mechanical Rooms): 1-inch wg.

1.3 DEFINITIONS

- A. Thermal Conductivity and Apparent Thermal Conductivity (k-Value): As defined in ASTM C 168. In this Section, these values are the result of the formula $\text{Btu} \times \text{in.}/\text{h} \times \text{sq. ft.} \times \text{deg F}$ at temperature differences specified. Values are expressed as Btu.
1. Example: Apparent Thermal Conductivity (k-Value): 0.26.

1.4 SUBMITTALS

- A. Product Data: For the following:
1. Fibrous-glass duct materials.
 2. Thermoset FRP duct materials.
 3. Thermoplastic duct (PVC) materials.
 4. Concrete ducts.
 5. Fabric ducts.
- B. Shop Drawings: CAD-generated and drawn to 1/8 inch equals 1 foot scale. Show fabrication and installation details for nonmetal ducts.
1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 2. Duct layout indicating sizes and pressure classes.
 3. Elevations of top and bottom of ducts.
 4. Dimensions of main duct runs from building grid lines.
 5. Fittings.
 6. Reinforcements and spacing.
 7. Seam and joint construction.
 8. Penetrations through fire-rated and other partitions.
 9. Equipment installation based on equipment being used on Project.
 10. Duct accessories, including access doors and panels.
 11. Hangers and supports, including methods for duct and building attachment, vibration isolation.
- C. Delegated-Design Submittal:
1. Duct materials and thicknesses.
 2. Joint and seam construction and sealing.
 3. Reinforcement details and spacing.
- D. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Other systems installed in same space as ducts.
3. Ceiling- and wall-mounting access doors and panels required to provide access to dampers and other operating devices.
4. Ceiling-mounting items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

- A. Welding certificates.
- B. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
- B. NFPA Compliance:
 1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
 2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- C. UL Compliance: UL listed and labeled as complying with UL 181.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FABRIC DUCTS

- A. Manufacturers:
 1. Ductsox Corporation.
 2. FabricAir, Inc.

- B. Performance Requirements: Classified by UL in accordance with the 25/50 flame spread/smoke developed requirements of NFPA 90A.
- C. Material: Air diffusers shall be constructed of a woven fire retardant fabric complying with the following physical characteristics:
1. Fabric Construction: Fabric shall be constructed of a polyester that includes 55 percent recycled content (80 percent post-industrial and 20 percent post-consumer), treated with a machine wash-able anti-microbial agent by the fabric manufacturer, of a non-linting filament yarn to meet the requirements of ISO Class 3 environment, and 100percent flame retardant.
 2. Weight: 6.8 oz./sq yd in accordance with ASTM D3776
 3. Color: Custom color as selected by Architect.
 4. Fabric Porosity: 2 (+2/-1) cfm/sq ft in accordance with ASTM D737, Frazier.
 5. Temperature Range: 0 deg F to 180 deg F.
 6. Fire Retardancy: Classified by Underwriters Laboratories in accordance with the flame spread/smoke developed requirements NFPA 90, ICC AC167 and UL 2518.
 7. Antimicrobial agent shall be proven 99 percent effective after 10 laundry cycles in accordance with AATCC Test Method 100.
- D. System Fabrication Requirements:
1. Textile system constructed in modular lengths (zippered) with proper securing clips, inlets, end caps, and mid-sections.
 2. Integrated air dispersion shall be:
 - a. Linear Vents (Gymnasium):
 - 1) Air dispersion accomplished by linear vent and permeable fabric. Linear vents must be sized in 1 CFM per linear foot increments (based on 0.5 inch static pressure), starting at 1 CFM through 90 CFM per linear foot. Linear vent is to consist of an array of open orifices rather than a mesh style vent to reduce maintenance requirements of mesh style vents. Linear vents should also be designed to minimize dusting on fabric surface.
 - 2) Size of vent openings and location of linear vents to be specified and approved by manufacturer.
 - b. Fixed Nozzles (Natatorium):

- 1) Air dispersion accomplished by using conical aerodynamic nozzles and permeable fabric. Diameter of nozzles and nozzle height shall be minimum 1/2 inch. Due to exact requirements of throw and maximum level of noise alternative flow models are not acceptable.
 - 2) Color of nozzles must match color of fabric. Unless otherwise specifically mentioned on drawings or otherwise in this specification, suppliers standard table is used for selection of color.
 - 3) Location and number of nozzles shall be specified and approved by manufacturer.
3. Inlet connection to metal duct via fabric draw band with anchor patches as supplied by manufacturer. Anchor patches shall be secured to metal duct via zip screw fastener (supplied by contractor).
 4. Inlet connection includes zipper for easy removal and maintenance.
 5. Lengths shall include required intermediate zippers as specified by manufacturer.
 6. System shall include adjustable flow devices to balance turbulence, airflow and distribution as needed. Flow restriction device shall include ability to adjust the airflow resistance from 0.06 to 0.60 in wg static pressure.
 7. End cap includes zipper for easy maintenance.
 8. Each section of fabric duct shall include identification labels documenting order number, section diameter, section length, piece number, code certifications and other pertinent information.

E. Design Parameters:

1. Designed for 0.5 inch water gage, yielding maximum operating pressure of 3.1 inches water gage.
2. Fabric diffusers limited to design temperatures between 10 deg F and 180 deg F.
3. Design cfm, static pressure, and diffuser length shall be designed or approved by manufacturer.
4. Do not use fabric diffusers in concealed locations.
5. Use fabric diffusers for positive pressure air distribution components of the mechanical ventilation system only.

F. Suspension Hardware:

1. Internal Hoop System and Tension Cable Suspension System: (Available for duct diameters from 8-inches to 60 inches). System consists of metallic internal hoops spaced 5 feet apart and attached to the interior of the fabric duct at the 4, 8, and 12 o'clock positions. Suspension system includes tension cable located above top dead center of fabric duct system. Hardware to include snap gliders, eyebolts, turnbuckles and securing hardware, as required.
2. Tensioned Internal Hoop System: (Available for duct diameters from 8-inches to 60 inches). System consists of cylindrical tensioning rings, intermediate rings, direct hang vertical suspension cables spaced at 6 foot intervals, and spacer tubing.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

- A. Install nonmetal duct where indicated and as detailed on Drawings.
- B. Install ducts with fewest possible joints.
- C. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
- D. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- E. Install ducts with a clearance of 1 inch.
- F. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.
- G. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts with sheet metal flanges. Overlap opening on 4 sides by at least 1-1/2 inches.
- H. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers and sleeves. Fire and

smoke dampers are specified in Division 15 Section "Duct Accessories."

3.2 HANGER AND SUPPORT INSTALLATION

- A. Hangers: Suspend duct attachments from building attachments with one of the following hanger types:
 - 1. Galvanized sheet metal strips, a minimum of 0.034 by 1 inch wide.
 - 2. Galvanized-steel rods, 1/4 inch in diameter, threaded along entire length.
 - 3. Load rated cable suspension system.
- B. Attach hangers to joints and reinforcing channels that occur within required hanger spacing. Attach hangers to transmit load to sides and bottom channels and no more than 6 inches from sides of ducts.
- C. Support equipment and metal duct components and accessories independent of ducts.
- D. Support terminal components separately.
- E. Install sheet metal sleeves to support dampers. For motorized dampers, extend sleeves to support operators.
- F. Install concrete inserts before placing concrete.
- G. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Inspect fibrous-glass duct systems according to "Inspection Checklist for Fibrous Glass Duct System Installation" in NAIMA AH116. Prepare a written report using the format of this checklist.
- C. Duct System Cleanliness Tests:
 - 1. Visually inspect duct system to ensure that no visible contaminants are present.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.4 START UP

A. Air Balance: Comply with requirements in Division 15 Section "Testing, Adjusting, and Balancing."

END OF SECTION 15816

SECTION 15817 - HVAC CASINGS

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUMMARY.....1
1.3 DEFINITIONS.....1
1.4 PERFORMANCE REQUIREMENTS.....2
1.5 SUBMITTALS.....2
1.6 QUALITY ASSURANCE.....2
1.7 COORDINATION.....3

PART 2 - PRODUCTS.....3
2.1 MANUFACTURERS.....3
2.2 SHEET METAL MATERIALS.....3
2.3 SEALANT MATERIALS.....4
2.4 GENERAL CASING FABRICATION REQUIREMENTS.....5
2.5 FACTORY-FABRICATED (ACOUSTICAL PLENUM) CASINGS.....6

PART 3 - EXECUTION.....8
3.1 EXAMINATION.....8
3.2 INSTALLATION.....8
3.3 FIELD QUALITY CONTROL.....9
3.4 CLEANING.....9

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 15 Section "Mechanical General Requirements."

1.2 SUMMARY

- A. Section Includes:
 - 1. Factory or shop-fabricated, field-assembled, double-wall casings for HVAC equipment.

1.3 DEFINITIONS

- A. Thermal Conductivity and Apparent Thermal Conductivity (k-Value): As defined in ASTM C 168. In this Section, these values are the result of the formula Btu x in./h x sq. ft.

x deg F at temperature differences specified. Values are expressed as Btu.

1. Example: Apparent Thermal Conductivity (k-Value): 0.26.

1.4 PERFORMANCE REQUIREMENTS

A. Static-Pressure Classes:

1. Upstream from Fan(s): 2-inch wg.
2. Downstream from Fan(s): 2-inch wg.

B. Acoustical Performance:

1. NRC: 1.09 according to ASTM C 423.
2. STC: 40 according to ASTM E 90.

C. Structural Performance:

1. Casings shall be fabricated to withstand 133 percent of the indicated static pressure without structural failure. Wall and roof deflection at the indicated static pressure shall not exceed 1/8 inch per foot of width.
 - a. Fabricate outdoor casings to withstand wind load of 15 lbf/sq. ft. and snow load of 30 lbf/sq. ft.

1.5 SUBMITTALS

A. Product Data: For factory-fabricated casings, sealant materials, and acoustic liner materials.

B. Product Certificates: For factory-fabricated casings, signed by product manufacturer.

1. Show sound-absorption coefficients in each octave band lower than those scheduled when tested according to ASTM C 423.
2. Show airborne sound transmission losses lower than those scheduled when tested according to ASTM E 90.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for casing joint and seam welding.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate sizes and locations of steel supports. Supports are specified in Division 05 Section "Metal Fabrications."
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SHEET METAL MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Exterior Surface Galvanized Coating Designation: G90.
 - 2. Interior Surface Galvanized Coating Designation:
 - a. Sections Not Exposed to Moisture: G90.
 - b. Sections Housing and Downstream from Cooling Coil and Humidifiers: G90.
- B. Stainless Steel: ASTM A 480/A 480M, Type 304, and having a No. 2D finish.
- C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet steel casings.
- D. Miscellaneous Materials and Products: Types and sizes required to comply with HVAC casing system requirements, including proper connection of ducts and equipment.

2.3 SEALANT MATERIALS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Water-Based Joint and Seam Sealant:
1. Application Method: Brush on.
 2. Solids Content: Minimum 65 percent.
 3. Shore A Hardness: Minimum 20.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
 7. Service: Indoor or outdoor.
 8. Substrate: Compatible with galvanized sheet steel or stainless steel.
- C. Solvent-Based Joint and Seam Sealant:
1. Application Method: Brush on.
 2. Base: Synthetic rubber resin.
 3. Solvent: Toluene and heptane.
 4. Solids Content: Minimum 60 percent.
 5. Shore A Hardness: Minimum 60.
 6. Water resistant.
 7. Mold and mildew resistant.
 8. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
 9. Service: Indoor or outdoor.
 10. Substrate: Compatible with galvanized sheet steel or stainless steel.
- D. Flanged Joint Sealant: Comply with ASTM C 920.
1. General: Single component, acid curing, silicone, elastomeric.
 2. Type: S.
 3. Grade: NS.
 4. Class: 25.
 5. Use: O.
- E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.4 GENERAL CASING FABRICATION REQUIREMENTS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 9, "Equipment and Casings," for acceptable materials, material thicknesses, and casing construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
1. Fabricate casings with more than 3-inch wg negative static pressure according to SMACNA's "Rectangular Industrial Duct Construction Standards."
 2. Casings with more than 2-inch wg positive static pressure may be fabricated according to SMACNA's "Rectangular Industrial Duct Construction Standards."
- B. Factory- or Shop-Applied Antimicrobial Coating:
1. Apply to the interior sheet metal surfaces of casing in contact with the airstream. Apply untreated clear coating to the exterior surface.
 2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
 3. Coating containing the antimicrobial compound shall have a hardness of 2H minimum when tested according to ASTM D 3363.
 4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 according to UL 723; certified by an NRTL.
 5. Applied Coating Color: Standard.
- C. Sealing Requirement: SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Seal Class A. Seal all seams, joints, connections, and abutments to building.
- D. Penetrations: Seal all penetrations airtight. Cover with escutcheons and gaskets, or fill with suitable compound so there is no exposed insulation. Comply with requirements for escutcheons specified in Division 15 Section "Basic Mechanical Materials and Methods." Provide shaft seals where fan shafts penetrate casing.
- E. Access Doors: Fabricate access doors according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 9-15, "Casing Access Doors - 2-inch wg (500 Pa)," and Figure 9-16, "Casing Access Doors - 3-10-

inch wg (750-2500 Pa)"; and according to pressure class of the plenum or casing section in which access doors are to be installed.

1. Size: 20 by 54 inches.
2. Vision Panel: Double-glazed, wire-reinforced safety glass with an airspace between panes and sealed with interior and exterior rubber seals.
3. Hinges: Piano or butt hinges and latches, number and size according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
4. Latches: Minimum of two wedge-lever-type latches, operable from inside and outside.
5. Neoprene gaskets around entire perimeters of door frames.
6. Doors shall open against air pressure.

F. Condensate Drain Pans: Formed sections of Type 304, stainless-steel sheet complying with requirements in ASHRAE 62.1. Pans shall extend a minimum of 12 inches past coil.

1. Double-wall construction shall have space between walls filled with foam insulation and sealed moisture tight.
2. Intermediate drain pan or drain trough shall collect condensate from top coil for units with stacked coils or stacked eliminators.
3. Insulation: Polystyrene or polyurethane.
4. Slopes shall be in a minimum of two planes to collect condensate from cooling coils (including coil piping connections and return bends), eliminators, and humidifiers when units are operating at maximum catalogued face velocity across cooling coil.
5. Each drain pan connection shall have a trap. Drain traps with depth and height differential between inlet and outlet equal or greater to the design static pressure plus 2-inch wg. Include slab height in trap calculation.

2.5 FACTORY-FABRICATED (ACOUSTICAL PLENUM) CASINGS

A. Description: Double-wall, insulated, pressurized equipment casing.

1. Manufacturers:
 - a. Industrial Acoustics Company, Inc.
 - b. Ruskin Sound Control.
 - c. VAW Systems Ltd.

d. Vibro-Acoustics.

- B. Panel Fabrication: Solid, galvanized sheet steel exterior shell and perforated, galvanized sheet steel interior shell; with 4-inch space between shells, as indicated.
1. Fabricate with a minimum number of joints.
 2. Weld exterior and interior shells to perimeter; to interior, longitudinal, galvanized-steel channels; and to box-end internal closures. Paint welds.
 3. Exterior Shell Thickness: 0.040 inch minimum.
 4. Interior Shell Thickness: 0.034 inch minimum, with 3/32-inch perforations at 3/16-inch staggered spacing for 23 percent open area.
 5. Fabricate perimeter and interior, longitudinal channel members with galvanized-steel shapes.
 6. Fill each panel assembly with noncombustible, acoustic quality, shot-free fiberglass insulation with long, resilient fibers bonded with a thermosetting resin.
 - a. Density shall be as required to insure conformance with laboratory test data.
 - b. Fiberglass shall be packed with a minimum of 10 percent compression during casing assembly.
 - c. Media shall be inert, mildew resistant, and vermin proof, and comply with NFPA 90A; and resilient such that it will not crumble or break, and conform to irregular surfaces.
 - d. Media shall not cause or accelerate corrosion of aluminum or steel.
 - e. Media shall be encapsulated in Mylar to prevent shedding, erosion and impregnation of the fiberglass.
 - f. Mineral wool shall not be permitted as a substitute for fiberglass.
 7. Fabricate panels with tongue-and-groove, continuous self-locking joints effective inside and outside each panel.
- C. Trim Items: Fabricate from a minimum of 0.052-inch galvanized sheet steel, furnished in standard lengths for field cutting.
- D. Access Doors: Fabricate personnel access doors at least 24 by 60 inches and other access doors in sizes indicated.
1. Fabricate doors of same thickness as panels, with a minimum 0.040-inch solid, interior and exterior, galvanized sheet steel shell.

2. Install a minimum of two ball-bearing hinges and two wedge-lever-type latches, operable from inside and outside. Install doors to open against air pressure differential. Install neoprene gaskets around entire perimeters of door frames.
3. Fabricate windows in doors consisting of double-glazed, wire-reinforced safety glass with an air space between panes and sealed with interior and exterior rubber seals.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine steel supports for compliance with requirements for conditions affecting installation and performance of HVAC casings.
- B. Examine casing insulation materials and liners before installation. Reject casings that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install casings according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible." Comply with recommended spacing of sheet metal screws and with requirements for casing sealing and trim positioning.
- B. Support casings on floor or foundation system. Secure and seal to base.
- C. Apply sealant to joints, connections, and mountings.
- D. Field-cut openings for pipe and conduit penetrations; insulate and seal according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- E. Support components rigidly with ties, braces, brackets, and anchors of types that will maintain housing shape and prevent buckling.
- F. Align casings accurately at connections, with 1/8-inch misalignment tolerance and with smooth interior surfaces.

G. Maintain duct seal class integrity throughout casings.

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:
1. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
 2. Determine leakage from entire system or section of system by relating leakage to surface area of test section. Comply with requirements for leakage classification of ducts connected to casings.
 3. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.

3.4 CLEANING

- A. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."
1. Intermediate level.

END OF SECTION 15817

SECTION 15820 - DUCT ACCESSORIES

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 DEFINITIONS.....2
1.3 SUBMITTALS.....2
1.4 QUALITY ASSURANCE.....3
1.5 EXTRA MATERIALS.....3

PART 2 - PRODUCTS.....3
2.1 MANUFACTURERS.....3
2.2 SHEET METAL MATERIALS.....3
2.3 BACKDRAFT DAMPERS.....4
2.4 LOW PRESSURE MANUAL VOLUME DAMPERS.....5
2.5 MOTORIZED CONTROL DAMPERS.....6
2.6 FIRE DAMPERS (CURTAIN STYLE).....6
2.7 SMOKE DAMPERS.....7
2.8 COMBINATION FIRE AND SMOKE DAMPERS.....8
2.9 DUCT SILENCERS (FIBERGLASS FILL).....10
2.10 TURNING VANES12
2.11 DUCT-MOUNTING ACCESS DOORS12
2.12 FLEXIBLE CONNECTORS13
2.13 FLEXIBLE DUCTS, LOW AND MEDIUM PRESSURE14
2.14 FLEXIBLE DUCT ELBOW SUPPORTS15
2.15 DUCT ACCESSORY HARDWARE15
2.16 FINISHES16

PART 3 - EXECUTION.....16
3.1 APPLICATION AND INSTALLATION.....16
3.2 FIELD QUALITY CONTROL.....18
3.3 ADJUSTING.....18

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 15 Section "Mechanical General Requirements."
 - 2. Division 15 Section "Testing, Adjusting, and Balancing" for duct test holes.
 - 3. Division 15 Section "Temperature Controls" for motorized control dampers.

4. Division 16 Section "Fire Alarm" for duct-mounting fire and smoke detectors.

1.2 DEFINITIONS

- A. NVLAP: National Voluntary Laboratory Accreditation Program.
- B. Low Pressure: Up to 2 inch WG and velocities less than 1,500 fpm. Construct for 2 inch WG positive or negative static pressure.
- C. Medium Pressure: Greater than 2 inch WG to 6 inch WG and velocities greater than 1,500 fpm and less than 2,500 fpm. Construct for 6 inch WG positive or negative static pressure.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
 1. For turning vanes, include data for pressure loss generated sound power levels.
 2. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.
- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
 1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control damper installations.
 - d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
 - e. Duct security bars.
 - f. Wiring Diagrams: Power, signal, and control wiring.
- C. Coordination Drawings: Reflected ceiling plans, drawn to scale and coordinating penetrations and ceiling-mounting

items. Show ceiling-mounting access panels and access doors required for access to duct accessories.

- D. Source quality-control reports.
- E. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with AMCA 500-D testing for damper rating.

1.5 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fusible Links: Furnish quantity equal to 10 percent of amount installed for each temperature rating.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SHEET METAL MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.
- B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

- C. Stainless Steel: ASTM A 480/A 480M, Types 304 and 316 as indicated.
- D. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. Extruded Aluminum: ASTM B 221, alloy 6063, temper T6.
- F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.
- H. Tie Rods: Stainless steel, 1/4-inch diameter for lengths 36 inches or less; 3/8-inch diameter for lengths longer than 36 inches for use in ducts in humid or corrosive atmospheres.
- I. Bird Screens: No. 2 mesh, 0.063 inch diameter galvanized wire screen with open area of not less than 72 percent. Conceal sharp edges by adding metal edging consisting of rod, flat or angle iron, or 16 gage galvanized sheet steel turned over at least 3/4 inch on both sides.

2.3 BACKDRAFT DAMPERS

- A. Manufacturers:
 - 1. American Warming and Ventilating.
 - 2. Greenheck.
 - 3. Ruskin Company.
- B. Description: Multiple-blade, parallel action counterbalanced, with blades of maximum 6-inch width, with sealed edges, assembled in rattle-free manner with 90-degree stop, steel ball bearings, and axles; adjustment device to permit setting for varying differential static pressure.
- C. Performance: Based on tests in accordance with AMCA Standard 500:
 - 1. Pressure drop not to exceed 0.15 inch wg at face velocity of 2500 fpm.

2. Leakage not to exceed 9.2 cfm per square foot at 1 inch wg differential and temperature of 70 deg F.

- D. Frame: 0.052-inch- thick, galvanized sheet steel or 0.063-inch- thick extruded aluminum, with welded corners and mounting flange.
- E. Blades: 0.025-inch- thick, roll-formed aluminum or 0.050-inch- thick aluminum sheet.
- F. Blade Seals: Manufacturer's standard seal material.
- G. Blade Axles: Nonferrous or galvanized steel.
- H. Tie Bars and Brackets: Aluminum or galvanized steel.

2.4 LOW PRESSURE MANUAL VOLUME DAMPERS

A. Manufacturers:

- 1. American Warming and Ventilating.
- 2. Arrow United Industries.
- 3. Greenheck.
- 4. Krueger.
- 5. Louvers and Dampers.
- 6. Nailor Industries Inc.
- 7. Ruskin Company.
- 8. Vent Products Company, Inc.
- 9. Young Regulator Company.

B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

- 1. Except for dampers in round ductwork sized 12 inches and smaller, provide end bearings.

C. Rectangular Volume Dampers: Multiple-opposed-blade design, AMCA certified for maximum leakage of 2 percent of total fan volume at shutoff, and suitable for horizontal or vertical applications.

D. Round Volume Dampers 16-inch Diameter and Smaller: Single-blade design, AMCA certified for maximum leakage of 2 percent of total fan volume at shutoff, and suitable for horizontal or vertical applications.

- E. Round Volume Dampers Larger than 16-inch Diameter: Multiple-opposed-blade design AMCA certified for maximum leakage of 2 percent of total fan volume at shutoff, and suitable for horizontal or vertical applications.
- F. Damper Materials:
1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
 2. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized sheet steel.
 3. Blade Axles: Galvanized steel.
 4. Bearings: Oil-impregnated bronze, molded synthetic, or stainless-steel sleeve type.
 5. Tie Bars and Brackets: Galvanized steel.
- G. Jackshaft: 1-inch- diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.
- H. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.5 MOTORIZED CONTROL DAMPERS

- A. Refer to Division 15 Section "Temperature Controls."

2.6 FIRE DAMPERS (CURTAIN STYLE)

- A. Manufacturers:
1. Air Balance, Inc.
 2. Greenheck.
 3. NCA Manufacturing, Inc.
 4. Nailor Industries Inc.
 5. Ruskin Company.
- B. Dynamic fire dampers with curtain style blades, and labeled according to UL 555, maximum velocity 2000 fpm, maximum static pressure 4 inches w.g.

- C. Fire Rating:
 - 1. 1-1/2 hours for 2 hour rated walls.
 - 2. 3 hours for 4 hour rated walls.

- D. Frame: Type B or Type C Curtain type with blades outside airstream; fabricated with roll-formed, galvanized steel in gages required by manufacturer's UL listing; with mitered and interlocking corners.

- E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
 - 1. Thickness: Equal to or thicker than the duct connected to it, and of length to suit application.
 - 2. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor, and thickness of damper frame complies with sleeve requirements.

- F. Mounting Orientation: Vertical or horizontal as indicated.

- G. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

- H. Fusible Links: Replaceable, 165 deg F rated.

2.7 SMOKE DAMPERS

- A. Manufacturers:
 - 1. Air Balance, Inc.
 - 2. Greenheck.
 - 3. Nailor Industries Inc.
 - 4. NCA Manufacturing, Inc.
 - 5. Ruskin Company.

- B. General Description: Smoke dampers with airfoil blades, labeled according to UL 555S, with minimum Class II leakage rating.

- C. Frame and Blades: 16 gage, galvanized sheet steel.

- D. Mounting Sleeve: Factory-installed, galvanized sheet steel.
 - 1. Thickness: Equal to or thicker than the duct connected to it, and of length to suit application.

- E. Rated pressure and velocity to exceed design airflow conditions.
- F. Damper Actuators: Electric modulating or two-position action as required.
 - 1. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 - 2. Size for torque required for damper seal at load conditions.
 - 3. Overload Protection: Microprocessor or an electronic based motor controller providing burnout protection if stalled before full rotation is reached. The actuator shall be electronically cut off at full open to eliminate noise generation with the holding noise level to be inaudible.
 - 4. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
 - 5. Power Requirements (Two-Position Spring Return): 24 or 120 V ac.
 - 6. Power Requirements (Proportional): Maximum (running) 12 VA at 24-V ac or 8 W at 24-V dc. Maximum (holding) 5VA at 24-V ac or 3 W at 24-V dc holding.
 - 7. Proportional Actuators (24V ac/dc): Control signal shall be 0-10vdc, 2-10vdc or 4-20mA as required to operate with associated controller. Include position feedback signal for 0-10vdc, 2-10vdc or 4-20mA as required to be monitored by associated controller.
 - 8. Actuator timing shall meet 15 sec.
 - 9. Temperature Rating: Actuator shall have a UL555S listing by the damper manufacturer for 250 deg F.
- G. Damper blade position end switches: Factory installed damper position switch package for both full open and full closed indication (equivalent to Ruskin SP100 switch package).
- H. Test Switch: Damper mounted momentary "test" push-button mounted 2-position "open/closed" toggle switch rated for 24V or 120V as required to allow testing and/or maintenance of motorized dampers.

2.8 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers:

1. Air Balance, Inc.
 2. Greenheck.
 3. Nailor Industries Inc.
 4. NCA Manufacturing, Inc.
 5. Ruskin Company.
- B. General Description: Combination fire and smoke dampers shall be labeled according to UL 555 and UL 555S. Leakage shall not exceed 10 cfm per square foot at 1 inch WG differential pressure (Leakage Class II).
- C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.
- D. Fire Rating:
1. 1-1/2 hours for 2 hour rated walls.
 2. 3 hours for 4 hour rated walls.
- E. Frame and Blades: 0.064-inch- thick, galvanized sheet steel.
- F. Mounting Sleeve: Factory-installed, galvanized sheet steel.
1. Thickness: Equal to or thicker than the duct connected to it, and of length to suit application.
- G. Rated pressure and velocity to exceed design airflow conditions.
- H. Damper Actuators: Electric modulating or two-position action as required.
1. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 2. Size for torque required for damper seal at load conditions.
 3. Overload Protection: Microprocessor or an electronic based motor controller providing burnout protection if stalled before full rotation is reached. The actuator shall be electronically cut off at full open to eliminate noise generation with the holding noise level to be inaudible.
 4. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
 5. Power Requirements (Two-Position Spring Return): 24 or 120 V ac.

6. Power Requirements (Proportional): Maximum (running) 12 VA at 24-V ac or 8 W at 24-V dc. Maximum (holding) 5VA at 24-V ac or 3 W at 24-V dc holding.
 7. Proportional Actuators (24V ac/dc): Control signal shall be 0-10vdc, 2-10vdc or 4-20mA as required to operate with associated controller. Include position feedback signal for 0-10vdc, 2-10vdc or 4-20mA as required to be monitored by associated controller.
 8. Actuator timing shall meet 15 sec.
 9. Temperature Rating: Actuator shall have a UL555S listing by the damper manufacturer for 250 deg F.
- I. Manual Heat Responsive Fuse Link with Reset and Damper Blade Position End Switches: Factory installed manual heat responsive fuse link with reset switch / damper position switch package for both full open and full closed indication (equivalent to Ruskin TS150 switch package).
 - J. Test Switch: Damper mounted momentary "test" push-button mounted 2-position "open/closed" toggle switch rated for 24V or 120V as required to allow testing and/or maintenance of motorized dampers.
- 2.9 DUCT SILENCERS (FIBERGLASS FILL)
- A. Manufacturers:
 1. Industrial Acoustics Co. Inc.
 2. Price Industries.
 3. Ruskin Company.
 4. VAW Systems Ltd.
 5. Vibro-Acoustics.
 - B. General Requirements:
 1. Factory fabricated.
 2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84.
 - C. Rectangular Units: Unless otherwise scheduled on the Drawings, fabricate casings with a minimum of 20 gage, solid galvanized sheet metal for outer casing and 22 gage, ASTM A 653/A 653M, G90, perforated galvanized sheet metal for inner casing.
 - D. Round Units: Unless otherwise scheduled on the Drawings:

1. Outer Casings:
 - a. ASTM A 653/A 653M, G90, galvanized sheet steel.
 - b. Up to 8 Inches in Diameter: 24 gage.
 - c. 9 through 22 Inches in Diameter: 22 gage.
 - d. 24 through 36 Inches in Diameter: 20 gage.
 - e. 38 through 50 Inches in Diameter: 18 gage.
 - f. 52 through 60 Inches in Diameter: 16 gage.
 - g. Casings fabricated of spiral lock-seam duct may be one gage thinner than that indicated.
 2. Interior Casing, Partitions, and Baffles:
 - a. ASTM A 653/A 653M, G90, galvanized sheet steel.
 - b. At least 24 gage thick and designed for minimum aerodynamic losses.
- E. Sheet Metal Perforations: 1/8-inch diameter for inner casing and baffle sheet metal.
- F. Fill Material: Inert and vermin-proof fibrous glass material, packed under not less than 5 percent compression.
1. Erosion Barrier: Mylar film with 1/4-inch standoff.
 - a. Return fan inlet and outlet silencer fill shall not be encapsulated in Mylar.
- G. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations.
1. Do not use nuts, bolts, or sheet metal screws for unit assemblies.
 2. Lock form and seal or continuously weld joints.
 3. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
 4. Reinforcement: Cross or trapeze angles for rigid suspension.
- H. Source Quality Control:
1. Acoustic Performance: Test according to ASTM E 477.
 - a. Tests performed in NVLAP accredited laboratory.
 - b. Include accreditation certificate with submittals.
 - c. Submittals from non-NVLAP accredited facilities will not be accepted.
 2. Record acoustic ratings, including dynamic insertion loss and self-noise power levels with an airflow of at least 2000-fpm face velocity.

3. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg static pressure, whichever is greater.

2.10 TURNING VANES

A. Manufactured Turning Vanes:

1. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.
2. Double-vane or airfoil-shaped, curved blades of galvanized sheet steel set into vane runners suitable for duct mounting.
3. Generated sound power level shall not exceed 54 decibels in octave band 4 at 2000 fpm in a 24-inch by 24-inch duct.
4. Manufacturers:
 - a. Aero/Dyne Company; H-E-P Turning Vanes.
 - b. Ductmate Industries, Inc.
 - c. Duro Dyne Corp.
 - d. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Manufactured Acoustic Turning Vanes:

1. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.
2. Double-vane curved blades of galvanized sheet steel with perforated faces and fibrous-glass fill set into vane runners suitable for duct mounting.
3. Manufacturers:
 - a. Ductmate Industries, Inc.
 - b. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

2.11 DUCT-MOUNTING ACCESS DOORS

- A. General Description: Fabricate doors airtight and suitable for duct pressure class. Doors may be field fabricated in accordance with SMACNA Standards, or commercially produced.
- B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch butt or piano hinge and cam latches.

1. Manufacturers:
 - a. Air Balance, Inc.
 - b. Greenheck.
 - c. Nailor Industries Inc.
 - d. Ruskin Company.
 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 3. Provide number of hinges and locks as follows:
 - a. Less Than 12 Inches Square: Secure with two sash locks.
 - b. Up to 18 Inches Square: Two hinges and two compression locks.
 - c. Up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
 - d. Sizes 24 by 48 Inches and Larger: One additional hinge.
- C. Door: Double wall, duct mounting, and round; fabricated of galvanized sheet metal with insulation fill and 1-inch thickness. Include cam latches.
1. Manufacturers:
 - a. Ductmate Industries, Inc.
 - b. Flexmaster U.S.A., Inc.
 2. Frame: Galvanized sheet steel, with spin-in notched frame.
- D. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.
- E. Insulation: 1-inch-thick, fibrous-glass or polystyrene-foam board.
- 2.12 FLEXIBLE CONNECTORS
- A. Manufacturers:
 1. ADSCO Manufacturing LLC.
 2. Duro Dyne Corp.
 3. Senior Flexonics Pathway.
 4. Ventfabrics, Inc.
 - B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
 - C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-

inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Select metal compatible with ducts.

- D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
1. Minimum Weight: 26 oz./sq. yd..
 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 3. Service Temperature: Minus 40 to plus 200 deg F.
- E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
1. Minimum Weight: 24 oz./sq. yd..
 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 3. Service Temperature: Minus 50 to plus 250 deg F.

2.13 FLEXIBLE DUCTS, LOW AND MEDIUM PRESSURE

- A. Manufacturers:
1. Flexmaster Type 8M, UL 181, Class 1.
 2. Automation Industries Thermaflex.
 3. Hart & Cooley.
- B. Flexible Ducts: Interlocking spiral of galvanized steel or aluminum construction or fabric supported by helically wound spring steel wire or flat steel bands; rated to 6 inches WG positive and 4 inches WG negative for low and medium pressure ducts.
- C. Insulated Flexible Ducts: Flexible duct wrapped with flexible glass fiber insulation, enclosed by a fire retardant polyethylene vapor barrier jacket; maximum 0.23 K value at 75 deg F.
- D. Acoustical performance tested in accordance with the Air Diffusion Council's *Flexible Air Duct Test Code FD 72-R1, Section 3.0, Sound Properties* shall be as follows:

The insertion loss (dB) of a 10 foot length of straight duct when tested in accordance with ASTM E477, at a velocity of 2500 feet per minute, shall be minimum:

Octave Band	2	3	4	5	6	7
Hz.	125	250	500	1000	2000	4000
6" diameter	8	32	38	35	39	25

8" diameter	13	32	36	35	36	21
12" diameter	15	29	28	33	26	14

The radiated noise reduction (dB) of a 10 foot length of straight duct when tested in accordance with ASTM E477, at a velocity of 2500 feet per minute, shall be minimum:

Octave Band	2	3	4	5	6	7
Hz.	125	250	500	1000	2000	4000
6" diameter	6	8	7	8	9	13
8" diameter	9	6	6	7	8	10
12" diameter	9	7	6	6	8	11

The self generated sound power levels (LW) dB are 10-12 Watt of a 10 foot length of straight duct for an empty sheet metal duct when tested in accordance with ASTM E477, at a velocity of 1000 feet per minute, shall not exceed:

Octave Band	2	3	4	5	6	7
Hz.	125	250	500	1000	2000	4000
6" diameter	42	31	23	18	17	21
8" diameter	41	34	27	19	18	21
12" diameter	53	44	36	27	21	22

- E. Flexible Duct Fittings: Galvanized steel, twist-in design with damper. Size as indicated.
- F. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 through 18 inches to suit duct size.

2.14 FLEXIBLE DUCT ELBOW SUPPORTS

- A. Manufacturer:
 - 1. Automation Industries Thermaflex; FlexFlow Elbow.
 - 2. Smart Air & Energy Solutions; SMART Flow Elbow.
- B. Elbow supports shall be constructed of durable composite material and be fully adjustable to support flexible duct diameters 6 inches through 16 inches.
- C. Elbow supports shall be UL listed for use in return air plenum spaces.

2.15 DUCT ACCESSORY HARDWARE

- A. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.16 FINISHES

- A. Chemical Resistant Coating: P-403 manufactured by Heresite Chemical Company.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts and PVC coated ducts; and aluminum accessories in aluminum ducts.
- C. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - 1. Install steel volume dampers in steel ducts.
 - 2. Install stainless steel volume dampers in stainless steel ducts.
 - 3. Install aluminum volume dampers in aluminum ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install fire dampers, combination fire and smoke dampers, and smoke dampers according to UL listing.
- G. Install duct silencers rigidly to ducts.
- H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. On upstream side of duct coils.

2. Upstream from duct filters.
 3. At outdoor-air intakes and mixed-air plenums.
 4. At drain pans and seals.
 5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 7. Control devices requiring inspection.
 8. Elsewhere as indicated.
- I. Install access doors with swing against duct static pressure.
- J. Install duct-mounting, rectangular access doors with long dimension at right angles to direction of airflow and of largest standard size which can be accommodated in duct. Maximum size: 21 by 14 inches.
- K. Install pressure relief doors vertically and level in accordance with manufacturer's instructions, between the fan and first operable damper.
- L. Label access doors according to Division 15 Section "Mechanical Identification."
- M. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.
- N. For fans developing static pressures of 5-inch wg and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- O. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.
- P. Connect diffusers or light troffer boots to low pressure ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- Q. Connect flexible ducts to metal ducts with draw bands.

- R. Install flexible duct elbow supports at each diffuser, grille, or register, and elsewhere as indicated.
- S. Install turning vanes in rectangular duct elbows in excess of 45 degrees, and where indicated:
 - 1. Use manufactured double-vane turning vanes unless otherwise specified.
 - 2. Seat outboard-most vane in heel of duct elbow.
 - 3. Provide vanes for all runner punchings, practice of eliminating every other vane is prohibited.
 - 4. Use single-vane turning vanes in low pressure square elbows.

3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Operate dampers to verify full range of movement.
 - 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 - 3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
 - 4. Inspect turning vanes for proper and secure installation.
 - 5. Operate remote damper operators to verify full range of movement of operator and damper.

3.3 ADJUSTING

- A. Adjust duct accessories for proper settings.
- B. Adjust fire dampers, combination fire and smoke dampers, and smoke dampers for proper action.
- C. Final positioning of manual-volume dampers is specified in Division 15 Section "Testing, Adjusting, and Balancing."

END OF SECTION 15820

SECTION 15838 - POWER VENTILATORS

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 PERFORMANCE REQUIREMENTS.....1
1.3 SUBMITTALS.....2
1.4 QUALITY ASSURANCE.....3
1.5 DELIVERY, STORAGE, AND HANDLING.....3
1.6 COORDINATION.....3
1.7 EXTRA MATERIALS.....3

PART 2 - PRODUCTS.....4
2.1 IN-LINE CENTRIFUGAL FANS.....4
2.2 CENTRIFUGAL ROOF VENTILATORS.....5
2.3 UPBLAST CENTRIFUGAL ROOF VENTILATORS.....6
2.4 KITCHEN HOOD EXHAUST FANS.....7
2.5 ROOF CURBS AND ACCESSORIES.....8
2.6 MOTORS.....9
2.7 SOURCE QUALITY CONTROL.....9

PART 3 - EXECUTION.....9
3.1 INSTALLATION.....9
3.2 CONNECTIONS.....10
3.3 FIELD QUALITY CONTROL.....10
3.4 ADJUSTING.....11

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 15 Section "Mechanical General Requirements."
 - 2. Division 15 Section "Motors."
 - 3. Division 15 Section "Common Work Results for HVAC" for common mechanical drive requirements for fans and air moving equipment.

1.2 PERFORMANCE REQUIREMENTS

- A. Classify according to AMCA 99.

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material thickness and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Roof curbs.
 - 7. Fan speed controllers.

- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
 - 2. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
 - 3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

- C. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Roof framing and support members relative to duct penetrations.
 - 2. Ceiling suspension assembly members.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

- D. Field quality-control test reports.

- E. Operation and Maintenance Data: For power ventilators to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.
- B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- D. UL Standard: Power ventilators shall comply with UL 705.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

1.6 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- C. Coordinate delivery and placement of roof curbs, and equipment supports. Installation of roof curbs, equipment supports, and roof penetrations is specified in Division 07 Section "Roof Accessories."

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective

covering for storage and identified with labels describing contents.

1. Belts: One set for each belt-drive unit.

PART 2 - PRODUCTS

2.1 IN-LINE CENTRIFUGAL FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Acme Engineering & Mfg. Corp.
 2. Aerovent; a Twin City Fan Company.
 3. Greenheck; SQ/BSQ Series.
 4. Loren Cook Company.
 5. Moffitt Corporation, Inc.
 6. PennBarry; a unit of Tomkins PLC.
- B. Description: In-line, belt-driven centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.
- C. Casing: Rectangular or cylindrical, flanged.
- D. Throat and Mounting Assembly: One-piece spun aluminum or continuously welded assembly.
 1. Stiffeners: Continuously welded.
 2. Bolts, nuts, rivets, and washers: Cadmium plated.
 3. Nuts: Self-locking type, vibration proof.
- E. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.
- F. Fan Wheels: Aluminum, backward curved airfoil blades welded to aluminum hub.
- G. Accessories:
 1. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
 2. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.
- H. Capacities and Characteristics: Refer to schedule(s) on Drawings.

- I. Vibration Isolators: Refer to Division 15 Section "Mechanical Vibration Controls."

2.2 CENTRIFUGAL ROOF VENTILATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Acme Engineering & Mfg. Corp.; Models PRN and PV.
 2. Aerovent; a Twin City Fan Company.
 3. Greenheck; Models G and GB.
 4. Loren Cook Company; Models ACED and ACEB.
 5. Moffitt Corporation, Inc.
 6. PennBarry; a unit of Tomkins PLC; Domex.
- B. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
- C. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
- D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- E. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 3. Sheaves: Cast-iron, adjustable-pitch motor sheave.
 4. Fan and motor isolated from exhaust airstream.
 5. Refer to Division 15 Section "Common Work Results for HVAC" for additional requirements.
- F. Accessories:
1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
 2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
- G. Provide prefabricated roof curbs for each fan.

H. Capacities and Characteristics: Refer to schedule(s) on Drawings.

2.3 UPBLAST CENTRIFUGAL ROOF VENTILATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Acme Engineering & Mfg. Corp.
 2. Aerovent; a Twin City Fan Company.
 3. Greenheck; CUBE Series.
 4. Loren Cook Company.
 5. Moffitt Corporation, Inc.
 6. PennBarry; a unit of Tomkins PLC; Fumex.
- B. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
- C. Housing: Spun-aluminum construction with square, one-piece, aluminum base with venturi inlet cone. Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
- D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- E. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 3. Sheaves: Cast-iron, adjustable-pitch motor sheave.
 4. Fan and motor isolated from exhaust airstream.
 5. Refer to Division 15 Section "Common Work Results for HVAC" for additional requirements.
- F. Accessories:
1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
 2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
- G. Provide prefabricated roof curbs for each fan.

H. Capacities and Characteristics: Refer to schedule(s) on Drawings.

2.4 KITCHEN HOOD EXHAUST FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Acme Engineering & Mfg. Corp.; Models PDURG and PNURG.
 2. Aerovent; a Twin City Fan Company.
 3. Greenheck; CUBE Series.
 4. JencoFan; Div. of Breidert Air Products.
 5. Loren Cook Company.
 6. Moffitt Corporation, Inc.
 7. PennBarry; a unit of Tomkins PLC; Fumex with Fatrap.
- B. Description: UL 762 labeled belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, heat baffle, curb base, and accessories.
- C. Housing: Spun-aluminum construction with square, one-piece, aluminum base with venturi inlet cone. Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains, grease collector, and drain connection.
1. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
- D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- E. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 3. Sheaves: Cast-iron, adjustable-pitch motor sheave.
 4. Fan and motor isolated from exhaust airstream.
 5. Refer to Division 15 Section "Common Work Results for HVAC" for additional requirements.
- F. Accessories:
1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.

G. Provide prefabricated roof curbs for each fan. Provide vented curb extension as required to locate fan discharge at a minimum of 40 inches above the roof.

H. Capacities and Characteristics: Refer to schedule(s) on Drawings.

2.5 ROOF CURBS AND ACCESSORIES

A. Construction: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch chemically treated wood nailer. Size as required to suit roof opening and fan base.

1. Manufacturers: Roof curbs shall be provided by the fan manufacturer, or one of the following:

a. Creative Metals.

b. Pate.

c. Roof Products & Systems.

d. ThyCurb.

e. Any of the approved roof mounted exhaust fan manufacturers.

2. Configuration: Self-flashing without a cant strip, with mounting flange, and suitable for flat roofs with tapered insulation.

3. Height: Curb shall extend a minimum 8 inches above top surface of roof insulation.

4. Sound Curb: Curb with sound-absorbing insulation matrix.

5. Metal Liner: Galvanized steel.

6. Burglar Bars: Minimum 1/2-inch- thick steel bars welded in place to form 6-inch squares.

7. Mounting Pedestal: Galvanized steel with removable access panel.

B. Roof Curb Extensions and Adapters:

1. Manufacturers: Roof curbs shall be provided by the fan manufacturer, or one of the following:

a. Creative Metals.

b. Pate.

c. Roof Products & Systems.

d. ThyCurb.

- e. Any of the approved roof mounted exhaust fan manufacturers.
- 2. Curb Extensions: Constructed of minimum 18 ga. galvanized steel.
 - a. 4-inch high construction with no damper shelf and no damper access.
 - b. 8-inch high construction with damper shelf; and removable panel, or access door.
 - c. 12-inch high construction with damper shelf; and removable panel, or access door (minimum required for motorized damper).
- 3. Curb Adapters: Constructed of minimum 18 ga. galvanized steel and designed to adapt or reduce curb cap dimensions to match new fans to existing roof curbs.

2.6 MOTORS

- A. Comply with requirements in Division 15 Section "Motors."

2.7 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Install floor-mounting units as specified in Division 15 Section "Mechanical Vibration Controls."
- C. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Division 07 Section "Roof Accessories" for installation of roof curbs.

- D. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
- E. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch. Vibration-control devices are specified in Division 15 Section "Mechanical Vibration Controls."
- F. Install units with clearances for service and maintenance.
- G. Label units according to requirements specified in Division 15 Section "Mechanical Identification."

3.2 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 15 Section "Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment according to Division 16 Section "Grounding and Bonding."
- D. Connect wiring according to Division 16 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive

- system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
 6. Adjust damper linkages for proper damper operation.
 7. Verify lubrication for bearings and other moving parts.
 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 10. Shut unit down and reconnect automatic temperature-control operators.
 11. Remove and replace malfunctioning units and retest as specified above.

- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Refer to Division 15 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor sheaves as required to achieve design airflow.
- E. Lubricate bearings.

END OF SECTION 15838

SECTION 15855 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUBMITTALS.....1

PART 2 - PRODUCTS.....2
2.1 AIR DIFFUSION DEVICES.....2
2.2 SOURCE QUALITY CONTROL.....3

PART 3 - EXECUTION.....3
3.1 EXAMINATION.....3
3.2 INSTALLATION.....3
3.3 ADJUSTING.....4

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 10 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
 - 2. Division 15 Section "Mechanical General Requirements."
 - 3. Division 15 Section "Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.2 SUBMITTALS

- A. Product Data: For each product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate Drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and

coordinated with each other, based on input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

PART 2 - PRODUCTS

2.1 AIR DIFFUSION DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 1. Krueger; Tomkins PLC.
 2. Nailor Industries of Texas Inc.
 3. Price Industries.
 4. Titus; Tomkins PLC.
- B. Terminal air diffusion devices have been chosen in terms of specific air distribution requirements, spacing, and sound characteristics.
- C. Provide plaster frames for units installed in plaster ceilings.
- D. Provide gaskets for supply terminal air devices mounted in finished surfaces.
- E. Finish:
 1. Air Diffusion Device Face and Visible Trim: Standard off white baked enamel finish unless noted otherwise.
 2. Air Diffusion Device Interior Surfaces, Including Blank-Offs: Black matte finish.
- F. Air pattern adjustments shall be made from the face of the device.
- G. Refer to drawings and schedules for quantities, types, and finishes.
- H. Coordinate frame types with Architectural Reflected Ceiling Plan.

2.2 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."
- B. Acoustical Applications and Sound Evaluation: Based on ARI Standard 885-98, "Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Wall-Mounted Supply Registers: Install 6 inches below finished ceiling unless otherwise indicated.
- D. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 15855

SECTION 15900 - TEMPERATURE CONTROLS

PART 1 - GENERAL.....	2
1.1 RELATED DOCUMENTS.....	2
1.2 SUMMARY.....	2
1.3 DEFINITIONS.....	2
1.4 SYSTEM DESCRIPTION.....	2
1.5 SEQUENCE OF OPERATION.....	3
1.6 SUBMITTALS.....	3
1.7 REFERENCES.....	8
1.8 QUALITY ASSURANCE.....	8
1.9 DELIVERY, STORAGE, AND HANDLING.....	9
1.10 COORDINATION	9
1.11 WARRANTY	10
1.12 POSTED OPERATING INSTRUCTIONS	10
1.13 SPECIAL TOOLS	10
1.14 PROTECTION OF PROPRIETARY INFORMATION	11
PART 2 - PRODUCTS.....	11
2.1 DESCRIPTION OF THE BUILDING AUTOMATION SYSTEM (BAS).....	11
2.2 BAS BUILDING NETWORK SUPERVISORY CONTROLLER.....	11
2.3 DIRECT DIGITAL CONTROL (DDC) FIELD LEVEL CONTROLLERS.....	12
2.4 DDC CONTROLLER SOFTWARE.....	13
2.5 DDC UNITARY EQUIPMENT CONTROLLERS.....	19
2.6 DDC UNIT VENTILATOR CONTROLLERS.....	20
2.7 DDC INPUT/OUTPUT SENSORS.....	20
2.8 DDC DATA COMMUNICATIONS NETWORK.....	24
2.9 CONTROL AND INSTRUMENTATION TUBING.....	25
2.10 CONTROL VALVES AND VALVE OPERATORS	25
2.11 DAMPERS - AUTOMATED	28
2.12 DAMPERS, INSULATED OUTDOOR AIR / RELIEF AIR / EXHAUST AIR - AUTOMATED.....	30
2.13 DAMPER OPERATORS - ELECTRIC	31
2.14 THERMOSTATS - ELECTRONIC & ELECTRIC	31
2.15 EMERGENCY POWER-OFF (EPO) PUSH-BUTTON	32
2.16 ELECTRICAL REQUIREMENTS FOR CONTROLS WORK	32
PART 3 - EXECUTION.....	33
3.1 INSTALLATION - CONTROL SYSTEMS.....	33
3.2 IDENTIFICATION AND MARKING.....	35
3.3 GRAPHIC DISPLAY GENERATION.....	36
3.4 OWNER INSTRUCTION AND TRAINING.....	37
3.5 CALIBRATION AND START-UP.....	37
3.6 ACCEPTANCE PROCEDURE.....	38

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.
- B. Related Sections include the following:
 - 1. Division 15 Section "Mechanical General Requirements."
 - 2. Division 15 Section "Basic Mechanical Materials and Methods."
 - 3. Division 15 Section "Testing, Adjusting, and Balancing."

1.2 SUMMARY

- A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

1.3 DEFINITIONS

- A. BACnet: Communications open protocol for building automation system networks and control (developed by ASHRAE and documented per ANSI/ASHRAE Standard 135-2012).
- B. BAS: Building Automation System
- C. CAD: Computer Aided Design.
- D. DDC: Direct-digital controls.

1.4 SYSTEM DESCRIPTION

- A. Temperature control building automation system consisting of BACnet (BTL certified) direct digital control system controllers, sensors, transducers, relays, switches, data communication network, etc. and all associated control wiring and raceway systems.
- B. BAS/DDC system programming, database generation for TC Contractor and 3rd party BACnet controllers. Graphic display generation accessible through Building Network

Supervisory Controller or at the remote operator workstation (when applicable for project).

- C. Electric thermostats, control valves, dampers, operators, control wiring, etc.
- D. Gauges, indicating devices, electric and electronic control accessories, and other control system devices.

1.5 SEQUENCE OF OPERATION

- A. Control sequences for HVAC systems, subsystems, and equipment are indicated on project drawings.

1.6 SUBMITTALS

- A. Submit under Division 15 provisions of respective project and as supplemented in this section.
- B. All control submittal requirements shall be submitted at one time with exception to control valves, automated dampers, and initial phases of work associated with fast-track projects (when required). Early submittals of control valve and automated dampers shall be incorporated with the complete temperature controls submittal.
- C. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
 - 1. Each control device labeled with setting or adjustable range of control
- D. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- E. Shop Drawings:
 - 1. Shop drawings shall be done on CAD. Minimum size 11" x 17".
 - 2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.

3. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
 4. Details of control enclosure including panel faces and interior, including controls, instruments, terminations blocks and component labeling.
 5. Written sequence of operation for each controlled system.
 6. Schedule of dampers including size, leakage, and flow characteristics (Refer to Design Data).
 7. Schedule of valves including leakage and flow characteristics (Refer to Design Data).
 8. Complete bill of materials to identify and quantify all control components
 9. Overall system schematic showing communication trunk cabling from Building Network Supervisory Controller(s) to BAS field level controllers including component locations and wire termination details.
 10. DDC controller layouts showing connected data points and LAN connections. DDC controller terminations including power supply and remote control component termination details shall be provided.
 11. Point list for each DDC controller including point descriptions and addresses. This information may be incorporated with DDC controller layouts.
 12. List of system graphics to be provided with proposed tree diagram of graphics organization. Items to include: Each system, floor plan.
- F. Graphic Displays: One month after TC Shop Drawing submittal, TC Contractor shall submit graphical display backgrounds for preliminary Engineer review. Concept for each floor plan, each system, each terminal unit template. Engineer understands that final representation of graphics may not be available until BAS database is established during course of construction. Thorough graphics review will be conducted by Engineer as part of the TC/BAS acceptance procedure.
- G. Design Data: Provide indicated component selection and sizing criteria for the following component categories:
1. Control valves:
 - a. Component tag.
 - b. Equipment served/function.
 - c. Media type.

- d. Design flow rate (GPM).
 - e. Design pressure drop (ft. head) or (psi), where applicable.
 - f. Calculated valve Cv where applicable.
 - g. Selected valve Cv where applicable.
 - h. Resultant pressure drop (ft. head) or (psi) with selected valve.
 - i. Valve size.
 - j. Line size to valve connection (excluding reducers).
 - k. Type (ball, butterfly, globe, etc.).
 - l. Configuration (2-way, 3-way mixing, 3-way diverting).
 - m. Normal position (normally open, normally closed, floating).
 - n. Actuator spring range (where applicable).
 - o. Actuator power requirement.
 - p. Valve shut-off rating (ft. head) or (psi)
 - q. Valve body pressure/temperature rating.
 - r. Valve manufacturer/model number.
 - s. Actuator manufacturer/model number.
2. Dampers:
- a. Component tag.
 - b. Equipment served/function.
 - c. Overall damper size (inch width x inch height).
 - d. Quantity of damper sections with respective size(s):
 - e. Material and gauge of thickness.
 - f. Mounting orientation (horizontal or vertical).
 - g. Blade configuration (parallel or opposed)
 - h. Pressure drop (in. WG).
 - i. Shut-off rating/differential pressure rating (in. wg).
 - j. Leakage rating (CFM/sq. ft. at 4 in. wg).
 - k. Normal position (normally open, normally closed, floating).
 - l. Actuator spring range (where applicable).
 - m. Actuator power requirement.
 - n. Actuator torque requirement.
 - o. Actuator quantity.
 - p. Damper manufacturer/model number.
 - q. Actuator manufacturer/model number.
3. Flow measuring probes - Air:

- a. Component tag.
 - b. Equipment served/function.
 - c. Duct dimension (inch width x inch height) if applicable.
 - d. Fan inlet diameter (inch) if applicable)
 - e. Probe quantity.
 - f. Probe length.
 - g. Flow rate (CFM).
 - h. Flow velocity (FPM).
 - i. Probe manufacturer/model number.
 - j. Transmitter manufacturer/model number.
4. Flow measuring probes - Water:
- a. Component tag.
 - b. Equipment served/function.
 - c. Pipe size/inside diameter (inch)
 - d. Probe length (inch).
 - e. Flow rate (GPM).
 - f. Flow velocity (FPS).
 - g. Probe manufacturer/model number.
 - h. Transmitter manufacturer/model number.
5. Flow measuring stations - Air:
- a. Component tag.
 - b. Equipment served/function.
 - c. Duct dimension (inch width x inch height).
 - d. Station dimension (inch width x inch height).
 - e. Flow rate (CFM).
 - f. Flow velocity (FPM).
 - g. Pressure drop (in. wg).
 - h. Station manufacturer/model number.
 - i. Transmitter manufacturer/model number.
6. Gauges:
- a. Component tag.
 - b. Equipment served/function.
 - c. Units/range of scale
- H. Wall mounted temperature sensor, thermostat and/or other temperature control device cover color shall be coordinated to match color of wall mounted electrical device components and cover plates - coordinate with electrical contractor. Provide samples of available temperature control device cover colors to Architect upon request or if available temperature control device colors

do not match electrical device colors so a desired color selection may be determined. Provide sample of temperature sensor / thermostat guard upon request of Architect, Engineer or Owner.

- I. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
- J. Submit field reports indicating operating conditions after detailed check out of systems at Date of Substantial Completion.
- K. Project Record Documents: Include the following:
 - 1. Revise Shop Drawings to reflect actual installation and operating sequences.
 - 2. Record actual locations of control components, including control units, thermostats, and sensors.
 - 3. Submit the electronic files for all as-built shop drawings on diskette in pdf format.
- L. Software and Firmware Operational Documentation: Include the following:
 - 1. DDC controller keypad operating instructions and DDC controller override features, where applicable.
 - 2. Device address list.
 - 3. Program Software Backup: On a magnetic media or compact disc, complete with data files.
 - 4. Software license required by and installed for DDC workstations and control systems.
 - 5. DDC workstation software operating instructions for scheduling equipment, trending data, displaying graphics, commanding points, adding/deleting/modifying points, changing setpoints, and setting up alarms.
 - 6. Advanced DDC workstation operating instructions for graphics generation, control sequence programming and program modification.
 - 7. Printout of software applications and graphic screens.
- M. Maintenance Manuals: Include the following:
 - 1. Product data with installation details, maintenance instructions and lists of spare parts for each type of control device.
 - 2. Keypad illustrations and step-by-step procedures indexed for each operator function, where applicable.

3. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
4. Calibration records and list of set points.

1.7 REFERENCES

- A. AMCA 500 - Test Methods for Louvers, Dampers and Shutters.
- B. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure fittings.
- C. ANSI/ASTM B32 - Solder Metal.
- D. ANSI/NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- E. ANSI/NFPA 90A - Installation of Air Conditioning and Ventilation Systems.
- F. ASTM B280 - Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- G. ASTM B75 - Seamless Copper Tube for General Engineering Purposes.
- H. ASTM D1693 - Environmental Stress - Cracking of Ethylene Plastics.
- I. NEMA DC 3 - Low-Voltage Room Thermostats.
- J. ASTM E1 - Specification for ASTM Thermometers.
- K. UL 1820 - Fire Test of Pneumatic Tubing for Flame and Smoke Characteristics Only.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is a certified installer of the automatic control system manufacturer for both installation and maintenance of units required for this Project.
- B. Manufacturer Qualifications: A firm experienced in manufacturing automatic temperature-control systems similar to those indicated for this Project and with a record of successful in-service performance.

- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated or optional to be factory mounted on equipment, arrange for shipping of control devices to unit manufacturer.

1.10 COORDINATION

- A. Coordinate work under Division 15 provisions and as supplemented in this section.
- B. Coordinate location of space temperature sensors, space humidity sensor, thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- C. Coordinate installation of system components with installation of mechanical systems and equipment to achieve compatibility.
- D. Ensure installation of components is complementary to installation of similar components in other systems.
- E. Coordinate control wiring requirements, including actual terminal block numbers, with mechanical equipment manufacturers or suppliers.
- F. Coordinate work with the Laboratory Controls Contractor to provide air supply requirements.
- G. Coordinate equipment with Division 13 Section "Lighting Controls" to achieve compatibility with equipment that interfaces with that system.
- H. Coordinate equipment with Division 13 Section "Fire Alarm" to achieve compatibility with equipment that interfaces with that system.

- I. Ensure control system installation is complete, checked, tested and functioning properly prior to system balancing and Owner/Engineer system checkout.
- J. Cooperate fully with the Test and Balance Contractor and provide labor to operate the temperature control system as required to meet the scope of work defined in Division 15 Section "Testing, Adjusting and Balancing."

1.11 WARRANTY

- A. Provide warranty per Division 15 Section "General Mechanical Requirements" and as supplemented in this section.
- B. Provide 24 hour per day emergency service during warranty period, with maximum response period of four (4) hours. Provide phone number(s) for quick assistance by a Service Engineer regarding hardware or software problems.
- C. Provide scheduled maintenance service during warranty period to inspect, calibrate, and adjust controls. Make a minimum of one eight hour service call every three months. Notify Owner prior to each scheduled inspection trip. Submit written reports upon completion of service.
- D. Provide any software or firmware revisions which are released by the DDC system manufacturer during the warranty period, at no additional cost to the Owner.

1.12 POSTED OPERATING INSTRUCTIONS

- A. Provide DDC controller related as-built documents in protective binder or clear plastic display envelope for each control enclosure panel. These instructions shall include such items as as-built control diagrams and sequence of operation, simplified narrative instructions and materials necessary to aid in the operation of the equipment at the local control panels.

1.13 SPECIAL TOOLS

- A. Deliver two sets of any special tools required for operation, adjustment, resetting or maintenance, not including PC laptop.

1.14 PROTECTION OF PROPRIETARY INFORMATION

- A. All proprietary manuals and software that are subject to a non-disclosure agreement shall be submitted by the proprietary equipment manufacturer to the Owner for signed approval during the warranty period.

PART 2 - PRODUCTS

2.1 DESCRIPTION OF THE BUILDING AUTOMATION SYSTEM (BAS)

- A. The building automation system (BAS) shall be fully integrated, distributed data processing system incorporating direct digital control (DDC) for the control and monitoring of heating, ventilating and air conditioning (HVAC) equipment and other related systems. Microprocessor based BAS field level DDC controllers shall be directly connected to HVAC equipment sensors and actuators. A data communication network shall allow data exchange between the BAS field level DDC controllers and the Building Network Supervisory Controller. The Building Network Supervisory Controller shall be the primary operator BAS interface point for the building either through web-browser direct or through server application software (when applicable) or through local or remote Operator Workstation (when applicable to project).
- B. **Approved Manufacturer - System / Installer (Location):**
 1. **Johnson Controls - Facility Explorer / Building Automated Systems & Services aka BASS (Sterling Height, MI).**

2.2 BAS BUILDING NETWORK SUPERVISORY CONTROLLER

- A. The Building Network Supervisory Controller shall provide the interface between the Owner's Ethernet and the field control devices, and provide global supervisory control functions over the control devices connected to the NAC. It shall be capable of executing application control programs to provide:
 - a. Calendar functions
 - b. Scheduling.
 - c. Trending.
 - d. Alarm monitoring and routing.
 - e. Time synchronization.
 - f. Integration of BACnet controller data.

- g. Network Management functions for all BACnet based devices.
 - B. The Network Area Controller shall provide the following hardware and driver features as a minimum:
 - a. One RS-232 port
 - b. One RS-485 port with BACnet MS/TP Driver.
 - c. Battery Backup
 - d. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity).
 - e. Where the option for expanded memory is available, it must be supplied.
 - C. **Provide Johnson Controls N2 driver as required for system or equipment integration requirements for project.**
 - D. **Manufacturer:**
 - a. **Johnson Controls (FX-60 Minimum).**
- 2.3 DIRECT DIGITAL CONTROL (DDC) FIELD LEVEL CONTROLLERS
- A. Modular in design and consisting of stand-alone microprocessor board with ROM and fully custom programmable RAM, EPROM, and/or EEPROM memory, integral interface equipment and power surge protection. DDC controllers shall be connected directly to sensors, controlled devices and the communication network.
 - B. Powerfail Restart and Battery Backup: Minimum of 72 battery backup hours for complete system RAM memory and clock, with automatic battery charger or 48 hour low voltage alarm warning. Upon full system power recovery, all clocks shall be automatically synchronized, and all controlled equipment shall be automatically re-started based on correct clock time and sequence of operation.
 - C. Provide fully functional communication interface ports for communication between processor, other processors, portable programmer's terminal, portable operator's unit or the remote Operator Workstation when applicable for project.
 - D. Panel enclosure for controller, associated power supply and other ancillary control components shall be finished steel or rigid plastic with hinged door and keyed lock.

Electronics shall be removable for protection during mounting of panel.

2.4 DDC CONTROLLER SOFTWARE

- A. Operating system shall work in real time, provide prioritized task scheduling, control time programs, monitor DDC controller communications, scan inputs and outputs, and contain built-in diagnostics.
- B. Input/output point processing shall include the following:
1. Continuous update of input and output values and/or conditions. All connected points are to be updated at least once per second.
 2. Assignment of proper engineering units and status condition identifiers to all points.
 3. In addition to physical or "hardware" points required, "software" points shall be provided where required for command access and meaningful displays, where required by the "execution" portion of this section or where required on the DDC input/output points lists. "Software" points shall appear identical to physical points in output displays and shall be assignable to text descriptors, logical groups, reports, etc. in the same manner as physical points. "Software" points shall be assigned alarm limits in the same manner as physical points.
- C. Command control software shall manage the receipt of commands from control panels, portable programmer's terminal, portable operator's unit or the remote Operator Workstation when applicable for project.
1. Command delay, programmable from 0 to 2 minutes, shall be provided to prevent simultaneous energizing of large loads. Command delays shall be honored throughout the BAS DDC network, not just within the DDC controller. Delays shall be assignable on an individual per point basis.
 2. Each command shall be assigned a command and residual priority to manage contentions created by multiple programs having access to the same command point. Only commands with a higher command priority than the existing residual priority shall be permitted to execute. Whenever a command is allowed to execute, its

assigned residual priority shall replace the existing residual priority.

3. A "fixed mode" option shall be supported to allow inputs to, and outputs from DDC control programs to be set to a fixed state or value. When in the "fixed mode," inputs and outputs shall be so noted in all reports.
4. A "last user" record is to be maintained to positively identify which program or manual command is in control of a given point. The last user information shall be displayed and printed along with other point data of logical groups.

D. Provide self-test procedure. Notify remote Operator Workstation (when applicable for project) for maintenance, performance, software, cable break, or data transmission problems. Identify variables as reliable or unreliable. Variables identified as unreliable shall use default in calculation.

E. Alarm Processing

1. High/Low Alarm: Analog input alarm comparison with the ability to assign two individual sets of high and low limits (warning and actual alarm) to an input. Each alarm shall be assigned a unique differential to prevent a point from oscillating into and out of alarm. Alarm comparisons are to be made each scan cycle.
2. Floating Alarm: Where analog controlled values are automatically varied by software (such as hot water temperature reset), a single set of alarm limits shall be provided for those varying values. These alarm limits shall then "float" a user definable differential above and below the varying setpoint value.
3. Abnormal Alarm: When a digital input is not in agreement with the commanded state of its associated output point, or when a digital input is not in its normal state, an abnormal alarm shall be generated. Abnormal "on" shall cause an alarm, as well as abnormal "off." Alarm time delay for digital inputs to prevent nuisance alarms shall be provided. Each digital input alarm time delay shall be adjustable from zero to two minutes in one-second increments.

4. Alarm lockout shall be provided to positively lock out alarms when equipment is turned off or when a true alarm is dependent on the condition of an associated point. Lockout points and lockout initiators shall be operator programmable. On initial startup of air handler and other mechanical equipment, a "timed lockout" period shall be assigned to analog points to allow them to reach a stable condition before activating alarm comparison logic. Timed lockout period shall be programmable on a per point basis from 0 to 90 minutes in one-minute increments.
5. The capability of automatically initiating commands upon the occurrence of an alarm.

F. Totalization

1. Run time shall be accumulated based on the status of digital input points. It shall be possible to totalize either on time or off time up to 10,000 hours with one-minute resolution. Run time counts shall be resident in memory and have DDC controller resident run time limits assignable through portable programmer's terminal, portable operator's unit or the remote Operator Workstation when applicable for project.
2. A transition counter shall be provided to accumulate the number of times a device has been cycled on or off. Counter shall be capable of accumulating 600,000 switching cycles. Limits shall be assignable to counts to provide maintenance alarm printouts.
3. Analog totalization capability shall be provided to allow the totalization of electricity, air, water and steam flow, etc. These flows shall be totalized with respect to time and converted to the appropriate energy unit. It shall be possible to automatically set time intervals for totalization, adjustable from one second to 365 days. The totalization program shall keep track of the maximum and minimum instantaneous analog value measured during the period, including the date and time at which each occurred.

G. DDC Controller Programming / Configuration

1. All DDC controllers shall be fully programmable or configurable per required controller application type. DDC controllers which require remote or factory

programming or configuration are not acceptable. DDC controllers with custom programs which may not be modified by the user are not acceptable. "Custom" programming shall mean allowing the alteration of actual control logic, and shall not be limited to allowing only the alteration of setpoints, gains, parameters, time constants, etc.

2. DDC controllers shall be provided to meet the control strategies as called for in the sequences of operation on the drawings. If a configurable application specific DDC controller cannot meet this requirement, a DDC fully programmable controller shall be provided.
3. All DDC controller setpoints, gains, parameters, time constants, etc., associated with DDC controller programs shall be available to the operator for display and modification via portable programmer's terminal, portable operator's unit or the remote Operator Workstation when applicable for project.
4. Each DDC controller shall have resident in its memory and available to the programs a full library of DDC algorithms, intrinsic control operators, and arithmetic, logic and relational operators for implementation of control sequences. Functions to be provided shall include, but not be limited to, the following:
 - a. Mathematical: Absolute value, calculate, square root, power, sign, average, totalize.
 - b. Logic: OR, AND, compare, negate.
 - c. Fixed Formula: High and low select, span, rate, ramp, enthalpy, wet bulb, dew point, relative humidity, humidity ratio, and filter.
 - d. Data Manipulation: Store, file and set.
 - e. Control Routines: Real-time based functions, proportional control, proportional-integral control, proportional-integral-derivative control, adaptive control (self-tuning), direct-acting, reverse acting, feedforward, fixed setpoint, calculated setpoint, adjustable setpoint, lead lag, hysteresis correction, event initiation/software interlock.

H. Building Automation System program applications (as required for controllers)

1. Time of day scheduling: Allow the creation and maintenance of operating schedules for selected points based on time of day and holiday scheduling. At least two independent start and stop times per day for each system shall be allowed. Each point shall be allowed to have a unique time program, or points shall be able to be grouped and assigned to a common time program. Both digital and analog output points shall be able to be assigned to a time program. This software shall work in conjunction with the time of day scheduler software at the remote Operator Workstation (when applicable for project). This program shall also work in conjunction with the optimum start and optimum stop application software.
2. Optimum Start: Start equipment based on outdoor temperature, space temperature, and system response to minimize energy usage and to assure that comfort conditions are reached exactly at scheduled occupancy time (occupancy schedules are defined under "Time of Day Scheduling"). This program shall operate in both the heating and cooling cycles. An adaptive algorithm shall be employed which automatically adjusts the start time according to previous performance and shall automatically assign longer lead times for weekend and holiday shutdowns.
3. Enthalpy Optimization: Using standard psychrometric calculations, automatically determine which air source, outdoor air or return air, presents the least total heat load, and automatically adjust mixed air damper position. When outside enthalpy exceeds return air enthalpy, the outside air damper shall go to its minimum position. Typically, the outside air damper must be in its minimum position before the cooling coil valve is allowed to open.
4. Duty Cycle: Periodically cycle electrical equipment to reduce energy consumption and/or energy demand. Each load shall be assigned a cycle interval and an off period. A load leveling algorithm shall be utilized to assure that cycle periods do not coincide.
5. Demand Limiting: Distributed power demand program shall be based on a sliding window instantaneous demand algorithm. The DDC controller(s) connected to the demand meter shall calculate the demand, forecast the demand trend, compare it to established demand limits, and initiate load shedding action or reestablishment of loads as required. Shedding shall

be on a sequential basis with least important loads shed first and restored last. Restoration cycle shall add the most important loads first. DDC controllers on the network shall each have a four-tier shed table for assignment of sheddable loads. When a request is issued to the network to shed a specific number of kilowatts, each DDC controller shall shed Tier 1 loads, Tier 2 loads, etc. until the shed requirement is met. The program shall have the capability to sum the readings from multiple meters connected to multiple DDC controllers on the network, and to shed various loads from multiple DDC controllers on the network.

6. Warm-Up: Position the outside air dampers in an adjustable (minimum) position, and trigger a digital output(s) normally used to signal air terminal units to move to their maximum flow settings. When the desired space temperature is reached, as determined by feedback from space temperature sensor(s), the digital output shall return the air terminal units to their normal operation. When occupancy time is reached, the outside air dampers shall be controlled by the normal occupied mode control sequence. During the warm-up cycle, the outside air damper shall be set at the position which minimizes outside air intake while preventing over/under pressurizing of ductwork. This program shall work in conjunction with the time scheduling program and/or the optimum start program as required.
7. Night Cycle: Cycle HVAC equipment on and off as required to maintain an operator selectable unoccupied space temperature. During the equipment "on" time, the outside air damper shall be maintained in an adjustable position which minimizes outside air intake while preventing over/under pressurization of ductwork. The equipment shall be cycled such that energy reduction during unoccupied periods is uniform.
8. Night Purge: Night Purge program shall apply to cooling cycle only. Night Purge shall introduce 100% outdoor air any time the outdoor air is above 50 degrees F, the space temperature is above 75 degrees F, the outdoor air temperature is below space temperature and the outdoor air dew point is less than 60 deg F. Purging shall stop when outdoor air is below 50 deg F, or space temperature is below 75 deg F, or outdoor temperature is less than 5 deg F cooler than

space temperature, or outdoor air dew point is greater than 60 deg F.

9. Reset Optimization: Adjust equipment discharge setpoints based on one of the following criteria:
 - a. By sensing the worst case requirements (e.g., the zone requiring the most heating or cooling and providing only the minimum energy required to meet the load.
 - b. Adjusting the setpoint in direct proportion to another sensed variable (e.g., reset supply water temperature based on outside temperature).

2.5 DDC UNITARY EQUIPMENT CONTROLLERS

- A. Microprocessor based controllers capable of stand-alone operation for unitary equipment. Controllers shall be networked together and connected to the building's BAS/DDC network.
- B. Each controller shall have electronic outputs compatible with the electronically operated control valves where applicable.
- C. TC contractor shall provide 24 VAC power requirements including transformers.
- D. If coordinated with mechanical contractor. Controllers and damper operators shall be furnished to the air terminal unit manufacturer for factory mounting by the air terminal unit manufacturer; otherwise, controls shall be field installed.
- E. Room temperature sensors for the DDC air terminal unit controllers:
 1. Sensing Element: Thermistor or resistance temperature detector (RTD) type. Accuracy shall be +/- 0.5 degrees F over the range of 55 degrees F to 95 degrees F, including calibration error, repeatability, hysteresis, and yearly drift.
 2. Cover: Locking type.
 3. Provide with exposed +/- warm/cool setpoint adjustment.
 4. Provide with exposed override switch to allow an occupant to reset the space to occupied control during the unoccupied cycle for a predetermined time period.

5. Provide with portable operator unit plug-in port.

2.6 DDC UNIT VENTILATOR CONTROLLERS

- A. Microprocessor based controllers capable of stand-alone operation for independent unit ventilators. Controllers shall be networked together and connected to the building's BAS/DDC network.
- B. Each controller shall have electronic outputs to electronically operate damper and control valve operators. Provide electronic type damper and control valve operators compatible with the controller provided.
- C. TC contractor shall provide 24 VAC power requirements including transformers.
- D. If coordinated with mechanical contractor. Controllers, damper and valve operators shall be furnished to unit ventilator manufacturer for factory mounting by the unit ventilator manufacturer; otherwise, controls shall be field installed.
- E. Room temperature sensors for the DDC unit ventilator controllers:
 - 1. Sensing Element: Thermistor or resistance temperature detector (RTD) type. Accuracy shall be +/- 0.5 degrees F over the range of 55 degrees F to 95 degrees F, including calibration error, repeatability, hysteresis, and yearly drift.
 - 2. Cover: Locking type.
 - 3. Provide with exposed setpoint adjustment dial and exposed temperature reading.
 - 4. Provide with exposed override switch to allow an occupant to reset the space to occupied control during the unoccupied cycle for a predetermined time period.
 - 5. Provide with portable operator unit plug-in port.

2.7 DDC INPUT/OUTPUT SENSORS

- A. Carbon Dioxide Sensors:
 - 1. Carbon dioxide sensing cell shall consist of a nondispersive infrared carbon dioxide gas cell that uses a pulsed source and has no free air optical path. Output shall be linearized 4-20 mA with the 24 VDC

input. In addition, the unit shall be capable of providing SPDT switching of an external low voltage circuit at an adjustable setpoint. The unit shall be specifically designed for the wall or duct application specified. Return air aspiration boxes shall be designed by and approved by the manufacturer. Unit shall have single point setpoint and span adjustment. The unit shall have no moving parts.

2. Power for the sensor shall be extended from a transformer or adaptor installed adjacent to the DDC controller enclosure panel, and shall be run parallel to the 4-20 mA signal cable.
3. Minimum sensing range shall be 0-2,000ppm.
4. Overall Accuracy shall be 3% of full scale including calibration error, repeatability, hysteresis and yearly drift.
5. Minimum calibration interval shall be 5 years.
6. Contractor shall provide all necessary equipment and test gas for calibration and shall calibrate all CO₂ sensors in accordance with the manufacturer's recommendations.
7. Manufacturer:
 - a. Honeywell.
 - b. Schneider Electric Controls.
 - c. Johnson Controls.
 - d. Siemens.
 - e. TelAire.
 - f. Vaisala.
 - g. Veris.

B. Current Switches:

1. Split-core or donut type transformer for monitoring AC current, with digital output signal. Current switches used on motor side of variable frequency drives shall have low frequency detection capability.
2. Current switches with digital output shall have adjustable trip settings. Provide field adjustment of current switches to trip at approximately 90% of normal motor operating amperage.
3. Manufacturers:
 - a. Johnson Controls.
 - b. NK Technologies.
 - c. Senva.

- d. Setra.
- e. Veris Industries.

C. Humidity Sensors:

1. Elements: Thin film capacitive type or bulk polymer resistance type with linear output, accurate within $\pm 2\%$ RH including calibration error, repeatability and hysteresis throughout the range of 0-99% RH at 77 deg F. Factory calibrate for maximum accuracy at mid-range of normal operating humidity. All humidity sensors shall be resistant to chlorine and other cleaning agents.
2. Room Sensors: With locking cover matching space temperature sensors used.
3. Duct Sensors: With duct probe and mounting plate.
4. Manufacturers:
 - a. Specified BAS product where available.
 - b. Rotronic.
 - c. GE Industrial, Sensing (formerly General Eastern).
 - d. Vaisala.

D. Outside Air Flow Differential Pressure Transmitters:

1. The transmitters shall be capable of receiving signals of static, velocity and reference pressures, amplifying and scaling the resulting differential pressure signal to produce a 4-20 mA output signal linear to differential pressure. The transmitters shall have manual zeroing capability.
2. The differential pressure transmitters shall not be affected by over-pressurization up to 1 psig, and shall be furnished with a factory calibrated span and automatic zeroing circuit. The transmitters shall be housed in an enclosure with integral terminal box and with power and output signal conduit connection ports and separate access plate.
3. Calibrated span: shall not exceed 150 percent of maximum expected input.
4. Reference Accuracy: $\pm 0.50\%$ of span.
5. Hysteresis and dead band (combined): Less than 0.2% of span.
6. Repeatability: 0.15% of span.
7. Linearity: $\pm 0.25\%$ of span.
8. Include LCD Display.

9. Manufacturers:

- a. Air Monitor-Veltron DPT 2500 Plus.
- b. Custom Electronics Systems.

E. Outside Air Temperature/Humidity Combination Transmitters:

1. Dual transmitters housed in a single hinged enclosure with integral probes configured for exterior wall mount application with PVC sun shield. Unit shall provide separate 4-20 mA signals for temperature and humidity measurement.
2. Temperature sensor shall be 1000 OHM thin film platinum resistance temperature detector with matching 4-20 mA transmitter having independent zero and span adjustments. Accuracy shall be ± 0.5 degrees F with a range of -25 degrees F to 125 degrees F.
3. Humidity sensor shall be washable thin film type with matching 4-20 mA transmitter having independent zero and span adjustments and linear output over a span of 0-100% RH. Accuracy shall be $\pm 2.5\%$ RH including calibration error, repeatability and hysteresis throughout the range of 0-95% RH at 77 deg F.
4. Manufacturer:
 - a. GE Industrial, Sensing (formerly General Eastern)
 - b. Veris.

F. Temperature Sensors:

1. Resistance temperature detectors (RTD) with platinum, nickel or balco element. Accuracy shall be ± 0.5 deg F over the entire range. Range shall be as indicated below, or as appropriate to the application.
2. Single point duct mounted sensors shall have 18" rigid probe and calibrated span of 20 - 120°F.
3. Averaging duct mounted sensors shall have 25' long averaging element and calibrated span of 20 - 120°F.
4. Liquid immersion sensors shall have welded stainless steel thermowells for ferrous pipe and brass thermowells for copper pipe. Length of sensor and thermowell shall be selected based on the diameter of the pipe to provide accurate, reliable and homogeneous sensing of the liquid temperature. Thermowell pressure rating shall meet or exceed the system minimum pressure rating. Sensors for chilled water application

shall have calibrated span of 20 - 120°F. Sensors for hot water applications shall have calibrated span of 40 - 240°F

5. Room sensors shall have locking cover and a minimum span of 40 - 90°F.
6. Outside air sensors shall have watertight inlet fitting and shall be shielded from direct rays of sun and wind.
7. Manufacturers:
 - a. Specified BAS product where available.
 - b. TCS.
 - c. Minco.
 - d. ACI.
 - e. MAMAC.

2.8 DDC DATA COMMUNICATIONS NETWORK

- A. Data communication network shall be provided to allow data exchange between the BAS field level DDC controllers and the Building Network Supervisory Controller.
- B. The BAS/DDC system-wide communication network shall consist of a primary peer-to-peer network, and at the Contractor's option, secondary sub-networks linked to the primary network. The primary network shall support peer-to-peer communications between primary network BAS field level DDC controllers. The Building Network Supervisory Controller shall be connected to the primary network. Secondary sub-networks when used shall interface with the primary network through the primary network BAS field level DDC controllers. At least one DDC controller connected to the primary peer-to-peer network shall be provided in each mechanical room, or as indicated on the drawings.
- C. Data communications media shall be twisted pair wires.
- D. The communications network shall allow shared point and control information between BAS field level DDC controllers. All required repeaters, hubs, active links, gateways, etc. and associated power supplies shall be provided as required to provide shared point and control information between BAS field level DDC controllers.
- E. Failure of any individual BAS field level DDC controller shall not cause the loss of communications between peer BAS field level DDC controllers.

F. All data transmitted must be positively acknowledged as received or negatively acknowledged as not received. Negative acknowledgments shall cause a retransmission of the data. Network connected devices must send a "functioning" message each network cycle. Lack of a "functioning" message after successive retries shall constitute a device failure and shall be recognized as such by the network.

G. Error recovery and communication initialization routines shall be resident in each network connected device.

2.9 CONTROL AND INSTRUMENTATION TUBING

A. Copper Tubing: ASTM B280 or ASTM B75, seamless, hard drawn or annealed.

1. Fittings: ANSI/ASME B16.22, wrought copper.
2. Joints: ANSI/ASTM B32, 95-5 tin antimony.

B. Copper Tubing: ASTM B280 or ASTM B75, seamless, hard drawn or annealed.

1. Fittings: UL approved rod or forged brass rated to 200 psig at 100 degrees F.
2. Joints: Ball Sleeve compression type.

C. Polyethylene Tubing: Black, UL 1820 flame and smoke retardant where exposed in an air plenum, virgin polyethylene, conforming to modified ASTM D1693 test. All non-metallic tubing shall be minimum 1/4" O.D.; micro-sleeve is not acceptable.

1. Fittings: UL approved rod or forged brass rated to 200 psig at 100 degrees F.
2. Joints: Compression or barbed type.

2.10 CONTROL VALVES AND VALVE OPERATORS

A. Pressure Dependent Characterized Ball Valves (2-way & 3-way):

1. Up to 2 inches: Bronze body with screwed ends, stainless steel or chrome plated brass ball, characterizing disc, stainless steel or brass stem, and resilient reinforced Teflon seats.
2. Manufacturers:

- a. Belimo.
- b. Bray / Delta Control Products.
- c. Honeywell.
- d. Schneider Electric Controls.
- e. Johnson Controls.
- f. Siemens

B. Butterfly Valves

1. Lugged style, ductile iron body, high performance resilient-seated (PTFE) butterfly valve with uninterrupted seat design, one-piece body, solid one-piece shaft. Sizes 2-20" with seat bonded to the body.
2. Temperature range up to 250°F and pressure rating to 250 psig.
3. Valve shutoff shall be bubble-tight in both directions.
4. Manufacturers:
 - a. DeZurik.
 - b. Honeywell.
 - c. Schneider Electric Controls.
 - d. Johnson Controls.
 - e. Siemens.
 - f. Belimo.

C. Solenoid Valves:

1. Solenoid valves for reheat coils, radiant ceiling panels and unit heaters shall be 24 VDC, electronic-type, for two-position operation.

D. **Poptop Zone Valves (2-way & 3-way) for Unitary Equipment:**

1. Manufacturers/Model:

- a. **Schneider Electric Controls (formerly Erie Controls) / VM Series poptop zone valves with AP23A000 model actuator with appropriate control signal to interface controller for the indicated application on control details.**

E. Electric Operators:

1. Operators shall be electronic type to accept signals from direct digital controller or modulating thermostat for proportional control.

2. Valves shall spring return to normal position as indicated. Terminal unit tempering coil control valve operators are not required to be spring return.
3. Select with sufficient shut-off power for system pressure and highest operating torque, and torque requirements of valves which may stick because of infrequent use.
4. Select to provide smooth proportioning control under operating conditions normal to the system.
5. Electric Butterfly Control Valve Actuators: Permanent split capacitor, reversible electric motor which drives a compound epicyclic gear, thermal overload protection, factory tested, factory lubricated, localized mechanical position indicator readable at 25 feet, 0-90 degree reversible operation, bolt directly to valve top plate.
 - a. When exposed to outside air, housing shall be weatherproof and suitable for outdoor location. Provide thermostatically controlled heater for prevention of condensation at low temperatures, 120 VAC. Actuator ambient temperature range shall be -20 degrees F to +140 degrees F.
6. Provide separate limit switches which close at the full open and full closed position, respectively.
7. Actuator shall include a manually operated handwheel for override of the valve position.

F. Hydronic Systems:

1. Valve minimum pressure rating shall meet or exceed the system minimum pressure rating as noted for each system in Division 15 Section "Valves," and in Division 15 Section "Hydronic Piping."
2. Valve minimum temperature ratings shall be 250 deg F.
3. For globe valves: Replaceable plugs and seats of stainless steel or brass, selected for maximum lift under application conditions.
4. Two way and three way valves shall have equal percentage characteristics. Size two way valve operators to close valves against pump shut off head.
5. Pressure independent control valves shall be used for 2-way applications unless otherwise indicated. Select to achieve scheduled flow rate of the associated heat transfer device. If the scheduled flow rate is too high to achieve with one valve, provide multiple valves sized at flow divided equally of the scheduled

flow rate and control all valves in unison - coordinate control valve quantity and the need for parallel piping of control valves with mechanical contractor.

6. Pressure Drop for pressure dependent characterized ball and globe valves: As scheduled on the drawings. If not scheduled, primary HVAC equipment control valves shall be selected for a pressure drop close as possible to 11.5 feet of head (5 psig), +/- 10%. If not scheduled, terminal equipment control valves shall be selected for a pressure drop close as possible to 11.5 feet of head (5psig) with allowable minimum of 2.3 feet of head (1 psig) where flow rates are minimal and valve Cv choices are limited. TC Contractor shall use valves from listed manufacturers that meet the pressure drop requirements.

2.11 DAMPERS - AUTOMATED

- A. Performance: Test in accordance with AMCA 500.
- B. Frames: Galvanized steel, minimum 16 gauge, minimum 2 inches in width, welded or riveted with corner reinforcement for 12 gage structural equivalence.
- C. Blades: Galvanized steel, minimum 14 gauge, maximum blade size 8 inches wide, 60 inches long, attached to minimum 1/2 inch shafts. Dampers which are required to have a static pressure rating over 4 inch W.G. shall have minimum 3/4 inch solid shafts.
- D. Blade Seals: Synthetic elastomeric or Neoprene, mechanically attached, field replaceable.
- E. Jackshafts (where required): Minimum 1/2 inch galvanized steel.
- F. Jamb Seals: Stainless steel.
- G. Bearings: Oil impregnated sintered bronze or lubricant free, solid stainless steel. Provide thrust washers at bearings for all dampers which are to be mounted with blades in the vertical position.
- H. Linkages: Accessible for maintenance. Linkages may be located in airstream. Linkages located in damper frame

shall be external to the duct, accessible for maintenance. Linkages located in the airstream shall be zinc-plated.

- I. Leakage: Less than 8 CFM per square foot based on 4 inches W.G. pressure differential.
- J. Static Pressure Rating: As scheduled on the drawings, or if not scheduled, minimum 4" W.G.
- K. Maximum Velocity: As scheduled on the drawings, or design for maximum velocity to be encountered in location where installed.
- L. Temperature Limits: -40 to 200 deg F.
- M. Dampers located in stainless steel or PVC coated ductwork (Refer to Division 15 Section "Metal Ducts" for ductwork requirements) and dampers located within stainless steel or corrosion-resistant coated environmental equipment (Refer to Division 15 Section "Environmental Equipment" for environmental equipment requirements): Fabricate and size as indicated above, with the following additional requirements.
 - 1. Frames: Type 316 stainless steel.
 - 2. Blades and shafts: Type 316 stainless steel.
 - 3. Blade seals: Type 316 stainless steel, mechanically attached.
 - 4. Jackshafts (where required): Minimum 3/4 inch stainless steel.
 - 5. Bearings: Solid stainless steel.
 - 6. Linkages: Accessible for maintenance. Linkages located in damper frames shall be external to the duct, accessible for maintenance. Linkages located in the airstream shall be Type 316 stainless steel.
 - 7. All components exposed to the airstream shall be constructed of Type 316 stainless steel:
- N. Manufacturers:
 - 1. American Warming & Ventilating.
 - 2. Arrow United Industries.
 - 3. Greenheck.
 - 4. Honeywell.
 - 5. Johnson Controls.
 - 6. Louvers & Dampers, Inc.
 - 7. Ruskin.

8. Tamco.
 9. Vent Products.
- 2.12 DAMPERS, INSULATED OUTDOOR AIR / RELIEF AIR / EXHAUST AIR
- AUTOMATED
- A. Performance: AMCA certified for Air Performance and Air Leakage.
 - B. Frames: Extruded aluminum, .080-inch thickness minimum, 4 inches deep minimum, thermally broken, and insulated with polystyrene or polyurethane foam insulation.
 - C. Blades: Extruded aluminum, internally insulated, and thermally broken. Maximum blade size 8 inches wide, 60 inches long.
 - D. Shafts: Minimum 7/16 inch hexagonal or square corrosion resistant zinc plated steel.
 - E. Blade Seals: Extruded EPDM, silicone, or synthetic elastomeric, mechanically attached.
 - F. Jamb Seals: Silicone, or synthetic elastomeric, mechanically attached.
 - G. Bearings: Dual bearing assembly of durable synthetic polymer resulting in no metal-to-metal contact. Provide thrust washers at bearings for all dampers which are to be mounted with blades in the vertical position.
 - H. Linkage: Linkage shall be installed in the frame side and shall be constructed of aluminum and/or corrosion resistant zinc plated steel.
 - I. Leakage: Less than 3 CFM per square foot at 1 inch W.G. pressure differential at minus 40 deg F.
 - J. Static Pressure Rating: As scheduled on the drawings, or if not scheduled, minimum 4 inches W.G.
 - K. Maximum Velocity: As scheduled on the drawings, or design for maximum velocity to be encountered in location where installed.
 - L. Temperature Limits: Minus 40 to 155 deg F.

- M. Manufacturers:
1. Greenheck ICD-45.
 2. Ruskin CDTI-50BF.
 3. Tamco Series 9000 BF

2.13 DAMPER OPERATORS - ELECTRIC

- A. Electric damper motor shall be 24 or 120 volt two-position or modulating as required with spring return type and sized to operate the damper with sufficient reserve power for smooth operation from full close to full open and tight shut-off. Damper motor shall have "O ring" gaskets for weatherproof operation.
- B. Number: Sufficient to achieve unrestricted movement throughout damper range. Provide sufficient number of operators such that one operator does not operate more than the maximum square footage of damper area as recommended in standard catalog of manufacturer.
- C. **Manufacturers:**
1. **Belimo.**
 2. **Johnson Controls.**

2.14 THERMOSTATS - ELECTRONIC & ELECTRIC

- A. Line Voltage Thermostats: Maximum dead band of 2 degrees F concealed temperature adjustment, locking cover, rated for load, single-pole or two-pole as required. Provide with integral manual On/Off/Auto selector switch where indicated. Provide with locking covers when located in public areas.
- B. Electric Room Thermostats (single setpoint type): Adjustable type, single setpoint, containing single bimetallic element, adjustable differential, minimum setting no greater than 1-1/2 deg F over a range of 55 deg F to 85 deg F. Provide locking covers with key operated setpoint adjustment, exposed setpoint indicator and exposed thermometer.
- C. Room Thermostat Accessories:
1. Thermostat Covers: Manufacturers standard with finish as selected by Architect.

2. Insulating Bases: Provide one inch insulating base for thermostats located on exterior walls.
 3. Adjusting Key: As required for device.
- D. Electric Low Limit Duct Thermostat (freezestat): Snap acting which trips if temperature sensed across any 12 inches of bulb length is equal to or below setpoint, fixed 5 deg F differential, range 30 deg F to 60 deg F, requiring minimum 20 feet length of bulb. Manual-reset unless indicated on drawings to be auto-reset type. Provide one thermostat for every 20 sq. ft. of coil surface. Switch shall be UL listed and rated for 10 amps at 120 VAC. Provide additional switch or contacts for connection to monitoring system.
- E. Strap-on Aquastat: UL listed, with a suitable removable spring clip attaching aquastat to pipe and a snap-acting SPDT switch.
- F. **Manufacturers:**
1. **Johnson Controls.**
- 2.15 EMERGENCY POWER-OFF (EPO) PUSH-BUTTON
- A. ADA compliant, push-button switch with clear cover to prevent inadvertent closure. Push-to-activate push-button, and providing two SPDT contacts rated 10 Amps at 120 VAC.
- B. Manufacturers:
1. Safety Technology International - model SS-2212PO
 2. Alarm Controls Corporation - model ADC-100.
- 2.16 ELECTRICAL REQUIREMENTS FOR CONTROLS WORK
- A. Electrical accessories such as relays, switches, contactors and control transformers shall meet the requirements of the Division 16 Specifications of respective project.
- B. Electrical wiring and conduit shall meet the requirements of the Division 16 Specifications.

- C. All control wiring in mechanical rooms and any other exposed areas shall be run in conduit. Low voltage temperature control wiring in concealed accessible locations (i.e. above lay-in ceilings), as well as low voltage temperature control wiring within partitions, may be run using plenum rated cable, neatly tie-wrapped and fastened to the building structure (not to ceiling or ceiling support wires).
- D. Conduits carrying control wiring shall be sized for a maximum fill of 40% of capacity.
- E. Where raceway is required, two separate raceway systems shall be provided; one for A.C. wiring and the other for D.C. wiring.
- F. Data transmission cabling and equipment grounding procedures shall meet the latest FCC guidelines for electromagnetic field generation.
- G. All control wiring sizes and types shall meet or exceed the equipment manufacturer's recommendations.

PART 3 - EXECUTION

3.1 INSTALLATION - CONTROL SYSTEMS

- A. Install in accordance with manufacturer's instructions.
- B. Check and verify location of temperature sensors, thermostats and other exposed control sensors with plans and room details before installation. Locate room temperature sensors and thermostats 48 inches above floor unless noted otherwise.
- C. The location of all control-related items to be mounted on the exterior of the building must be approved by the Architect prior to installation. Indicate proposed locations on the shop drawings.
- D. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. Sensors used for closed loop control must be connected to the same DDC controller as the associated output signal.
- E. Provide conduit and electrical wiring where required.

- F. All wiring in altered and unaltered areas shall be run concealed. "Wiremold" in finished areas shall be allowed when wiring cannot be run concealed in walls or partitions. Minimize "wiremold" routing.
- G. Splicing of DDC sensor cabling at junction boxes shall not be acceptable.
- H. All equipment which has moving parts and is remotely started by the control system shall be provided with warning labels no less than 2 inches in height, and in bright warning color, stating that the equipment is remotely started by automatic controls. Such labels shall be posted clearly in the area of any moving parts, such as belts, fans, pumps, etc.
- I. Coil and conceal excess capillary on remote element instruments.
- J. Install thermometers in air duct systems on flanges.
- K. Install all gauges and thermometers in locations where they are easily read from normal floor level. Provide tubing or wiring as required.
- L. Locate all control components and accessories such that they are easily accessible for adjustment, service and replacement.
- M. Locate, size, and support sensing elements in airstreams so that they properly sense the representative condition. Controlling, transmitting and indicating elements shall be located to sense the average condition. Safety elements shall be located to sense the extreme condition.
- N. Locate and size sensing elements in liquid lines so that they are in moving liquid and not in stagnant or turbulent locations. Wells shall not obstruct the flow of the liquid being measured. Pipes one inch and smaller shall be increased at least one pipe size at the point of insertion.
- O. Locate pressure sensing taps in liquid lines in straight runs of pipe with at least 10 pipe diameters of straight pipe both upstream and downstream of pressure tap. Provide a shut-off cock in sensing line at each pressure tap.

- P. Install pressure sensing elements in ducts and casings with clean, sharp taps to accurately read true static pressure, avoiding velocity influence and turbulence.
- Q. Locate, support and install all control components and accessories so that they will not be subject to vibration, excessive temperatures, dirt, moisture or other harmful conditions beyond their rated limitations.
- R. Where insulation is penetrated due to the installation of sensing elements or tubing, reseal the openings air and vapor tight. Provide brackets for devices to be located on insulated surfaces so as to clear the finished surface of the insulation and to avoid puncturing the vapor seal.
- S. Provide all necessary relays, switches, linkages, control devices, accessories and connections as required for a complete and operational control system as specified herein and shown.
- T. All electric valve and damper operators shall be capable of moving from full closed to full open, or vice versa, within 120 seconds.

3.2 IDENTIFICATION AND MARKING

- A. All sensors, relays, switches, etc. shall be marked with the same identification number as used on the as-built shop drawings. Use Brother P-touch label maker or similar with black text on clear or white super adhesive tape. If label applied in wet environment, spray label with clear enamel for waterproofing.
- B. Wire shall be color coded according to functional use. Identify color coding format on record drawings.
- C. Identify each wire as to ID number at each controller termination, field device termination or on the field device.
- D. All control panels and auxiliary enclosures shall be supplied with engraved phenolic nameplate permanently attached identifying it as control panel number, system served, area served, fed from lighting panel number, circuit number, etc.

3.3 GRAPHIC DISPLAY GENERATION

- A. Provide the following graphic displays as a minimum at the operator interface, arranged in logical penetration paths:
1. Overall campus layout which shows all of the buildings on the Owner's campus.
 2. Individual building layout or isometric for each building connected to the system.
 3. Floor plans for each floor within each building, with display of present values of space conditions sensed by connected space sensors, display of the name of the air handler associated with each space sensor, display of the room number in which the sensor is located and color coding to indicate whether the sensed space condition is within the acceptable range, is too high, or is too low. TC Contractor shall confirm Owner desired room names prior to graphics generation which may differ from the room names indicated on construction documents.
 4. Schematic diagram for each HVAC system. Each system schematic display shall include at least the following:
 - a. Schematic arrangement of ductwork, fans, dampers, coils, valves, piping, pumps, equipment etc.
 - b. System name.
 - c. Area served.
 - d. Present value or status of all inputs, along with present setpoint.
 - e. Present percent open for each damper, valve, etc. based on commanded position.
 - f. Reset schedule parameters for all points, where applicable.
 - g. Present occupancy mode.
 - h. Present economizer mode, where applicable.
 - i. Present outside air temperature.
 - j. Associated space conditions and setpoints, where applicable.
 - k. Status of application programs (e.g., warm-up, night cycle, duty cycle, etc.).
 - l. Color coding to indicate normal and abnormal values, alarms, etc.
 5. Manual override capability for each on/off or open/closed controlled digital output (for fans,

pumps, 2-position dampers and valves, etc.) and each modulating analog output (for dampers, valves, VFD speed modulation type points, etc.) shall be provided. Graphic display of output point auto or manual override status shall be provided.

6. Sequence of operation in written (text) format for each HVAC system.
7. Overall BAS system schematic.
8. System management graphic for each network device and/or DDC controller.

3.4 OWNER INSTRUCTION AND TRAINING

- A. Provide a minimum of twenty four (24) hours of combined on-site and classroom instruction and training to the Owner on the operation of the control systems for the initial installation.
- B. Instruction and training shall be performed by a competent Contractor representative familiar with the control systems operation, maintenance and calibration.
- C. Training shall take place after check, test, start-up of temperature controls system at a time mutually agreed upon by the Owner and Contractor.
- D. Provide 3 of computer training & tutorial CD's describing workstation operation and functions.
- E. Provide 3 of literature pertaining to the operation and maintenance of the DDC system components provided.

3.5 CALIBRATION AND START-UP

- A. After installation and connection of control components, test, adjust and re-adjust as required all control components in terms of function, design, systems balance and performance. Make systems ready for environmental equipment acceptance tests.
- B. After environmental equipment has been accepted and after the systems have operated in normal service for two weeks, check the adjustment on control components and recalibrate where required. Components not in calibration shall be recalibrated to function as required, or shall be replaced. Control devices, linkages, and other control components shall be calibrated and adjusted for stable and

accurate operation in accordance with the design intent and to obtain optimum performance from the equipment controlled. Cause every device to automatically operate as intended to ensure its proper functionality.

3.6 ACCEPTANCE PROCEDURE

- A. Upon successful completion of start-up and recalibration as indicated in this section, the Architect shall be requested in writing to inspect the satisfactory operation of the control systems.
- B. Demonstrate operation of all control systems, including each individual component, to the Owner and Architect.
- C. After correcting all items appearing on the punch list, make a second written request to the Owner and Architect for inspection and approval.
- D. After all items on the punch list are corrected and formal approval of the control systems is provided by the Architect, the Contractor shall indicate to the Owner in writing the commencement of the warranty period.

END OF SECTION 15900

SECTION 15950 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL.....2
1.1 RELATED DOCUMENTS.....2
1.2 SUMMARY.....2
1.3 DEFINITIONS.....2
1.4 SUBMITTALS.....4
1.5 QUALITY ASSURANCE.....5
1.6 PROJECT CONDITIONS.....6
1.7 COORDINATION.....6
1.8 WARRANTY.....7

PART 2 - PRODUCTS (NOT APPLICABLE).....7

PART 3 - EXECUTION.....7
3.1 EXAMINATION.....7
3.2 PREPARATION.....9
3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING.....9
3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS.....10
3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS.....11
3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS.....13
3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS.....14
3.8 PROCEDURES FOR HYDRONIC SYSTEMS.....14
3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS.....16
3.10 PROCEDURES FOR PRIMARY-SECONDARY-FLOW HYDRONIC SYSTEMS.....16
3.11 PROCEDURES FOR MOTORS16
3.12 PROCEDURES FOR CONDENSING UNITS17
3.13 PROCEDURES FOR HEAT-TRANSFER COILS17
3.14 PROCEDURES FOR TEMPERATURE MEASUREMENTS17
3.15 PROCEDURES FOR COMMERCIAL KITCHEN HOODS17
3.16 PROCEDURES FOR SPACE PRESSURIZATION MEASUREMENTS AND
ADJUSTMENTS.....18
3.17 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING
EXISTING SYSTEMS.....20
3.18 TOLERANCES21
3.19 REPORTING21
3.20 FINAL REPORT21
3.21 INSPECTIONS31
3.22 ADDITIONAL TESTS32

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 15 Section "Mechanical General Requirements."
 - 2. Division 15 Section "Basic Mechanical Materials and Methods."
 - 3. Division 15 Section "Common Work Results for HVAC."

1.2 SUMMARY

- A. This Section includes testing, adjusting, and balancing to produce design objectives for the following:
 - 1. Air Systems:
 - a. Constant-volume air systems.
 - b. Variable-air-volume systems.
 - 2. Hydronic Piping Systems:
 - a. Constant-flow systems.
 - b. Variable-flow systems.
 - c. Primary-secondary systems.
 - 3. HVAC equipment quantitative-performance settings.
 - 4. Kitchen hood airflow balancing.
 - 5. Exhaust hood airflow balancing.
 - 6. Space pressurization testing and adjusting.
 - 7. Existing systems TAB.
 - 8. Verifying that automatic control devices are functioning properly.
 - 9. Reporting results of activities and procedures specified in this Section.
- B. Include rebalancing of air systems, or system portions affected by recommended sheave changes.

1.3 DEFINITIONS

- A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
- B. AHJ: Authority having jurisdiction.

- C. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.
- D. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.
- E. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.
- F. NC: Noise criteria.
- G. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- H. RC: Room criteria.
- I. Report Forms: Test data sheets for recording test data in logical order.
- J. Smoke-Control System: An engineered system that uses fans to produce airflow and pressure differences across barriers to limit smoke movement.
- K. Smoke-Control Zone: A space within a building that is enclosed by smoke barriers and is a part of a zoned smoke-control system.
- L. Stair Pressurization System: A type of smoke-control system that is intended to positively pressurize stair towers with outdoor air by using fans to keep smoke from contaminating the stair towers during an alarm condition.
- M. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.
- N. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

- O. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- P. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
- Q. TAB: Testing, adjusting, and balancing.
- R. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
- S. Test: A procedure to determine quantitative performance of systems or equipment.
- T. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 SUBMITTALS

- A. Qualification Data: Within 30 days from Contractor's Notice to Proceed, submit 2 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 30 days from Contractor's Notice to Proceed, submit 2 copies of the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within 30 days from Contractor's Notice to Proceed, submit 2 copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.
- D. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.
- E. Sample Report Forms: Submit two sets of sample TAB report forms.
- F. Warranties specified in this Section.

1.5 QUALITY ASSURANCE

- A. TAB Firm Qualifications: Engage a TAB firm certified by either AABC or NEBB.
- B. Smoke Control System Testing: Additional Qualifications: The TAB firm shall be a qualified special inspector for the smoke control systems. The TAB firm for the smoke control system shall have expertise in fire protection engineering, mechanical engineering, and certification as air balancers.
- C. Approved Balancing Agencies.
 - 1. The TAB firm selected shall be from the following list:
 - a. Absolut Balance Company, Inc.; South Lyon, MI.
 - b. Airflow Testing Inc.; Lincoln Park, MI.
 - c. Barmatic Inspecting Co., Inc.; Lincoln Park, MI.
 - d. Ener-Tech Testing; Holly, MI.
 - e. Enviro-Aire/Total Balance Co.; St. Clair Shores, MI.
 - f. International Test & Balance Inc.; Southfield, MI.
- D. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.
 - 1. Agenda Items: Include at least the following:
 - a. Submittal distribution requirements.
 - b. The Contract Documents examination report.
 - c. TAB plan.
 - d. Work schedule and Project-site access requirements.
 - e. Coordination and cooperation of trades and subcontractors.
 - f. Coordination of documentation and communication flow.
- E. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.

2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

F. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems." TAB firm's forms approved by Architect.

G. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

H. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.

1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.8 WARRANTY

- A. National Project Performance Guarantee: If AABC standards are used, provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:
1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
 2. Systems are balanced to optimum performance capabilities within design and installation limits.
- B. Special Guarantee: If NEBB standards are used, provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:
1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
 2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.
- B. Examine system and equipment test reports.
- C. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- D. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned

and tight, and equipment with functioning controls is ready for operation.

- E. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.
- F. Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.
- G. Examine strainers for clean screens and proper perforations.
- H. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- I. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- J. Examine system pumps to ensure absence of entrained air in the suction piping.
- K. Examine equipment for installation and for properly operating safety interlocks and controls.
- L. Examine automatic temperature system components to verify the following:
 - 1. Dampers, valves, and other controlled devices are operated by the intended controller.
 - 2. Dampers and valves are in the position indicated by the controller.
 - 3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
 - 4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
 - 5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
 - 6. Sensors are located to sense only the intended conditions.
 - 7. Sequence of operation for control modes is according to the Contract Documents.
 - 8. Controller set points are set at indicated values.

9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to indicated values.

M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Perform the following field tests and inspections to new and renovated portions of duct systems according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:

1. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
2. Maximum Allowable Leakage: Leakage rates are scheduled on the Drawings.

C. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating,

and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.

- B. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.
- C. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts, or use reduced scale contract documents with notations.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- E. Cut insulation, and drill ducts for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes with neat patches, neoprene plugs, threaded plugs, or threaded twist-on metal caps, and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.
- F. Check air flow within intake plenums and mixing boxes of air handling units for uneven flow and temperature stratification and prepare a report with profile elevations (temperature and velocity) on each coil or filter face for Architect.
- G. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

- H. Verify that motor starters are equipped with properly sized thermal protection.
- I. Check dampers for proper position to achieve desired airflow path.
- J. Check for airflow blockages.
- K. Check condensate drains for proper connections and functioning.
- L. Check for proper sealing of air-handling unit components.
- M. Check for proper sealing of air duct system.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure fan static pressures to determine actual static pressure as follows:
 - a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
 - 3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
 - 4. Select required sheave sizes and advise installing contractor to change drive sheaves accordingly. Refer to Division 15 Section "Common Work Results for HVAC" for additional requirements.

5. When existing air handling systems require rebalancing, select required sheave sizes and advise Mechanical Contractor to change drive sheaves accordingly. Refer to Division 15 Section "Common Work Results for HVAC" for additional requirements.
 6. Do not recommend fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
1. Measure airflow at a point downstream from the balancing damper and adjust volume dampers until the proper airflow is achieved.
 - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure terminal outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.
- B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Set outside-air dampers at minimum, and return- and exhaust-air dampers at a position that simulates full-cooling load.
 2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
 3. Measure total system airflow. Adjust to within indicated airflow.
 4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
 5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow.
 - a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
 6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
 7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the

main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.

8. Record the final fan performance data.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts, or use reduced scale contract documents with notations.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
 1. Open all manual valves for maximum flow.
 2. Check expansion tank liquid level.
 3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
 4. Check flow-control valves for specified sequence of operation and set at indicated flow.
 5. Set system controls so automatic valves are wide open to heat exchangers.
 6. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
 7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.

3.8 PROCEDURES FOR HYDRONIC SYSTEMS

- A. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:
 1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump

- manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
 4. Report flow rates that are not within plus or minus 5 percent of design.
- B. Set calibrated balancing valves, if installed, at calculated presettings.
- C. Measure flow at all stations and adjust, where necessary, to obtain first balance.
1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
- D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
- E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
1. Determine the balancing station with the highest percentage over indicated flow.
 2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
 3. Record settings and mark balancing devices.
- F. Equipment installed with pressure independent characterized control valves (PICCV) or auto-flow devices shall not require hydronic system balancing unless multiple coils are served from a single PICCV or auto-flow device (Example: AHU coil banks with multiple coils). Measure flow through each PICCV and auto-flow device and compare measured value to scheduled value to verify proper valve/device was installed and valve is functional. Verify flow for 100 percent of PICCV and auto-flow devices. Report discrepancies.

- G. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
- H. Measure the differential-pressure control valve settings existing at the conclusions of balancing, and record in report.

3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

- A. Balance variable-flow hydronic systems by following the "Proportional Balancing Procedure" in accordance with NEBB.
- B. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.10 PROCEDURES FOR PRIMARY-SECONDARY-FLOW HYDRONIC SYSTEMS

- A. Balance the primary system crossover flow first, then balance the secondary system.

3.11 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer, model, and serial numbers.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Efficiency rating.
 - 5. Power factor.
 - 6. Nameplate and measured voltage, each phase.
 - 7. Nameplate and measured amperage, each phase.
 - 8. Starter size.
 - 9. Starter thermal-protection-element rating.
 - 10. Fuse number and size.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.12 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

3.13 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Water Coils: Measure the following data for each coil:
 - 1. Entering- and leaving-water temperature.
 - 2. Water flow rate.
 - 3. Water pressure drop.
 - 4. Dry-bulb temperature of entering and leaving air.
 - 5. Wet-bulb temperature of entering and leaving air for cooling coils.
 - 6. Airflow.
 - 7. Air pressure drop.
- B. Refrigerant Coils: Measure the following data for each coil:
 - 1. Dry-bulb temperature of entering and leaving air.
 - 2. Wet-bulb temperature of entering and leaving air.
 - 3. Airflow.
 - 4. Air pressure drop.
 - 5. Refrigerant suction pressure and temperature.

3.14 PROCEDURES FOR TEMPERATURE MEASUREMENTS

- A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.
- B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.
- C. Measure outside-air, wet- and dry-bulb temperatures.

3.15 PROCEDURES FOR COMMERCIAL KITCHEN HOODS

- A. Measure, adjust, and record the airflow of each kitchen hood. For kitchen hoods designed with integral makeup air, measure and adjust the exhaust and makeup airflow. Measure

airflow by duct Pitot-tube traverse. If a duct Pitot-tube traverse is not possible, provide an explanation in the report of the reason(s) why and also the reason why the method used was chosen.

- B. After balancing is complete, do the following:
 - 1. Measure and record the static pressure at the hood exhaust-duct connection.
 - 2. Measure and record the hood face velocity. Make measurements at multiple points across the face of the hood. Perform measurements at a maximum of 12 inches between points and between any point and the perimeter. Calculate the average of the measurements recorded. Verify that the hood average face velocity complies with the Contract Documents and governing codes.
 - 3. Check the hood for capture and containment of smoke using a smoke emitting device. Observe the smoke pattern. Make adjustments to room airflow patterns to achieve optimum results.

- C. Visually inspect the hood exhaust duct throughout its entire length in compliance with authorities having jurisdiction. Begin at the hood connection and end at the point it discharges outdoors. Report findings.
 - 1. Check duct slopes as required.
 - 2. Verify that duct access is installed as required.
 - 3. Verify that point of termination is as required.
 - 4. Verify that duct air velocity is within the range required.
 - 5. Verify that duct is within a fire-rated enclosure.

- D. Report deficiencies.

3.16 PROCEDURES FOR SPACE PRESSURIZATION MEASUREMENTS AND ADJUSTMENTS

- A. Before testing for space pressurization, observe the space to verify the integrity of the space boundaries. Verify that windows and doors are closed and applicable safing, gaskets, and sealants are installed. Report deficiencies and postpone testing until after the reported deficiencies are corrected.

- B. Measure, adjust, and record the pressurization of each room, each zone, and each building by adjusting the

supply, return, and exhaust airflows to achieve the indicated conditions.

- C. Measure space pressure differential where pressure is used as the design criteria, and measure airflow differential where differential airflow is used as the design criteria for space pressurization.
 - 1. For pressure measurements, measure and record the pressure difference between the intended spaces at the door with all doors in the space closed. Record the high-pressure side, low-pressure side, and pressure difference between each adjacent space.
 - 2. For applications with cascading levels of space pressurization, begin in the most critical space and work to the least critical space.
 - 3. Test room pressurization first, then zones, and finish with building pressurization.
- D. To achieve indicated pressurization, set the supply airflow to the indicated conditions and adjust the exhaust and return airflow to achieve the indicated pressure or airflow difference.
- E. For spaces with pressurization being monitored and controlled automatically, observe and adjust the controls to achieve the desired set point.
 - 1. Compare the values of the measurements taken to the measured values of the control system instruments and report findings.
 - 2. Check the repeatability of the controls by successive tests designed to temporarily alter the ability to achieve space pressurization. Test overpressurization and underpressurization, and observe and report on the system's ability to revert to the set point.
 - 3. For spaces served by variable-air-volume supply and exhaust systems, measure space pressurization at indicated airflow and minimum airflow conditions.
- F. In spaces that employ multiple modes of operation, such as normal mode and emergency mode or occupied mode and unoccupied mode, measure, adjust, and record data for each operating mode.
- G. Record indicated conditions and corresponding initial and final measurements. Report deficiencies.

3.17 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

- A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
 - 1. Measure and record the operating speed, airflow, and static pressure of each fan.
 - 2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
 - 3. Check the condition of filters.
 - 4. Check the condition of coils.
 - 5. Check the operation of the drain pan and condensate drain trap.
 - 6. Check bearings and other lubricated parts for proper lubrication.
 - 7. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

- B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished.
 - 1. New filters are installed.
 - 2. Coils are clean and fins combed.
 - 3. Drain pans are clean.
 - 4. Fans are clean.
 - 5. Bearings and other parts are properly lubricated.
 - 6. Deficiencies noted in the preconstruction report are corrected.

- C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
 - 1. Compare the indicated airflow of the renovated work to the measured fan airflows and determine the new fan, speed, filter, and coil face velocity.
 - 2. If calculations increase or decrease the airflow and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated airflow and water flow rates. If 5 percent or less, equipment adjustments are not required.
 - 3. Air balance each air outlet.

3.18 TOLERANCES

- A. Set HVAC system airflow and water flow rates within the following tolerances:
 - 1. Air handling equipment and outlets: Plus or minus 5 percent.
 - a. Where terminal units serve 6 or more outlets within a common room, individual outlets may vary up to plus or minus 10 percent of design flow rates if overall room supply is within plus or minus 5 percent.
 - 2. Heating-Water Flow Rate: 0 to minus 10 percent.
 - 3. Cooling-Water Flow Rate: 0 to plus 5 percent.

3.19 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.20 FINAL REPORT

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.
- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
 - 1. Include a list of instruments used for procedures, along with proof of calibration.

- C. Final Report Contents: In addition to certified field report data, include the following:
1. Pump curves.
 2. Fan curves.
 3. Manufacturers' test data.
 4. Field test reports prepared by system and equipment installers.
 5. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.
- D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
1. Title page.
 2. Name and address of TAB firm.
 3. Project name.
 4. Project location.
 5. Architect's name and address.
 6. Engineer's name and address.
 7. Contractor's name and address.
 8. Report date.
 9. Signature of TAB firm who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Notes to explain why certain final data in the body of reports varies from indicated values.
 14. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outside-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.

- h. Other system operating conditions that affect performance.
- E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
- 1. Quantities of outside, supply, return, and exhaust airflows.
 - 2. Water flow rates.
 - 3. Terminal units.
 - 4. Balancing stations.
- F. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:
- 1. Unit Data: Include the following:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - j. Number of belts, make, and size.
 - k. Number of filters, type, and size.
 - 2. Motor Data:
 - a. Make and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - g. Power factor efficiency.
 - 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Preheat coil static-pressure differential in inches wg.
 - g. Cooling coil static-pressure differential in inches wg.

- h. Heating coil static-pressure differential in inches wg.
- i. Outside airflow in cfm.
- j. Return airflow in cfm.
- k. Outside-air damper position.
- l. Return-air damper position.
- m. Vortex damper position.

G. Apparatus-Coil Test Reports:

1. Coil Data:

- a. System identification.
- b. Location.
- c. Coil type.
- d. Number of rows.
- e. Fin spacing in fins per inch o.c.
- f. Make and model number.
- g. Face area in sq. ft.
- h. Tube size in NPS.
- i. Tube and fin materials.
- j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

- a. Airflow rate in cfm.
- b. Average face velocity in fpm.
- c. Air pressure drop in inches wg.
- d. Outside-air, wet- and dry-bulb temperatures in deg F.
- e. Return-air, wet- and dry-bulb temperatures in deg F.
- f. Entering-air, wet- and dry-bulb temperatures in deg F.
- g. Leaving-air, wet- and dry-bulb temperatures in deg F.
- h. Water flow rate in gpm.
- i. Water pressure differential in feet of head or psig.
- j. Entering-water temperature in deg F.
- k. Leaving-water temperature in deg F.

H. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

- a. System identification.
- b. Location.
- c. Make and type.
- d. Model number and unit size.

- e. Manufacturer's serial number.
 - f. Fuel type in input data.
 - g. Output capacity in Btuh.
 - h. Ignition type.
 - i. Burner-control types.
 - j. Motor horsepower and rpm.
 - k. Motor volts, phase, and hertz.
 - l. Motor full-load amperage and service factor.
 - m. Sheave make, size in inches, and bore.
 - n. Sheave dimensions, center-to-center, and amount of adjustments in inches.
2. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Entering-air temperature in deg F.
 - c. Leaving-air temperature in deg F.
 - d. Air temperature differential in deg F.
 - e. Entering-air static pressure in inches wg.
 - f. Leaving-air static pressure in inches wg.
 - g. Air static-pressure differential in inches wg.
 - h. Low-fire fuel input in Btuh.
 - i. High-fire fuel input in Btuh.
 - j. Manifold pressure in psig.
 - k. High-temperature-limit setting in deg F.
 - l. Operating set point in Btuh.
 - m. Motor voltage at each connection.
 - n. Motor amperage for each phase.
 - o. Heating value of fuel in Btuh.
- I. Fan Test Reports: For supply, return, and exhaust fans, include the following:
 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Sheave dimensions, center-to-center, and amount of adjustments in inches.
 2. Motor Data:
 - a. Make and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.

- f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
- g. Number of belts, make, and size.
- 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.

- J. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 - 1. Report Data:
 - a. System and air-handling unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft..
 - g. Indicated airflow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual airflow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.

- K. Air-Terminal-Device Reports:
 - 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Test apparatus used.
 - d. Area served.
 - e. Air-terminal-device make.
 - f. Air-terminal-device number from system diagram.
 - g. Air-terminal-device type and model number.
 - h. Air-terminal-device size.
 - i. Air-terminal-device effective area in sq. ft..
 - 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary airflow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final airflow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.

- L. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flowmeter type.
 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Entering-water temperature in deg F.
 - c. Leaving-water temperature in deg F.
 - d. Water pressure drop in feet of head or psig.
 - e. Entering-air temperature in deg F.
 - f. Leaving-air temperature in deg F.
- M. Compressor and Condenser Reports: For refrigerant side of unitary systems, stand-alone refrigerant compressors, air-cooled condensing units, or water-cooled condensing units, include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Unit make and model number.
 - d. Compressor make.
 - e. Compressor model and serial numbers.
 2. Test Data (Indicated and Actual Values):
 - a. Inlet-duct static pressure in inches wg.
 - b. Outlet-duct static pressure in inches wg.
 - c. Entering-air, dry-bulb temperature in deg F.
 - d. Leaving-air, dry-bulb temperature in deg F.
 - e. Condenser entering-water temperature in deg F.
 - f. Condenser leaving-water temperature in deg F.
 - g. Condenser-water temperature differential in deg F.
 - h. Condenser entering-water pressure in feet of head or psig.
 - i. Condenser leaving-water pressure in feet of head or psig.
 - j. Condenser-water pressure differential in feet of head or psig.
 - k. Control settings.
 - l. Voltage at each connection.
 - m. Amperage for each phase.
 - n. Kilowatt input.
 - o. Crankcase heater kilowatt.
 - p. Number of fans.

- q. Condenser fan rpm.
 - r. Condenser fan airflow rate in cfm.
 - s. Condenser fan motor make, frame size, rpm, and horsepower.
 - t. Condenser fan motor voltage at each connection.
 - u. Condenser fan motor amperage for each phase.
- N. Cooling Tower or Condenser Test Reports: For cooling towers or condensers, include the following:
- 1. Unit Data:
 - a. Unit identification.
 - b. Make and type.
 - c. Model and serial numbers.
 - d. Nominal cooling capacity in tons.
 - e. Water-treatment chemical feeder and chemical.
 - f. Number and type of fans.
 - g. Fan motor make, frame size, rpm, and horsepower.
 - h. Fan motor voltage at each connection.
 - i. Sheave make, size in inches, and bore.
 - j. Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - k. Number of belts, make, and size.
 - l. Pump make and model number.
 - m. Pump manufacturer's serial number.
 - n. Pump motor make and frame size.
 - o. Pump motor horsepower and rpm.
 - 2. Pump Test Data (Indicated and Actual Values):
 - a. Voltage at each connection.
 - b. Amperage for each phase.
 - c. Water flow rate in gpm.
 - 3. Water Test Data (Indicated and Actual Values):
 - a. Entering-water temperature in deg F.
 - b. Leaving-water temperature in deg F.
 - c. Water temperature differential in deg F.
 - d. Entering-water pressure in feet of head or psig.
 - e. Leaving-water pressure in feet of head or psig.
 - f. Water pressure differential in feet of head or psig.
 - g. Water flow rate in gpm.
 - h. Bleed water flow rate in gpm.
 - 4. Air Data (Indicated and Actual Values):
 - a. Duct airflow rate in cfm.
 - b. Inlet-duct static pressure in inches wg.
 - c. Outlet-duct static pressure in inches wg.
 - d. Average entering-air, wet-bulb temperature in deg F.

- e. Average leaving-air, wet-bulb temperature in deg F.
 - f. Ambient wet-bulb temperature in deg F.
- O. Heat-Exchanger/Converter Test Reports: For steam and hot-water heat exchangers, include the following:
- 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and type.
 - e. Model and serial numbers.
 - f. Ratings.
 - 2. Steam Test Data (Indicated and Actual Values):
 - a. Inlet pressure in psig.
 - b. Condensate flow rate in lb/h.
 - 3. Primary Water Test Data (Indicated and Actual Values):
 - a. Entering-water temperature in deg F.
 - b. Leaving-water temperature in deg F.
 - c. Entering-water pressure in feet of head or psig.
 - d. Water pressure differential in feet of head or psig.
 - e. Water flow rate in gpm.
 - 4. Secondary Water Test Data (Indicated and Actual Values):
 - a. Entering-water temperature in deg F.
 - b. Leaving-water temperature in deg F.
 - c. Entering-water pressure in feet of head or psig.
 - d. Water pressure differential in feet of head or psig.
 - e. Water flow rate in gpm.
- P. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
- 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.
 - e. Model and serial numbers.
 - f. Water flow rate in gpm.
 - g. Water pressure differential in feet of head or psig.
 - h. Required net positive suction head in feet of head or psig.
 - i. Pump rpm.

- j. Impeller diameter in inches.
 - k. Motor make and frame size.
 - l. Motor horsepower and rpm.
 - m. Voltage at each connection.
 - n. Amperage for each phase.
 - o. Full-load amperage and service factor.
 - p. Seal type.
2. Test Data (Indicated and Actual Values):
- a. Static head in feet of head or psig.
 - b. Pump shutoff pressure in feet of head or psig.
 - c. Actual impeller size in inches.
 - d. Full-open flow rate in gpm.
 - e. Full-open pressure in feet of head or psig.
 - f. Final discharge pressure in feet of head or psig.
 - g. Final suction pressure in feet of head or psig.
 - h. Final total pressure in feet of head or psig.
 - i. Final water flow rate in gpm.
 - j. Voltage at each connection.
 - k. Amperage for each phase.
- Q. Air-to-Air Heat-Recovery Unit Reports:
1. Unit Data:
- a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and type.
 - e. Model and serial numbers.
2. Motor Data:
- a. Make and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
3. If fans are an integral part of the unit, include the following for each fan:
- a. Make and type.
 - b. Arrangement and size.
 - c. Sheave make, size in inches, and bore.
 - d. Sheave dimensions, center-to-center, and amount of adjustments in inches.
4. Test Data (Indicated and Actual Values):
- a. Total exhaust airflow rate in cfm.
 - b. Purge exhaust airflow rate in cfm.
 - c. Outside airflow rate in cfm.

- d. Total exhaust fan static pressure in inches wg.
- e. Total outside-air fan static pressure in inches wg.
- f. Pressure drop on each side of recovery wheel in inches wg.
- g. Exhaust air temperature entering in deg F.
- h. Exhaust air temperature leaving in deg F.
- i. Outside-air temperature entering in deg F.
- j. Outside-air temperature leaving in deg F.
- k. Calculate sensible and total heat capacity of each airstream in MBh.

3.21 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
2. Randomly check the following for each system:
 - a. Measure airflow of at least 10 percent of air outlets.
 - b. Measure water flow of at least 5 percent of terminals.
 - c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
 - d. Measure sound levels at two locations.
 - e. Measure space pressure of at least 10 percent of locations.
 - f. Verify that balancing devices are marked with final balance position.
 - g. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:

1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect.
2. TAB firm test and balance engineer shall conduct the inspection in the presence of Architect.
3. Architect shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of

the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.

4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.22 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION 15950

SECTION 16010 - ELECTRICAL GENERAL REQUIREMENTS

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUMMARY.....2
1.3 REFERENCES.....2
1.4 QUALITY ASSURANCE.....2
1.5 CODES, PERMITS AND FEES.....3
1.6 DRAWINGS.....3
1.7 MATERIAL AND EQUIPMENT MANUFACTURERS.....4
1.8 INSPECTION OF SITE.....5
1.9 ITEMS REQUIRING PRIOR APPROVAL.....5
1.10 SHOP DRAWINGS/SUBMITTALS6
1.11 COORDINATION DRAWINGS6
1.12 OPERATION AND MAINTENANCE INSTRUCTIONAL MANUALS7
1.13 RECORD DRAWINGS7
1.14 INSTRUCTION OF OWNER PERSONNEL8
1.15 WARRANTY8
1.16 USE OF EQUIPMENT8

PART 2 - PRODUCTS.....9

PART 3 - EXECUTION.....9
3.1 INSTALLATION OF EQUIPMENT.....9
3.2 DEMOLITION WORK.....9
3.3 TEMPORARY SERVICES.....10
3.4 CHASES AND RECESSES.....10
3.5 CUTTING, PATCHING AND DAMAGE TO OTHER WORK.....11
3.6 EXCAVATION AND BACKFILLING.....11
3.7 EQUIPMENT CONNECTIONS.....11
3.8 CLEANING.....11
3.9 PROTECTION AND HANDLING OF EQUIPMENT AND MATERIALS.....12
3.10 EXTRA WORK12
3.11 DRAWINGS AND MEASUREMENTS12

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 SUMMARY

- A. This Section includes electrical general administrative and procedural requirements. The following requirements are included in this Section to supplement the requirements specified in Division 1 Specification Sections.

1.3 REFERENCES

- A. All materials shall be new. The electrical and physical properties of all materials, and the design, performance characteristics, and methods of construction of all items of equipment, shall be in accordance with the latest issue of the various, applicable Standard Specifications of the following recognized authorities:
 1. A.N.S.I. American National Standards Institute
 2. A.S.T.M. American Society for Testing Materials
 3. I.C.E.A. Insulated Cable Engineers Association
 4. I.E.E.E. Institute of Electrical and Electronics Engineers
 5. N.E.C. National Electrical Code
 6. N.E.C.A. National Electrical Contractors Association
 7. N.E.M.A. National Electrical Manufacturer's Association
 8. U.L. Underwriters Laboratories, Inc.
 9. N.E.C.A. 1-2000, "Practices for Good Workmanship in Electrical Contracting (ANSI)."

1.4 QUALITY ASSURANCE

- A. Scope of Work: Furnish all labor, material, equipment, technical supervision, and incidental services required to complete, test and leave ready for operation the electrical systems as specified in the Division 16 Sections and as indicated on Drawings.
- B. Ordinances and Codes: Perform all Work in accordance with applicable Federal, State and local ordinances and regulations, the Rules and Regulations of NFPA, NECA, and UL, unless otherwise indicated.
 1. Notify the Architect/Engineer before submitting a proposal should any changes in Drawings or Specifications be required to conform to the above codes, rules or regulations. After entering into Contract, make all changes required to conform to above ordinances, rules and regulations without additional expense to the Owner.

- C. Source Limitations: All equipment of the same or similar systems shall be by the same manufacturer.
- D. Tests and Inspections: Perform all tests required by state, city, county and/or other agencies having jurisdiction. Provide all materials, equipment, etc., and labor required for tests.
- E. Performance Requirements: Perform all work in a first class and workmanlike manner, in accordance with the latest accepted standards and practices for the trades involved.
- F. Sequence and Schedule: Work so as to avoid interference with the work of other trades. Be responsible for removing and relocating any work which in the opinion of the Owner's Representatives causes interference.

1.5 CODES, PERMITS AND FEES

- A. Unless otherwise indicated, all required permits, licenses, inspections, approvals and fees for electrical work shall be secured and paid for by the Contractor. All work shall conform to all applicable codes, rules and regulations.
- B. Rules of local utility companies shall be complied with. Coordinate with the utility company supplying service to the installation and determine all devices including, but not limited to, all current and potential transformers, meter boxes, C.T. cabinets and meters which will be required and include the cost of all such items and all utilities costs in proposal.
- C. All work shall be executed in accordance with the rules and regulations set forth in local and state codes. Prepare any detailed Drawings or diagrams which may be required by the governing authorities. Where the Drawings and/or Specifications indicate materials or construction in excess of code requirements, the Drawings and/or Specifications shall govern.

1.6 DRAWINGS

- A. The Drawings show the location and general arrangement of equipment, electrical systems and related items. They shall be followed as closely as elements of the construction will permit.

- B. Examine the Drawings of other trades and verify the conditions governing the work on the job site. Arrange work accordingly, providing such fittings, conduit, junction boxes and accessories as may be required to meet such conditions.
- C. Deviations from the Drawings, with the exception of minor changes in routing and other such incidental changes that do not affect the functioning or serviceability of the systems, shall not be made without the written approval of the Architect/Engineer.
- D. The architectural and structural Drawings take precedence in all matters pertaining to the building structure, mechanical Drawings in all matters pertaining to mechanical trades and electrical Drawings in all matters pertaining to electrical trades. Where there are conflicts or differences between the Drawings for the various trades, report such conflicts or differences to the Architect/Engineer for resolution.
- E. Drawings are not intended to be scaled for rough-in or to serve as shop drawings. Take all field measurements required to complete the Work.

1.7 MATERIAL AND EQUIPMENT MANUFACTURERS

- A. All items of equipment shall be furnished complete with all accessories normally supplied with the catalog items listed and all other accessories necessary for a complete and satisfactory operating system. All equipment and materials shall be new and shall be standard products of manufacturers regularly engaged in the production of electrical equipment and shall be of the manufacturer's latest design.
- B. If an approved manufacturer is other than the manufacturer used as the basis for design, the equipment or product provided shall be equal in size, quality, durability, appearance, capacity, and efficiency through all ranges of operation, shall conform with arrangements and space limitations of the equipment shown on the plans and/or specified, shall be compatible with the other components of the system and shall comply with the requirements for Items Requiring Prior Approval specified in this section of the Specifications. All costs to make these items of equipment comply with these requirements including, but not limited to, electrical work, and building alterations shall be

included in the original Bid. Similar equipment shall be by one manufacturer.

1.8 INSPECTION OF SITE

- A. Visit the site, examine and verify the conditions under which the Work must be conducted before submitting Proposal. The submitting of a Proposal implies that the Contractor has visited the site and understands the conditions under which the Work must be conducted. No additional charges will be allowed because of failure to make this examination or to include all materials and labor to complete the Work.

1.9 ITEMS REQUIRING PRIOR APPROVAL

- A. Bids shall be based upon manufactured equipment specified. All items that the Contractor proposes to use in the Work that are not specifically named in the Contract Documents must be submitted for review prior to bids. Such items must be submitted in compliance with Division 1 specifications. Requests for prior approval must be accompanied by complete catalog information, including but not limited to, model, size, accessories, complete electrical information and performance data in the form given in the equipment schedule on the drawings at stated design conditions. Where items are referred to by symbolic designations on the drawings, all requests for prior approval shall bear the same designations.
 - 1. Equipment to be considered for prior approval shall be equal in quality, durability, appearance, capacity and efficiency through all ranges of operation, shall fulfill the requirements of equipment arrangement and space limitations of the equipment shown on the plans and/or specified and shall be compatible with the other components of the system.
 - 2. All costs incurred to make equipment comply with other requirements, including providing maintenance, clearance, electrical, replacement of other components, and building alterations shall be included in the original bid.
- B. Voluntary alternates may be submitted for consideration, with listed addition or deduction to the bid.

1.10 SHOP DRAWINGS/SUBMITTALS

- A. Submit project-specific submittals for review in compliance with Division 1.
- B. All shop Drawings shall be submitted in groupings of similar and/or related items (lighting fixtures, switchgear, etc.). Incomplete submittal groupings will be returned unchecked.
- C. Provide detailed layout shop Drawings (on transparent media) of all lighting and power distribution systems, routing of conduits, combining of circuits, circuiting, details and related information necessary of installation and maintenance. After review by the Architect/Engineer, a copy of Drawings will be stamped and returned to the Contractor.
- D. If deviations (not substitutions) from Contract Documents are deemed necessary by the Contractor, details of such deviations, including changes in related portions of the project and the reasons therefore, shall be submitted with the submittal for approval.
- E. Submit for approval shop drawings for all electrical systems or equipment but not limited to the items listed below. Where items are referred to by symbolic designation on the Drawings and Specifications, all submittals shall bear the same designation (light fixtures). Refer to other sections of the electrical Specifications for additional requirements.
 - 1. Panelboards
 - 2. Dry-Type Transformers
 - 3. Enclosed Controllers
 - 4. Disconnect Switches
 - 5. Contactors
 - 6. Time Controllers
 - 7. Wiring Devices
 - 8. Lighting Fixtures
 - 9. Occupancy Sensors (material and lay-out drawings)
 - 10. Fire Alarm Systems
 - 11. Sound Systems
 - 12. Clocks

1.11 COORDINATION DRAWINGS

- A. Submit project specified coordination drawings for review in compliance with Division 1 Specification Sections.

1.12 OPERATION AND MAINTENANCE INSTRUCTIONAL MANUALS

- A. Submit project specific Operation and Maintenance Instructional Manuals for review in compliance with Division 1 Specification Sections.
- B. Provide complete operation and maintenance instructional manuals covering all electrical equipment herein specified, together with parts lists. Maintenance and operating instructional manuals shall be job specific to this project. Generic manuals are not acceptable. Four (4) copies of all literature shall be furnished for Owner and shall be bound in ring binder form. Maintenance and operating instructional manuals shall be provided when construction is approximately 75% complete.
- C. The operating and maintenance instructions shall include a brief, general description for all mechanical systems including, but not limited to:
 - 1. Routine maintenance procedures.
 - 2. Lubrication chart listing all types of lubricants to be used for each piece of equipment and the recommended frequency of lubrication.
 - 3. Trouble-shooting procedures.
 - 4. Contractor's telephone numbers for warranty repair service.
 - 5. Submittals.
 - 6. Recommended spare parts lists.
 - 7. Names and telephone numbers of major material suppliers and subcontractors.
 - 8. System schematic drawings on 8-1/2" x 11" sheets.

1.13 RECORD DRAWINGS

- A. Submit record drawings in compliance with Division 1.
- B. Contractor shall submit to the Architect/Engineer, record drawings on electronic media or mylar which have been neatly marked to represent as-built conditions for all new electrical work.
- C. The Contractor shall keep accurate note of all deviations from the construction documents and discrepancies in the underground concealed conditions and other items of construction on field drawings as they occur. The marked up field documents shall be available for review by the Architect, Engineer and Owner at their request.

1.14 INSTRUCTION OF OWNER PERSONNEL

- A. Before final inspection, instruct Owner's designated personnel in operation, adjustment, and maintenance of electrical equipment and systems at agreed upon times. A minimum of 8 hours of formal instruction to Owner's personnel shall be provided for each building. Additional hours are specified in individual specification sections.
- B. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
- C. In addition to individual equipment training provide overview of each electrical system. Utilize the as-built documents for this overview.
- D. Prepare and insert additional data in operation and maintenance manual when need for such data becomes apparent during instruction, or as requested by Owner.

1.15 WARRANTY

- A. Warranty: Comply with the requirements in Division 1 Specification Sections. Contractor shall warranty that the electrical installation is free from defects and agrees to replace or repair, to the Owner's satisfaction, any part of this electrical installation which becomes defective within a period of one year (unless specified otherwise in other Division 26 sections) from the date of substantial completion following final acceptance, provided that such failure is due to defects in the equipment, material, workmanship or failure to follow the contract documents.
- B. File with the Owner any and all warranties from the equipment manufacturers including the operating conditions and performance capacities they are based on.

1.16 USE OF EQUIPMENT

- A. The use of any equipment, or any part thereof for purposes other than testing even with the Owner's consent, shall not be construed to be an acceptance of the work on the part of the Owner, nor be construed to obligate the Owner in any way to accept improper work or defective materials.

- B. Do not use Owner's lamps for temporary lighting except as allowed and directed by the Owner. Equip lighting fixtures with new lamps when the project is turned over to the Owner.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

3.1 INSTALLATION OF EQUIPMENT

- A. Install all equipment in strict accordance with all directions and recommendations furnished by the manufacturer. Where such directions are in conflict with the Drawings and Specifications, report such conflicts to the Architect/Engineer for resolution.
- B. Device Location:
 - 1. Allow for relocation prior to installation of wiring devices and other control devices, for example, receptacles, switches, fire alarm devices, and access control devices, within a 10-foot radius of indicated location without additional cost.

3.2 DEMOLITION WORK

- A. All demolition of existing electrical equipment and materials will be done by this Contractor unless otherwise indicated. Include all items such as, but not limited to, electrical equipment, devices, lighting fixtures, conduit, and wiring called out on the Drawings and as necessary whether such items are actually indicated on the Drawings or not in order to accomplish the installation of the specified new work.
- B. In general, demolition work is indicated on the Drawings. However, the Contractor shall visit the job site to determine the full extent and character of this work.
- C. Unless specifically noted to the contrary, removed materials shall not be reused in the work. Salvaged materials that are to be reused shall be stored safe against damage and turned over to the appropriate trade for reuse. Salvaged materials of value that are not to be reused shall remain the property of the Owner unless such ownership is waived. Items on which

the Owner waives ownership shall become the property of the Contractor, who shall remove and legally dispose of same, away from the premises.

- D. Where equipment or fixtures are removed, outlets shall be properly blanked off, and conduits capped. After alterations are done, the entire installation shall present a "finished" look, as approved by the Architect/Engineer. The original function of the present electrical work to be modified shall not be changed unless required by the specific revisions to the system as specified or as indicated.
- E. Reroute signal wires, lighting and power wiring as required to maintain service. Where walls and ceilings are to be removed as shown on the Drawings, the conduit is to be cut off by the Electrical Trades so that the abandoned conduit in these walls and ceilings may be removed with the walls and ceilings by the Architectural Trades. All dead-end conduit runs shall be plugged at the remaining line outlet boxes or at the panels.
- F. Where new walls and/or floors are installed which interfere with existing outlets, devices, etc., the Electrical Trades shall adjust, extend and reconnect such items as required to maintain continuity of same.
- G. All electrical work in altered and unaltered areas shall be run concealed wherever possible. Use of surface raceway or exposed conduits will be permitted only where approved by the Architect/Engineer.
- H. Existing lighting shall be reused where indicated on plans. Reused fixtures shall be detergent cleaned, relamped and reconditioned suitable for satisfactory operation and appearance.

3.3 TEMPORARY SERVICES

- A. Provide and remove upon completion of the project, in accordance with the general conditions and as described in Division 1, a complete temporary electrical and telephone service during construction.

3.4 CHASES AND RECESSES

- A. Provided by the architectural trades, but the Contractor shall be responsible for their accurate location and size.

3.5 CUTTING, PATCHING AND DAMAGE TO OTHER WORK

- A. Refer to General Conditions for requirements.
- B. All cutting, patching and repair work shall be performed by the Contractor through approved, qualified subcontractors. Contractor shall include full cost of same in bid.

3.6 EXCAVATION AND BACKFILLING

- A. Provide all excavation, trenching, tunneling, dewatering and backfilling required for the electrical work. Coordinate the work with other excavating and backfilling in the same area.
- B. Where conduit is installed less than 2'6" below the surface of pavement, provide concrete encasement, 4" minimum coverage, all around or as shown on the electrical Drawings.
- C. Backfill all excavations with well-tamped granular material. Backfill all excavations under wall footings with lean mix concrete up to underside of footings and extend concrete within excavation a minimum of four (4) feet each side of footing. Granular backfill shall be placed in layers not more than 8 inches in thickness, 95 percent compaction throughout with approved compaction equipment. Tamp, roll as required. Excavated material shall not be used.
- D. Backfill outside building with granular material to a height 12 inches over top of pipe compacted to 95 percent compaction as specified above. Backfill remainder of excavation with unfrozen, excavated material in such a way to prevent settling.

3.7 EQUIPMENT CONNECTIONS

- A. Make connections to equipment, motors, lighting fixtures, and other items included in the work in accordance with the approved shop Drawings and rough-in measurements furnished by the manufacturers of the particular equipment furnished. All additional connections not shown on the Drawings, but called out by the equipment manufacturer's shop Drawings shall be provided.

3.8 CLEANING

- A. All debris shall be removed daily as required to maintain the work area in a neat, orderly condition.

- B. Final cleanup shall include, but not be limited to, washing of fixture lenses or louvers, switchboards, substations, motor control centers, panels, etc. Fixture reflectors and lenses or louvers shall be left with no water marks or cleaning streaks.

3.9 PROTECTION AND HANDLING OF EQUIPMENT AND MATERIALS

- A. Equipment and materials shall be protected from theft, injury or damage.
- B. Protect conduit openings with temporary plugs or caps.
- C. Provide adequate storage for all equipment and materials delivered to the job site. Location of the space will be designated by the Owner's representative or Architect/Engineer. Equipment set in place in unprotected areas must be provided with temporary protection.

3.10 EXTRA WORK

- A. For any extra electrical work which may be proposed, this Contractor shall furnish to the General Contractor, an itemized breakdown of the estimated cost of the materials and labor required to complete this work. The Contractor shall proceed only after receiving a written order from the General Contractor establishing the agreed price and describing the work to be done.

Prior to any extra work which may be proposed, the Electrical Contractor shall submit unit prices (same prices for increase/decrease of work) for the following items: 1/2", 3/4", 1", 1-1/2" conduit; #12, #10, #8, #6, #2 wire; receptacle, I.G. receptacle, data box, fire alarm horn/strobe, fire alarm strobe, P.A. speaker, clock, or other devices which may be required for any proposed extra work.

3.11 DRAWINGS AND MEASUREMENTS

- A. These Specifications and accompanying Drawings are intended to describe and provide for finished work. They are intended to be cooperative, and what is called for by either shall be as binding as if call for by both. The Contractor understands that the work herein described shall be complete in every detail.

- B. The Drawings are not intended to be scaled for rough-in measurements nor to serve as Shop Drawings. Field measurements necessary for ordering materials and fitting the installation to the building construction and arrangement are the Contractor's responsibility. The Contractor shall check latest Architectural Drawings and locate light switches from same where door swings are different from Electrical Drawings.

END OF SECTION 16010

SECTION 16055 - OVERCURRENT PROTECTIVE DEVICE COORDINATION AND ARC
FLASH STUDY

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SCOPE.....1
1.3 REFERENCES.....2
1.4 SUBMITTALS FOR REVIEW/APPROVAL.....3
1.5 SUBMITTALS FOR CONSTRUCTION.....3
1.6 QUALIFICATIONS.....3
1.7 COMPUTER SOFTWARE PROGRAMS.....4

PART 2 - PRODUCTS.....4
2.1 STUDIES.....4
2.2 DATA COLLECTION.....4
2.3 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY.....5
2.4 PROTECTIVE DEVICE COORDINATION STUDY.....6
2.5 ARC FLASH HAZARD ANALYSIS.....7
2.6 REPORT SECTIONS.....9

PART 3 - EXECUTION.....11
3.1 FIELD ADJUSTMENT.....11
3.2 ARC FLASH WARNING LABELS.....11

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 SCOPE

- A. The contractor shall furnish short-circuit and protective device coordination studies as prepared by the electrical equipment manufacturer.
- B. The contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in NFPA 70E -Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE 1584

equations that are presented in NFPA70E-2004, Annex D prepared by the electrical equipment manufacturer.

- C. The scope of the studies shall include all new distribution equipment supplied by the equipment manufacturer under this contract as well as all directly affected existing distribution equipment at the customer facility.

1.3 REFERENCES

- A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
1. IEEE 141 - Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
 2. IEEE 242 - Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
 3. IEEE 399 - Recommended Practice for Industrial and Commercial Power System Analysis
 4. IEEE 241 - Recommended Practice for Electric Power Systems in Commercial Buildings
 5. IEEE 1015 - Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
 6. IEEE 1584 -Guide for Performing Arc-Flash Hazard Calculations
- B. American National Standards Institute (ANSI):
1. ANSI C57.12.00 - Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
 2. ANSI C37.13 - Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
 3. ANSI C37.010 - Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
 4. ANSI C 37.41 - Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.
- C. The National Fire Protection Association (NFPA)
1. NFPA 70 -National Electrical Code, latest edition
 2. NFPA 70E - Standard for Electrical Safety in the Workplace

1.4 SUBMITTALS FOR REVIEW/APPROVAL

- A. The short-circuit and protective device coordination studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

1.5 SUBMITTALS FOR CONSTRUCTION

- A. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. Five (5) bound copies of the complete final report shall be submitted. Additional copies of the short-circuit input and output data, where required, shall be provided on CD in PDF format.
- B. The report shall include the following sections:
 - 1. Executive Summary.
 - 2. Descriptions, purpose, basis and scope of the study.
 - 3. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties.
 - 4. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection.
 - 5. Fault current calculations including a definition of terms and guide for interpretation of the computer printout.
 - 6. Details of the incident energy and flash protection boundary calculations.
 - 7. Recommendations for system improvements, where needed.
 - 8. One-line diagram.
- C. Arc flash labels shall be provided in hard copy and a copy of the computer analysis software viewer program is required to provide arc flash labels in electronic format.

1.6 QUALIFICATIONS

- A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the

supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.

- B. The Registered Professional Electrical Engineer shall be a full-time employee of the equipment manufacturer.
- C. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies.
- D. The equipment manufacturer shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analysis it has performed in the past year.

1.7 COMPUTER SOFTWARE PROGRAMS

- A. Computer Software Programs: Subject to compliance with requirements, provide products by one of the following:
 - 1. EDSA Micro Corporation.
 - 2. SKM Systems Analysis, Inc.
 - 3. ESA Inc.
 - 4. CGI CYME.
 - 5. Operation Technology, Inc.

PART 2 - PRODUCTS

2.1 STUDIES

- A. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer.
- B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E -Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D prepared by the equipment manufacturer.

2.2 DATA COLLECTION

- A. Contractor shall furnish all data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis

studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

- B. Source combination may include present and future motors and generators.
- C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner.
- D. If applicable, include fault contribution of existing motors in the study. The Contractor shall obtain required existing equipment data to satisfy the study requirements.

2.3 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

- A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standard 141-1993.
- B. Transformer design impedances shall be used when test impedances are not available.
- C. Provide the following:
 - 1. Calculation methods and assumptions
 - 2. Selected base per unit quantities
 - 3. One-line diagram of the system being evaluated
 - 4. Source impedance data, including electric utility system and motor fault contribution characteristics
 - 5. Tabulations of calculated quantities
 - 6. Results, conclusions, and recommendations.
- D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:
 - 1. Electric utility's supply termination point
 - 2. Incoming switchgear
 - 3. Unit substation primary and secondary terminals
 - 4. Low voltage switchgear
 - 5. Motor control centers
 - 6. Standby generators and automatic transfer switches
 - 7. Branch circuit panelboards
 - 8. Other significant locations throughout the system.

- E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.
- F. Protective Device Evaluation:
 - 1. Evaluate equipment and protective devices and compare to short circuit ratings
 - 2. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses
 - 3. Notify design engineer in writing, of existing, circuit protective devices improperly rated for the calculated available fault current.

2.4 PROTECTIVE DEVICE COORDINATION STUDY

- A. Proposed protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.
- B. Include on each TCC graph, a complete title and one-line diagram with legend identifying the specific portion of the system covered.
- C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
- D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
- E. Plot the following characteristics on the TCC graphs, where applicable:
 - 1. Electric utility's overcurrent protective device
 - 2. Medium voltage equipment overcurrent relays
 - 3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
 - 4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
 - 5. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves
 - 6. Conductor damage curves
 - 7. Ground fault protective devices, as applicable
 - 8. Pertinent motor starting characteristics and motor damage points, where applicable

9. Pertinent generator short-circuit decrement curve and generator damage point
10. The largest feeder circuit breaker in each motor control center and applicable panelboard.

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.5 ARC FLASH HAZARD ANALYSIS

- A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.
- B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.
- C. The Arc-Flash Hazard Analysis shall include all significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA where work could be performed on energized parts.
- D. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm².
- E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations
- F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution

from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

- G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:
1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.
 2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).
- H. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.
- I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.
- J. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.
- K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

2.6 REPORT SECTIONS

- A. Input data shall include, but not be limited to the following:
1. Feeder input data including feeder type (cable or bus), size, length, number per phase, conduit type (magnetic or non-magnetic) and conductor material (copper or aluminum).
 2. Transformer input data, including winding connections, secondary neutral-ground connection, primary and secondary voltage ratings, kVA rating, impedance, % taps and phase shift.
 3. Generation contribution data, (synchronous generators and Utility), including short-circuit reactance ($X''d$), rated MVA, rated voltage, three-phase and single line-ground contribution (for Utility sources) and X/R ratio.
 4. Motor contribution data (induction motors and synchronous motors), including short-circuit reactance, rated horsepower or kVA, rated voltage, and X/R ratio.
- B. Short-Circuit Output Data shall include, but not be limited to the following reports:
1. Low Voltage Fault Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
 - a. Voltage
 - b. Calculated fault current magnitude and angle
 - c. Fault point X/R ratio
 - d. Equivalent impedance
 2. Momentary Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
 - a. Voltage
 - b. Calculated symmetrical fault current magnitude and angle
 - c. Fault point X/R ratio
 - d. Calculated asymmetrical fault currents
 - 1) Based on fault point X/R ratio
 - 2) Based on calculated symmetrical value multiplied by 1.6
 - 3) Based on calculated symmetrical value multiplied by 2.7
 - e. Equivalent impedance
 3. Interrupting Duty Report shall include a section for three-phase and unbalanced fault calculations and shall

show the following information for each applicable location:

- a. Voltage
- b. Calculated symmetrical fault current magnitude and angle
- c. Fault point X/R ratio
- d. No AC Decrement (NACD) Ratio
- e. Equivalent impedance
- f. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a symmetrical basis
- g. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a total basis

C. Recommended Protective Device Settings:

1. Phase and Ground Relays:

- a. Current transformer ratio
- b. Current setting
- c. Time setting
- d. Instantaneous setting
- e. Recommendations on improved relaying systems, if applicable.

2. Circuit Breakers:

- a. Adjustable pickups and time delays (long time, short time, ground)
- b. Adjustable time-current characteristic
- c. Adjustable instantaneous pickup
- d. Recommendations on improved trip systems, if applicable.

D. Incident energy and flash protection boundary calculations

1. Arcing fault magnitude
2. Protective device clearing time
3. Duration of arc
4. Arc flash boundary
5. Working distance
6. Incident energy
7. Hazard Risk Category
8. Recommendations for arc flash energy reduction

PART 3 - EXECUTION

3.1 FIELD ADJUSTMENT

- A. The contractor shall adjust relay and protective device settings according to the recommended settings table provided by the coordination study.
- B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.
- C. Notify design engineer in writing of any required major equipment modifications.

3.2 ARC FLASH WARNING LABELS

- A. The contractor shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.
- B. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.
- C. The label shall include the following information, at a minimum:
 - 1. Location designation
 - 2. Nominal voltage
 - 3. Flash protection boundary
 - 4. Hazard risk category
 - 5. Incident energy
 - 6. Working distance
 - 7. Engineering report number, revision number and issue date.
- D. Labels shall be machine printed, with no field markings.
- E. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
 - 1. For each 480 and applicable 208 volt panelboard, one arc flash label shall be provided.

2. For each motor control center, one arc flash label shall be provided.
3. For each low voltage switchboard, one arc flash label shall be provided.
4. For each switchgear, one flash label shall be provided.
5. For medium voltage switches one arc flash label shall be provided

F. Labels shall be field installed by the contractor.

END OF SECTION 16055

SECTION 16060 - GROUNDING AND BONDING

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUMMARY.....1
1.3 REFERENCES.....1
1.4 SUBMITTALS.....2
1.5 PROJECT RECORD DOCUMENTS.....3
1.6 QUALITY ASSURANCE.....3

PART 2 - PRODUCTS.....4
2.1 MANUFACTURERS.....4
2.2 GROUNDING CONDUCTORS.....4
2.3 CONNECTOR PRODUCTS.....5
2.4 GROUNDING ELECTRODES.....6

PART 3 - EXECUTION.....6
3.1 EQUIPMENT GROUNDING.....6
3.2 CONNECTIONS.....8
3.3 INSTALLATION.....9
3.4 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING.....13
3.5 TELECOMMUNICATIONS GROUNDING.....14
3.6 FIELD QUALITY CONTROL.....15

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.
- B. Related Sections include the following:
 - 1. Division 16 Section "Electrical General Requirements".
 - 2. Division 16 Section "Conductors and Cables".

1.3 REFERENCES

- A. ASTM B 3: Specification for Soft or Annealed Copper Wire.

- B. ASTM B 8: Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.
 - C. ASTM B 33: Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.
 - D. ASTM B 187: Specification for Copper, Bus Bar, Rod, and Shapes and General Purpose Rod, Bar, and Shapes.
 - E. IEEE 81: Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
 - F. IEEE 142: Grounding of Industrial and Commercial Power Systems.
 - G. IEEE 1100 - 1992: Recommended Practice for Powering and Grounding Sensitive Electronic Equipment.
 - H. IEEE C2: National Electrical Safety Code.
 - I. NETA MTS - 2001: Maintenance Testing Specifications.
 - J. NFPA 70: National Electrical Code.
 - K. NFPA 70B: Recommended Practice for Electrical Equipment Maintenance.
 - L. NFPA 780: Lightning Protection Code.
 - M. TIA/EIA 607: Commercial Building Grounding and Bonding Requirements Standard.
 - N. UL 96: Lightning Protection Components.
 - O. UL 467: Grounding and Bonding Equipment.
 - P. UL 486 A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.
 - Q. UL 486B: Wire Connectors for Use with Aluminum Conductors.
- 1.4 SUBMITTALS
- A. Product Data: For each type of product indicated.
 - B. Product Data: For the following:
 - 1. Ground rods.

- C. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
- D. Field Test Reports: Submit written test reports to include the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
 - 4. Indicate overall system resistance to ground.
 - 5. Indicate overall Telecommunications system resistance to ground.

1.5 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 26 "Electrical General Requirements".
- B. Accurately record actual locations of grounding electrodes and connections to building steel.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Refer to specification section "Electrical Testing."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 - 1. Comply with UL 467.
- C. Comply with NFPA 70; for overhead-line construction and medium-voltage underground construction, comply with IEEE C2.
- D. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.
- E. Comply with ANSI/TIA/EIA-607 "Standard for Commercial Building Grounding and Bonding Requirements for Telecommunications".
- F. Comply with ANSI/IEEE 1100 -1992 "Powering and Grounding Sensitive Electronic Equipment".

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Grounding Conductors and Cables:
 - a. Refer to Division 26 Section "Conductors and Cables".
 2. Grounding Rods:
 - a. American Electric-Blackburn.
 - b. Apache Grounding/Erico Inc.
 - c. Chance/Hubbell.
 3. Mechanical Connectors:
 - a. American Electric-Blackburn.
 - b. Burndy.
 - c. Chance/Hubbell.
 4. Exothermic Connections:
 - a. Cadweld.

2.2 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Division 16 Section "Conductors and Cables."
- B. Material: Aluminum, copper-clad aluminum, and copper.
- C. Equipment Grounding Conductors: Insulated with green-colored insulation.
- D. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.
- E. Grounding Electrode Conductors: Stranded cable.
- F. Underground Conductors: Bare, tinned, stranded, copper unless otherwise indicated.
- G. Bare Copper Conductors: Comply with the following:
1. Solid Conductors: ASTM B 3.
 2. Assembly of Stranded Conductors: ASTM B 8.
 3. Tinned Conductors: ASTM B 33.
- H. Copper Bonding Conductors: As follows:

1. Bonding Conductor: Stranded copper conductor; size per the NEC.
 2. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; size per the NEC.
 3. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; size per the NEC.
- I. Aluminum Bonding Conductors: As follows:
1. Bonding Conductor: Stranded aluminum conductor; size per the NEC.
 2. Bonding Jumper: Aluminum tape, braided bare aluminum conductors, terminated with aluminum ferrules; size per the NEC.
- J. Ground Conductor and Conductor Protector for Wood Poles: As follows:
1. No. 4 AWG minimum, soft-drawn copper conductor.
 2. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir, or cypress or cedar.
- K. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.
- L. Telecommunications Main Grounding Busbar (TMGB)
1. 48" (min) x 4" x ¼" tin plated, copper busbar with three rows of ¼ x 20 tapped holes 3" on center.
- M. Telecommunications Grounding Busbar (TGB)
1. 12" (min) x 2" x ¼" tin plated, copper busbar with two rows of ¼ x 20 tapped holes 3" on center.
- N. Telecommunications Bonding Backbone (TBB)
1. Minimum No. 2 AWG insulated stranded copper.
- O. Telecommunications Bonding Conductors
1. Minimum No. 6 AWG insulated stranded copper.
- 2.3 CONNECTOR PRODUCTS
- A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.

- C. Welded Connectors: Exothermic-welded type, in kit form, and selected for the specific application per manufacturer's written instructions.
- D. Compression-Type Connectors: Pure, wrought copper, per ASTM B187.

2.4 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel.
 - 1. Size: 5/8 (16 mm) in diameter.
 - 2. Length: 120 inches (3000 mm).
- B. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Provide handholes as specified in Division 2 Section "Underground Ducts and Utility Structures."

PART 3 - EXECUTION

3.1 EQUIPMENT GROUNDING

- A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
- B. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
- C. Underground Grounding Conductors: No. 2/0 AWG minimum. Bury at least 24 inches (600 mm) below grade or bury 12 inches (300 mm) above duct bank when installed as part of the duct bank.
- D. In raceways, use insulated equipment grounding conductors.
- E. Install equipment grounding conductors in all feeders and circuits. Terminate each end on suitable lugs, bus or bushing.
- F. Busway Supply Circuits: Install insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

- G. Computer Outlet Circuits: Install insulated equipment grounding conductor in branch-circuit runs from computer-area power panels or power-distribution units.
- H. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate grounding conductor from raceway and from panelboard grounding terminals. Terminate at the isolated equipment ground bus of the source panelboard unless otherwise indicated.
- I. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate equipment grounding conductor. Isolate equipment grounding conductor from raceway and from panelboard grounding terminals. Terminate at the isolated ground bus in the circuit's overcurrent device enclosure unless otherwise indicated.
- J. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.
- K. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.
- L. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components.
- M. Metal Poles Supporting Outdoor Lighting Fixtures: Provide a grounding electrode in addition to installing a separate equipment grounding conductor with supply branch-circuit conductors.
- N. Verify specific equipment grounding requirements with the manufacturer's recommendations.

3.2 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
 - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
 - 2. Make connections with clean, bare metal at points of contact.
 - 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 - 4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 - 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

- B. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells. Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

- C. Equipment Grounding Conductor Terminations.

- D. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and larger.

- E. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

- F. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

- G. Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and ground rods.

- H. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.
- I. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- J. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.3 INSTALLATION

- A. Equipotential Ground: Interconnect grounding electrodes to form one, electrically continuous, equipotential grounding electrode system. Grounding electrodes to be interconnected include:
 - 1. Ground rods.
 - 2. Counterpoise ground.
 - 3. Ufer ground.
 - 4. Lightning protection system.
 - 5. Metal water service pipe.
 - 6. Plate electrode.
- B. Ground Rods: Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.
 - 1. Verify that final backfill and compaction has been complete before driving ground rods.
 - 2. Drive ground rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.
 - 3. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.
- C. Counterpoise Ground:
 - 1. Ground the steel framework of the building with a driven ground rod at the base of every corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.

2. Provide a grounding conductor (counterpoise), electrically connected to each ground rod and to each steel column, extending around the perimeter of the building. Use conductors not less than No. 2/0 AWG for counterpoise and for tap to building steel. Bury counterpoise not less than 18 inches (450 mm) below grade and 24 inches (600 mm) from building foundation.
- D. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, Paragraph 250-81(c):
1. Provide a minimum of 20 feet (6 m) of bare copper conductor not smaller than No. 4 AWG. If concrete foundation is less than 20 feet (6 m) long, coil excess conductor within the base of the foundation.
 2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts.
 3. Extend grounding conductor below grade and connect to building grounding grid or to a grounding electrode external to concrete.
- E. Common Ground Bonding with Lightning Protection System: Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor. Install in conduit where routed above grade.
- F. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage. Install in conduit where routed above grade.
- G. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.
- H. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main

metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

- I. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.
- J. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.
- K. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.
- L. Separately Derived AC Power Systems: Ground separately-derived ac power system neutrals including distribution transformers to grounding electrodes per NFPA 70.
- M. Packaged Engine Generator: Solidly ground the packaged engine generator neutral to the normal power source neutral. Do not ground the generator neutral to a separate grounding electrode.
- N. Install one test well for each service at the ground rod electrically closest to the service entrance. Set top of well flush with finished grade or floor.
- O. Grounding Bus:
 - 1. Install grounding bus in the locations listed below and elsewhere as indicated:
 - a. Electrical equipment rooms.
 - b. Telephone equipment rooms.
 - c. Rooms housing service equipment.
 - 2. Use insulated spacer; space 1 inch (25.4 mm) from wall and support from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.
- P. Equipment Grounding: Provide a permanent and continuous bonding of conductor enclosures, equipment frames, power distribution equipment ground busses, cable trays, metallic raceways, and other non-current carrying metallic parts of the electrical system.

- Q. Access Floor Pedestal Ground: Ground access floor pedestals where indicated.
1. Provide access floor pedestal ground plate where indicated.
 - a. Provide ½ inch (12 mm) thick x 4 inches (102 mm) wide x 12 inches (305 mm) long, soft copper bar, bolted construction with minimum six 3/8 inch (10 mm) diameter drilled holes 1 ½ inches (38 mm) on center.
 - b. Provide cadmium plated bolts, nuts and screws.
 - c. Mount plate on ¾ inch (19 mm) plywood with 2 inch (50 mm) wood spacers.
 2. Provide No. 2 AWG insulated ground conductor from pedestal to pedestal ground plate or building steel.
 3. Provide No. 2 AWG insulated ground conductor from pedestal ground plate to building steel.
 4. Tie wrap ground conductor as close to concrete floor as possible at every other pedestal.
 5. Clean all pedestals prior to welding.
- R. Access Floor Ground Grid: Install ground grid under access floors where indicated.
1. Construct grid of No. 2 AWG bare copper wire installed on 24 inch centers both ways.
 2. Bond each access floor pedestal to grid.
- S. Bond together each metallic raceway, pipe, duct and other metal object entering space under access floors. Bond to underfloor ground grid. Bond to pedestal ground plate or Bond to building steel. Use No. 2 AWG bare copper conductor.
- T. Provide grounding and bonding in patient care areas to meet requirements of NFPA 99 and ANSI/NFPA 70.
- U. Bond together metal siding not attached to grounded structure; bond to ground.
- V. Pool Structures: Provide a common bonding grid with a solid copper conductor not smaller than No. 8 AWG. Bond together the following:
1. All metallic parts of the pool or fountain structure, including reinforcing steel of the pool or fountain shell, coping stones, and deck.
 2. All forming shells and mounting brackets of no-niche luminaries.
 3. All metal fittings within or attached to the pool or fountain structure that are greater than 4 inches (100 mm)

in any dimension and penetrate the pool or fountain structure more than one inch (25 mm).

4. Metal parts of electrical equipment associated with the pool or fountain water circulating system, including pump motors and metal parts of equipment associated with pool covers, including electric motors.
5. Metal sheathed cables and raceways, metal piping, and all fixed metal parts including fences, awnings, door and window frames, except those separated from the pool or fountain by a permanent barrier shall be bonded that are within the following distances of the pool:
 - a. Within 5 feet (1.5 m) horizontally of the inside walls of the pool.
 - b. Within 12 feet (3.7 m) measured vertically above the maximum water level of the pool, or any observation stands, towers, or platforms, or any diving structure.

- W. Provide a flexible braid bonding jumper at each set of columns at expansion joints.

3.4 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

- A. Manholes and Handholes: Install a driven ground rod close to wall, inside manhole, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide a No. 1/0 AWG conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.
- B. Connections to Manhole Components: Connect all exposed-metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.
- C. Pad-Mounted Transformers and Switches: Install two ground rods and counterpoise circling pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with transformers/substations by connecting them to underground

cable and grounding electrodes. Use not less than a No. 2 AWG conductor for counterpoise and for taps to equipment ground pad. Bury counterpoise not less than 18 inches (450 mm) below grade and 6 inches (150 mm) from the foundation.

3.5 TELECOMMUNICATIONS GROUNDING

- A. Telecommunications Grounding System: The telecommunications grounding system shall consist of:
1. Telecommunications Main Grounding Busbar (TMGB) located in the main telecommunications room near the telecommunications service entrance. Bond to the main building electrical grounding electrode system via a No. 3/0 AWG copper ground conductor.
 2. A Telecommunications Grounding Busbar (TGB) in each telecommunications room, cabinets, etc.
 3. A Telecommunications Bonding Backbone (TBB) tying together the TMGB and each TGB.
 4. Bonding of all equipment racks, raceways, non-current carrying metallic equipment and surge protection devices within the telecommunications room to the TGB's or TMGB using approved bonding conductors. Each piece of equipment shall be bonded individually directly to the ground bus.
- B. All bonding connections shall be installed at an accessible location for inspection and maintenance.
- C. All telecommunications bonding connections shall be of an approved mechanical type connection. Do not use exothermic welds unless specifically indicated on the Drawings.
- D. The physical routing shall, in general, follow the same path as the backbone cable system.
- E. Bond each TGB directly to the building steel with a No. 6 AWG conductor.
- F. Do not use TGB's as a power system ground connection unless specifically noted on the Drawings.
- G. All bonding connectors and conductors shall be UL listed for the purpose intended.
- H. Mount TMGB and TGB bus to backboard or wall using 2" standoff insulators.

- I. Individually bond each piece of non-current carrying metallic equipment in the Telecommunications Room to the TGB.
- J. Install continuous cable from the TMGB to the furthest TGB. Bond all TGB's to TBB with bare No. 6 AWG copper ground conductor and T-tap grounding hardware.

3.6 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality control tests in accordance with Division 26 section "Electrical Testing"
 1. Inspect grounding and bonding system conductors and connections for tightness and proper installation and for compliance with the Drawings and Specifications.
 2. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
 - a. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal.
 - b. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - c. Perform tests, by the fall-of-potential method according to IEEE 81. Instrumentation utilized shall be as defined in Section 12 of IEEE 81 and shall be specifically designed for ground impedance testing. Provide sufficient spacing so that curves flatten in the 62% area of the distance between the item under test and the current electrode.
 - d. Perform ground-impedance measurements utilizing either the intersecting curves method of the slope method. (Ref. Nos. 40 and 41 in IEEE Std. 81).
 - e. Equipment Grounds: Utilize two-point method of IEEE 81. Measure between equipment ground being testing and known low-impedance grounding electrode or system.
 3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

- a. Equipment Rated 500 kVA and Less: 10 ohms.
 - b. Equipment Rated 500 to 1000 kVA: 5 ohms.
 - c. Equipment Rated More Than 1000 kVA: 3 ohms.
 - d. Substations and Pad-Mounted Switching Equipment: 5 ohms.
 - e. Manhole Grounds: 10 ohms.
 - f. The telecommunications grounding system shall have a maximum resistance of 1 ohm as measured from the TMGB ground to earth ground.
4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 16060

SECTION 16073 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUMMARY.....1
1.3 DEFINITIONS.....1
1.4 PERFORMANCE REQUIREMENTS.....2
1.5 SUBMITTALS.....2
1.6 QUALITY ASSURANCE.....2
1.7 COORDINATION.....3

PART 2 - PRODUCTS.....3
2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS.....3
2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES.....5

PART 3 - EXECUTION.....6
3.1 APPLICATION.....6
3.2 SUPPORT INSTALLATION.....7
3.3 INSTALLATION OF FABRICATED METAL SUPPORTS.....8
3.4 CONCRETE BASES.....8
3.5 PAINTING.....9

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted support systems.
 - 2. Nonmetallic slotted support systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze hangers. Include Product Data for components.
 - 2. Steel slotted channel systems. Include Product Data for components.
 - 3. Nonmetallic slotted channel systems. Include Product Data for components.
 - 4. Equipment supports.
- C. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
 - 3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 4. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 6. Channel Dimensions: Selected for applicable load criteria.
- B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. Fabco Plastics Wholesale Limited.
 - d. Seasafe, Inc.
 3. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
 4. Fitting and Accessory Materials: Same as channels and angles.
 5. Rated Strength: Selected to suit applicable load criteria.
- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel or stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 5 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.
- E. Support all electrical items independently of supports provided by the other trades.
- F. Support conduits and boxes using steel conduit straps or 1/4-inch minimum diameter threaded rod hangers. Suspended ceiling hangers or hanger wire shall not be used (except to support flexible metallic conduit and manufactured wiring systems).
- G. Support cable trays with support brackets or 3/8" diameter minimum threaded rod hangers at intervals not exceeding 8'-0" for straight runs. Additional supports shall be provided at tray fittings.
- H. Hangers shall be of sufficient strength that their deflection at mid span does not exceed 1/240 of the hanger span length after the cables are installed.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
 - 6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.
- E. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.
- F. Obtain permission from Architect/Engineer before using powder-actuated anchors.

- G. Obtain permission from Architect/Engineer before drilling or cutting structural members.
- H. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
- I. Install surface-mounted cabinets and panelboards with minimum of four anchors.
- J. In wet and damp locations use steel channel supports to stand cabinets and panelboards one inch (25 mm) off wall.
- K. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.
- L. The Contractor shall replace all supports and channels that sag, twist, and/or show signs of not providing proper structural support, to the equipment, it is intended for, as determined by the Owner and Architect/Engineer. All costs associated with replacing supports and steel channels shall be incurred by the Contractor.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 5 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Provide concrete bases for all floor mounted electrical equipment.
- B. Provide concrete bases for all exterior, grade level electrical equipment, and where indicated.
- C. Base/Pad Construction:
 - 1. Construct per manufacturer's recommendations for particular equipment, including suggested piers and dowel rods.

2. Construct concrete bases for primary and secondary power distribution equipment per requirements of the electrical utility, where submitted for its review.

D. Anchor equipment to base per both supports and equipment manufacturer's instructions.

E. Coordinate conduit openings and sleeve locations in base with requirements of equipment to be supported.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of the base.

2. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 16073

SECTION 16120 - CONDUCTORS AND CABLES

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUMMARY.....1
1.3 SUBMITTALS.....1
1.4 QUALITY ASSURANCE.....2

PART 2 - PRODUCTS.....2
2.1 MANUFACTURERS.....2
2.2 CONDUCTORS AND CABLES.....2
2.3 CONNECTORS AND SPLICES.....3

PART 3 - EXECUTION.....3
3.1 CONDUCTOR AND INSULATION APPLICATIONS.....3
3.2 INSTALLATION.....4
3.3 CONNECTIONS.....6
3.4 FIELD QUALITY CONTROL.....7

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.
- B. Related Sections include the following:
 - 1. Division 16 Section "Control/Signal Transmission Media" for transmission media used for control and signal circuits.
 - 2. Division 16 Section "Electrical Identification" for conductor and cable color-coding.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Qualification Data: For testing agency.

- C. Field Quality-Control Test Reports: From a qualified testing and inspecting agency engaged by Contractor.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 CONDUCTORS AND CABLES

- A. Manufacturers, Copper:
 - 1. Triangle.
 - 2. Royal.
 - 3. Rome.
 - 4. General Cable Corporation.
 - 5. Southwire Company.
 - 6. Draka USA.
- B. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.
- C. Conductor Material: Copper.

- D. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.
- E. Conductor Insulation Types: Type THHN-THWN and XHHW complying with NEMA WC 70.
- F. Multiconductor Cable: Metal-clad cable, Type MC with ground wire.
- G. Power Cable for Variable Frequency Controlled Motors: 600V and 2000V, three conductor, XLPE cable with three symmetrical positioned ground conductors and a continuous impervious corrugated aluminum armor and overall PVC jacket. Cable shield transfer impedance shall be less than 10 ohms per meter up to 30 MHZ when tested in accordance with NEMA WC 61.
 - 1. Approved manufacturers for VFC power cables:
 - a. Southwire Armor-x
 - b. Draka USA

2.3 CONNECTORS AND SPLICES

- A. Manufacturers:
 - 1. AFC Cable Systems, Inc.
 - 2. AMP Incorporated/Tyco International.
 - 3. Hubbell/Anderson.
 - 4. O-Z/Gedney; EGS Electrical Group LLC.
 - 5. 3M Company; Electrical Products Division.
 - 6. T & B.
 - 7. Burndy.
 - 8. ILSCO.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR AND INSULATION APPLICATIONS

- A. Service Entrance: Type XHHW, single conductors in raceway.
- B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.
- C. Exposed Feeders #4/0 and larger: Type XHHW, single conductor in raceway.

- D. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
- E. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspace: Type THHN-THWN, single conductors in raceway.
- F. Exposed Branch Circuits, including in Crawlspace: Type THHN-THWN, single conductors in raceway.
- G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway and metal-clad cable, Type MC, for branch circuit drops to devices and within partition walls. MC cable shall not be run in ceiling space in lengths greater than 6'-0".
- H. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.
- I. Underground Feeders and Branch Circuits: XHHW single conductors in conduit.
- J. Cord Drops and Portable Appliance Connections: Type SO, hard service cord.
- K. Fire Alarm Circuits: Type THHN-THWN, in raceway or Power-limited, fire-protective, signaling circuit cable.
- L. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- M. Class 2 Control Circuits: Type THHN-THWN, in raceway.
- N. Critical Fire Control Circuits: Type RHH, single conductor in raceway. UL classified with two hour fire rating when installed in EMT conduit per the NEC and UL electrical circuit protective system (FHIT) #25 of the UL fire resistance directory. Support every 5' on center.
- O. Variable Speed Drives to Motors: Use VFD power cable manufactured by Southwire or Draka. Support every 5' on center.

3.2 INSTALLATION

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Support cables according to Division 26 Section "Basic Electrical Materials and Methods."
- F. Seal around cables penetrating fire-rated elements according to Division 7 Section "Through-Penetration Firestop Systems."
- G. Each feeder shall be of the same conductor and insulation material (phase, neutral, and parallel).
- H. Identify and color-code conductors and cables according to Division 26 Section "Electrical Identification."
- I. All wiring shall be installed in conduit or approved raceway. All raceways shall be provided with a ground conductor unless noted otherwise on the Contract Documents.
- J. Use conductor not smaller than 12 AWG for power and lighting circuits. Unless indicated otherwise, all circuits shall be 2#12, 1#12G, ¾"C. Do not share neutrals.
- K. Use conductor not smaller than 14 AWG for control circuits, provided by Electrical Contractor.
- L. Support communication cables above accessible ceiling, using spring metal clips or plastic cable ties to support cables from structure. Do not rest cable on ceiling panels.
- M. Use suitable cable fittings and connectors.
- N. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- O. Clean conductor surfaces before installing lugs and connectors.

- P. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
- Q. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and larger.
- R. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
- S. Branch circuits may be combined up to 6 circuits in a homerun conduit. Electrical Contractor shall be responsible for derating of conductors as required by N.E.C. Do not share neutrals.
- T. Use piercing connector with insulating covers for conductor splices and taps, 8 AWG and larger.
- U. Where the armor of type AC cable terminates, a fitting shall be provided to protect the wiring from abrasion. An approved bushing shall be provided between the conductors and the armor.
- V. Type MC cable shall be supported and secured at intervals not exceeding 4'-0".
- W. Fittings used for MC cable shall be identified for such use.
- X. AC/MC cable shall not be used for home runs to receptacle or distribution panels.
- Y. Between support, hangers and termination no more than 3" deflection from the bottom of the cable to a horizontal line between the support/hanger or termination.

3.3 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

3.4 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality control tests in accordance with Division 26 section "Electrical Testing"
1. Description: Test all feeders rated 100 A and above.
 2. Visual and Mechanical Inspection
 - a. Inspect cables for physical damage and proper connection in accordance with the one line diagram.
 - b. Test cable mechanical connections with an infrared survey.
 - c. Check cable color-coding against project Specifications and N.E.C. requirements.
 3. Electrical Tests
 - a. Perform insulation resistance test on each conductor with respect to ground and adjacent conductors. Applied potential to be 1000 volts dc for 1 minute.
 - b. Perform continuity test to insure proper cable connection.
 4. Test Values
 - a. Minimum insulation resistance values shall be not less than fifty mega-ohms.
- B. Test Reports: Prepare a written report to record the following:
1. Test procedures used.
 2. Test results that comply with requirements.
 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION 16120

SECTION 16130 - RACEWAYS AND BOXES

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUMMARY.....1
1.3 DEFINITIONS.....2
1.4 SUBMITTALS.....2
1.5 QUALITY ASSURANCE.....3
1.6 COORDINATION.....3

PART 2 - PRODUCTS.....3
2.1 MANUFACTURERS.....3
2.2 METAL CONDUIT AND TUBING.....3
2.3 FIRE ALARM EMT.....4
2.4 NONMETALLIC CONDUIT AND TUBING.....4
2.5 METAL WIREWAYS.....5
2.6 NONMETALLIC WIREWAYS.....5
2.7 SURFACE RACEWAYS.....6
2.8 BOXES, ENCLOSURES, AND CABINETS.....6
2.9 FACTORY FINISHES.....7

PART 3 - EXECUTION.....7
3.1 RACEWAY APPLICATION.....7
3.2 INSTALLATION.....8
3.3 PROTECTION.....12
3.4 CLEANING.....12

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
 - 1. Division 16 Section, "Basic Electrical Materials and Methods" for exterior ductbanks, manholes, and underground utility construction.
 - 2. Division 7 Section, "Through-Penetration Firestop Systems"

3. Division 16 Section "Wiring Devices" for devices installed in boxes and for floor-box service fittings, and for access floor boxes and service poles.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical nonmetallic tubing.
- C. FMC: Flexible metal conduit.
- D. IMC: Intermediate metal conduit.
- E. LFMC: Liquidtight flexible metal conduit.
- F. LFNC: Liquidtight flexible nonmetallic conduit.
- G. RNC: Rigid nonmetallic conduit.
- H. PVC: Polyvinyl Chloride.
- I. HDPE: High Density Polyethylene.

1.4 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Manufacturer Seismic Qualification Certification: Submit certification that enclosures, cabinets, accessories, and components will withstand seismic forces defined in Division 26 Section "Electrical Supports and Seismic Restraints." Include the following:
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.
- C. All work in natatorium/pool area shall be in accordance with N.E.C. article 680, "Swimming Pools, Fountains, and Similar Installations."

1.6 COORDINATION

- A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 METAL CONDUIT AND TUBING

- A. Manufacturers:
 1. AFC Cable Systems, Inc.
 2. Alflec Inc.
 3. Allied Tube Triangle Century.
 4. Anamet Electrical, Inc.; Anaconda Metal Hose.
 5. International Metal Hose.
 6. Electri-Flex Co

7. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
8. LTV Steel Tubular Products Company - Manhattan/CDT/Cole-Flex.
9. Maverick.
10. O-Z Gedney; unit of General Signal.
11. Wheatland.

B. Rigid Steel Conduit: ANSI C80.1.

C. IMC: ANSI C80.6.

D. EMT and Fittings: ANSI C80.3.

1. Fittings: Steel set-screw type.

E. LFMC: Flexible steel conduit with PVC jacket.

F. Fittings: NEMA FB 1; compatible with conduit and tubing materials.

2.3 FIRE ALARM EMT

A. Manufacturers:

1. Allied Tube Triangle Century.

B. EMT conduit with bright red topcoat; Fire Alarm EMT.

C. EMT and Fittings: ANSI C80.3.

2.4 NONMETALLIC CONDUIT AND TUBING

A. Manufacturers:

1. American International.
2. Anamet Electrical, Inc.; Anaconda Metal Hose.
3. Arnco Corp.
4. Cantex Inc.
5. Certainteed Corp.; Pipe and Plastics Group.
6. Condux International.
7. ElecSys, Inc.
8. Electri-Flex Co.
9. Integral.
10. Kor-Kap.
11. Lamson and Sessions: Carlon Electrical Products.
12. Manhattan/CDT/Cole-Flex.
13. RACO; Division of Hubbell, Inc.
14. Scepter.
15. Spiralduct, Inc./AFC Cable Systems, Inc.

16. Thomas & Betts Corporation.

B. ENT: NEMA TC 13.

C. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.

D. ENT and RNC Fittings: NEMA TC 3; match to conduit or tubing type and material.

E. LFNC: UL 1660.

F. HDPE: UL 651, ASTM D 3350, ASTM D 1248 Schedule 40.

2.5 METAL WIREWAYS

A. Manufacturers:

1. Hoffman.
2. Square D.

B. Material and Construction: Sheet metal sized and shaped as indicated, NEMA 1.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

E. Wireway Covers: Hinged type.

F. Finish: Manufacturer's standard enamel finish.

2.6 NONMETALLIC WIREWAYS

A. Manufacturers:

1. Hoffman.
2. Lamson & Sessions; Carlon Electrical Products.

B. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.

- C. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.
- D. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- E. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

2.7 SURFACE RACEWAYS

- A. Surface raceway (Wiremold - ivory color) shall be used in finished areas. Do not use EMT conduit in finished areas unless directed by the Architect.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating and ivory finish.
 - 1. Manufacturers:
 - a. Airey-Thompson Sentinel Lighting: Wiremold Company (The).
 - b. Walker Systems, Inc.; Wiremold Company (The).
 - c. Wiremold Company (The); Electrical Sales Division.
- C. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.8 BOXES, ENCLOSURES, AND CABINETS

- A. Sheet Metal Outlet and Device Boxes: NEMA OS 1. Shall be used within walls or ceiling.
- B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover. Shall be used in all exposed, non-recessed, locations.
- C. Nonmetallic Outlet and Device Boxes: NEMA OS 2. Shall be used in corrosive areas.
- D. Floor Boxes: Cast metal, fully adjustable, rectangular.
- E. Floor Boxes: Nonmetallic, nonadjustable, round.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

- G. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover. Shall be used in areas exposed to water.
- H. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
- I. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

2.9 FACTORY FINISHES

- A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard paint applied to factory-assembled surface raceways, enclosures, and cabinets before shipping.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors Applications:
 - 1. Exposed: Rigid steel or IMC.
 - 2. Concealed: Rigid steel or IMC.
 - 3. Underground, Single Run: RNC.
 - 4. Underground, Grouped: RNC.
 - 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 6. Boxes and Enclosures: NEMA 250, Type 3R.
- B. Indoor Applications:
 - 1. Exposed, Not Subject to Physical Damage in non-finished areas: EMT.
 - 2. Exposed, Not Subject to Severe Physical Damage in non-finished areas: EMT.

3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit up to 10'-0" above finished floor. Includes raceways in the following locations:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 6. Damp or Wet Locations: IMC.
 7. Raceways Embedded in Concrete Above Grade: EMT or Rigid Steel.
 8. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: EMT.
 9. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: EMT.
 10. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: EMT.
 11. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.
- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
 1. Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
 2. Rigid Steel Conduits: Use only fittings approved for use with that material.
 3. EMT Conduits: Use steel set-screw fittings.
- E. Do not install aluminum conduits embedded in or in contact with concrete.
- 3.2 INSTALLATION
- A. Install conduit in accordance with NECA "National Electrical Installation Standards".
 - B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

- C. Complete raceway installation before starting conductor installation.
- D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- E. Install temporary closures to prevent foreign matter from entering raceways.
- F. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.
- G. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.
- H. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
 - 1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
- I. Raceways Embedded in Slabs:
 - 1. Raceways embedded in slabs shall be limited to above grade concrete decks. Embedded conduit shall be limited to servicing floor boxes and equipment located in open spaces away from accessible walls.
 - 2. Install in middle 1/3 of slab thickness where practical and leave at least 2 inches (50 mm) of concrete cover.
 - 3. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
 - 4. Space raceways laterally to prevent voids in concrete.
 - 5. Run conduit larger than 1-inch trade size (DN 27) parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 - 6. Conduits shall run flat. Do not allow conduits to cross.
- J. Raceways installed under slab on grade: Use Schedule 40 nonmetallic conduit with rigid steel conduit sweeps, route conduits a minimum of 6" below bottom of slab.
- K. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.

1. Run parallel or banked raceways together on common supports.
 2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
- L. Join raceways with fittings designed and approved for that purpose and make joints tight.
1. Use insulating bushings to protect conductors.
- M. Tighten set screws of threadless fittings with suitable tools.
- N. Terminations:
1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
 2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.
- O. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire.
- P. Provide pull string and 25% spare capacity in every branch circuit conduit.
- Q. Telephone and Signal System Raceways, 2-Inch Trade Size (DN 53) and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet (45 m) and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.
1. Electrical conduit (LB's) are not permitted.
 2. Conduits shall have no more than two 90 degree bends between pull points or pull boxes.
 3. Conduits shall contain no continuous sections longer than 100 ft. without a pull point/box.
 4. The bend radius of conduit must be at least 6 times the internal diameter for a conduit 2 inches or less and a

- radius of 10 times the diameter for a conduit greater than two inches.
5. All conduit ends shall have an insulated bushing.
- R. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where otherwise required by NFPA 70.
- S. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches (150 mm) above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.
- T. Flexible Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.
- U. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.
- V. Set floor boxes level and flush with finished floor surface.
- W. Set floor boxes level. Trim after installation to fit flush with finished floor surface.
- X. Install hinged-cover enclosures and cabinets plumb. Support at each corner.
- Y. Do not route feeders across roof.
- Z. Provide a pull box (a handhole for outdoor applications) for each conduit run that exceeds 250 feet. Provide two pull boxes (handholes for outdoor applications) for runs that exceed 500 feet.

- AA. Conduit run in natatorium/pool area shall be EMT with compression fittings, and painted by the painting contractor (corrosion treatment paint per Architect's requirements).
- BB. Provide bonding of the pool structure/equipment per N.E.C. article 680-22. Coordinate with the pool contractor.
- CC. Route conduits in finished areas with exposed ceilings at underside of structural deck or as high as possible.
- DD. Conduits that route through, to, or from a hazardous classified space (Class I or II) shall have proper seal offs when exiting or entering the hazardous classified space.
- EE. Outlet boxes within hazardous locations shall be of the proper class and division as noted in the N.E.C.
- FF. Offset outlet boxes on opposite sides of common walls to prevent sound transmission between adjoining rooms.
- GG. Firestop raceways passing through rated walls and floors in accordance with Division 07 specifications. See architectural drawings for locations of rated assemblies.

3.3 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.4 CLEANING

- A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION 16130

SECTION 16140 - WIRING DEVICES

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUMMARY.....1
1.3 DEFINITIONS.....2
1.4 REFERENCES.....2
1.5 SUBMITTALS.....3
1.6 QUALITY ASSURANCE.....3
1.7 COORDINATION.....3

PART 2 - PRODUCTS.....3
2.1 MANUFACTURERS.....3
2.2 RECEPTACLES.....4
2.3 WALL SWITCHES.....4
2.4 DIGITAL TIME SWITCHES.....5
2.5 DIMMER SWITCHES.....5
2.6 WALL PLATES.....7
2.7 FLOOR SERVICE FITTINGS.....7
2.8 FINISHES.....7

PART 3 - EXECUTION.....8
3.1 INSTALLATION.....8
3.2 IDENTIFICATION.....9
3.3 CONNECTIONS.....9
3.4 FIELD QUALITY CONTROL.....10

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Single and duplex receptacles, ground-fault circuit interrupters, integral surge suppression units, and isolated-ground receptacles.
 - 2. Single- and double-pole snap switches and dimmer switches.
 - 3. Device wall plates.
 - 4. Pin and sleeve connectors and receptacles.

5. Floor service fittings, poke-through assemblies, access floor boxes, and service poles.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. PVC: Polyvinyl chloride.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.4 REFERENCES

- A. DSCC W-C-596G: Federal Specification Connector, Electrical, Power, General Specification.
- B. DSCC W-C-896F: Federal Specification Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification).
- C. IEC 309-1, Part 1: General Requirements: Plugs, Socket-Outlets and Couplers for Industrial Purposes
- D. NEMA FB 11: Plugs, Receptacles, and Connectors of the Pin and Sleeve Type for Hazardous Locations.
- E. NEMA WD 1: General Requirements for Wiring Devices.
- F. NEMA WD 6: Wiring Device - Dimensional Requirements.
- G. UL 20: General-Use Snap Switches.
- H. UL 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.
- I. UL 486B: Wire Connectors for Use with Aluminum Conductors.
- J. UL 498: Electrical Attachment Plugs and Receptacles.
- K. UL 943: Ground Fault Circuit Interrupters.

1.5 SUBMITTALS

- A. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations for each type of product indicated.
- B. Qualification Data: For testing agency.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.
- B. Source Limitations: Obtain each type of wiring device through one source from a single manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with NFPA 70.

1.7 COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
 - 1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 RECEPTACLES

- A. **All receptacles shall be tamper resistant (adjust model numbers listed below as required).**
- B. Straight-Blade and Locking Receptacles: Heavy-Duty grade.
- C. Straight-Blade-Type Receptacles: Comply with NEMA WD 1, NEMA WD 6, DSCC W-C-596G, and UL 498. Configuration 5-20R duplex receptacle.
1. Manufacturers:
 - a. Hubbell Incorporated; Wiring Device-Kellems HBL 5362.
- D. Self-Test GFCI's: Duplex GFCI Convenience Receptacles, 125 V, 20 A. Comply with NEMA WD1, NEMA WD6 configuration 5-20R, UL 498, Federal Specification W-C-596 and UL 943, Class A, and include indicator light that is lighted when device is tripped. Must have self-test feature and SafeLock protection™: conducts an automatic test every second, ensuring its always ready to protect. If the device fails the self-test, the indicator light flashes to signal that the GFCI should be replaced. With SafeLock Protection™, if critical components are damaged and ground fault protection is lost, power to receptacle must be discontinued.
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work, include, but are not limited to the following:
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pass & Seymour/LeGrand; Wiring Devices Division: 2096.
 - b. Hubbell equal.
- E. Industrial Heavy-Duty Pin and Sleeve Devices: Comply with IEC 309-1.
- F. Hazardous (Classified) Location Receptacles: Comply with NEMA FB 11.

2.3 WALL SWITCHES

- A. Manufacturers:
 1. Hubbell Incorporated; Wiring Device-Kellems 1220 Series.
- B. Device body: Plastic toggle handle.

- C. Single- and Double-Pole Switches: Comply with DSCC W-C-896F and UL 20.
- D. Provide single-pole, two-pole, three-way and four-way switches as indicated.
- E. Provide pilot light where indicated.
- F. Provide key type where indicated. Furnish a minimum of six keys to Owner.
 - 1. Switch shall be Hubbell 1220 series (or equal as specified above) with locking coverplate.
 - 2. Coverplate shall be Hubbell HBL96062, straight keyed cylinder type lock, with stainless steel finish.
- G. Combination Switch and Receptacle: Both devices in a single gang unit with plaster ears and removable tab connector that permit separate or common feed connection.
 - 1. Switch: 20 A, 120/277-V ac.
 - 2. Receptacle: NEMA WD 6, Configuration 5-20R.

2.4 DIGITAL TIME SWITCHES

- A. General:
 - 1. Watt Stopper TS-400 or equal. Operation on 100 to 300 volts.
 - 2. Digital time switch turns lights off automatically after pre-set time. Pushbutton operation with time setting from 5 minutes to 12 hours.
 - 3. Back-lit LCD shows timer countdown.

2.5 DIMMER SWITCHES

- A. General:
 - 1. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on/off switches and audible frequency and EMI/RFI filters.
 - 2. Dimmer switches shall provide full-range, variable control of light intensity utilizing a continuous Square Law dimming curve.
 - 3. Provide protected memory during temporary power failures that restores lights to same level of intensity set prior to power interruption.
 - 4. Provide dimmer switches UL listed for the type of load being served (incandescent, fluorescent, magnetic low voltage transformer, electronic low voltage

transformer). Universal load-type dimmer switches shall not be acceptable.

5. Provide dimmers that provide no adverse effects on other components of the electrical system being served (low voltage transformers, ballasts, lamps, etc.).

B. Incandescent Lamp Dimmers:

1. Manufacturers:
 - a. Lutron Model N-2000-W.
 - b. Leviton Model 82000-W.
 - c. Hubbell equal.
2. Modular, 120 V, 60 Hz with continuously adjustable control; single pole with soft tap or other quiet switch; and 5-inch wire connecting leads.
3. Dimmer switches serving magnetic low voltage transformers shall be designed to control and provide a symmetrical ac waveform to the input of the magnetic low voltage transformer and not cause the transformer to operate above its rated operating current or temperature.
4. Dimmer switches serving solid-state low-voltage transformers shall not affect the sound rating of the transformer and not cause lamp flicker at any point in the dimming range.
5. Control: Continuously adjustable slider with slide-to-off; with single-pole or three-way switching to suit connections.
6. Power Rating: 2000 W.

C. Fluorescent Lamp Dimmer Switches:

1. Manufacturers:
 - a. Hubbell Incorporated; Wiring Device-Kellems
 - b. Lutron.
 - c. Leviton.
2. Modular; single-pole, compatible with electronic dimming ballast provided with fluorescent light fixtures and rated for the specified load and voltage; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.
3. Control: Continuously adjustable slider with pre-set; single-pole or three-way switching to suit connections.
4. Power rating: 1200 W.

2.6 WALL PLATES

A. Manufacturers:

1. Provide wall plates and corresponding wiring devices from same manufacturer.

B. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: 0.035-inch- thick, satin-finished stainless steel.
3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Wet Locations: Gasketed Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."
 - a. Manufacturers:
 - 1) Red Dot Model CKSGV (cast aluminum), Thomas & Betts.

2.7 FLOOR SERVICE FITTINGS

A. Manufacturers:

1. Wiremold.

B. Type: Modular, fully adjustable recessed-type, with services indicated suitable for wiring method used.

C. Compartments: Provide barrier separating power from telecommunications cabling. Provide recessed-type floor service fittings with independent compartments and feed through wiring capability.

D. Service Plate: Provide service plate type as indicated. Provide protective ring for flush service plates.

E. Power Receptacle(s): NEMA WD 6, Configuration 5-20R Heavy-duty grade duplex receptacle, black finish, unless otherwise indicated.

F. Telecommunications Outlet: Blank cover with bushed cable opening.

2.8 FINISHES

A. Color:

1. Wiring Devices Connected to Normal Power System: White at each school, unless otherwise indicated or required by NFPA 70.
2. Wiring Devices Connected to Emergency Power System: Red.
3. Wall Switches: White, unless otherwise indicated.
4. Dimmer Switches: White, unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Prior to installation of devices, verify wall openings are neatly cut and will be completely covered by wall plates, clean debris from outlet boxes and provide extension rings to bring outlet boxes flush with finished surface.
- C. Install devices and assemblies level, plumb, and square with building lines.
- D. Install wall dimmers to achieve full rating specified and indicated after derating for ganging according to manufacturer's written instructions.
- E. Arrangement of Devices:
 1. Coordinate locations of outlet boxes provided under Division 26 Section "Raceways and Boxes" to obtain mounting heights indicated on Drawings.
 2. Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on top.
 3. Where multiple switches, dimmers, and/or occupancy sensors are adjacent to each other, provide a single cover plate. Custom fabricate, if required, for all combinations. Provide separate boxes or barriers as required for the application.
 4. Install horizontally mounted receptacles with grounding pole on the left.
 5. Install GFCI receptacles so that the "Push To Test" and "Reset" designations can be read correctly. If printed in both directions, install with ground pole on top.
 6. Install switches with OFF position down.

- F. Install cover plates on switch, receptacle, and blank outlets in finished areas.
- G. Use oversized plates for outlets installed in masonry walls.
- H. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.
- I. Remove wall plates and protect devices and assemblies during painting.
- J. Coordinate installation of access floor boxes with access floor system provided by Architectural trades.
- K. Install properly oriented access floor boxes into cutouts in access floor tiles and secure to tiles per Manufacturer's instructions.
- L. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.
- M. Adjust devices and wall plates to be flush and level. Three corners of wall plates must be in contact with wall surfaces. Devices shall be solidly mounted against the box.

3.2 IDENTIFICATION

- A. Comply with Division 26 Section "Electrical Identification."
 - 1. Receptacles: Identify panelboard and circuit number from which served. Use adhesive label as specified in Division 26 Section "Electrical Identification" with black-filled lettering on back side of wall plate, and durable wire markers or tags inside outlet boxes.

3.3 CONNECTIONS

- A. Ground equipment according to Division 16 Section "Grounding and Bonding." Connect wiring device grounding terminal to outlet box with bonding jumper. Use of quick ground strap or screw is not acceptable.
- B. Connect wiring according to Division 16 Section "Conductors and Cables." Connect wiring devices by wrapping conductor around screw terminal or by using back wiring and tightening the screw securely.

- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Inspect each wiring device for defects.
 - 2. Operate each wall switch with circuit energized and verify proper operation.
 - 3. After installing wiring devices and after electrical circuitry has been energized, test each receptacle for proper polarity, ground continuity, and compliance with requirements.
 - 4. Test each GFCI receptacle for proper operation with both local and remote fault simulations according to manufacturer's written instructions.
- B. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION 16140

SECTION 16145 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUMMARY.....1
1.3 REFERENCES.....2
1.4 DEFINITIONS.....2
1.5 SUBMITTALS.....3
1.6 QUALITY ASSURANCE.....3
1.7 COORDINATION.....3
1.8 DELIVERY, STORAGE, AND HANDLING.....4

PART 2 - PRODUCTS.....4
2.1 MANUFACTURERS.....4
2.2 GENERAL LIGHTING CONTROL DEVICE REQUIREMENTS.....4
2.3 OCCUPANCY SENSORS.....4
2.4 LIGHTING CONTACTORS.....9

PART 3 - EXECUTION.....10
3.1 LIGHTING CONTACTOR INSTALLATION.....10
3.2 OUTDOOR PHOTOELECTRIC CONTROL INSTALLATION.....10
3.3 TIME CONTROLLER INSTALLATION.....10
3.4 OCCUPANCY SENSOR INSTALLATION.....10
3.5 WIRING INSTALLATION.....11
3.6 IDENTIFICATION.....11
3.7 FIELD QUALITY CONTROL.....12
3.8 ADJUSTING.....12

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following lighting control devices:
 - 1. Occupancy sensors.
 - 2. Lighting contactors.
- B. Related Sections include the following:
 - 1. Division 16 Section "Electrical General Requirements".

2. Division 16 Section "Wiring Devices" for wall-box dimmers and manual light switches.

1.3 REFERENCES

- A. IEEE C62.41: Guide for Surge Voltages in Low-Voltage AC Power Circuits.
- B. IEEE C136.10: Standard for Roadway Lighting Equipment Locking-Type Photocontrol Devices and Mating Receptacle Physical and Electrical Interchangeability and Testing.
- C. NEMA ICS 2: Industrial Control and Systems Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC Part 8: Disconnect Devices for Use in Industrial Control Equipment.
- D. NFPA 70: National Electrical Code.
- E. UL 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.
- F. UL 486B: Wire Connectors for Use with Aluminum Conductors.
- G. UL 773: Plug-in, Locking Photocontrols for Use with Area Lighting.
- H. UL 773A: Nonindustrial Photoelectric Switches for Lighting Control.
- I. UL 917: Clock Operated Switches.
- J. UL 1449: Transient Voltage Surge Suppressors.
- K. UL 1598: Luminaires.
- L. NECA 130-2010: Installing and Maintaining Wiring Devices.

1.4 DEFINITIONS

- A. LED: Light-emitting diode.
- B. PIR: Passive infrared.
- C. ULTRASONIC: Active emission of at least 35 kHz sound waves, using Doppler reflectance to detect motion.

- D. MICROPHONIC: Passive reception to listen for continued occupancy, with circuitry to filter out white noise.
- E. MULTI-Tech: Using PIR and ultrasonic or microphonic technologies in one sensor.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated including physical data and electrical performance.
- B. Shop Drawings: Show installation details for occupancy and light-level sensors.
 - 1. Lighting plan showing location, orientation, and coverage area of each sensor.
 - 2. Interconnection diagrams showing field-installed wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. Include the following:
 - 1. Description of operation and servicing procedures.
 - 2. List of major components.
 - 3. Recommended spare parts.
 - 4. Programming instructions and system operation procedures.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.7 COORDINATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the site under provisions of Division 16 Section "Electrical General Requirements".
- B. Store and protect products under provisions of Division 16 Section "Electrical General Requirements".

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2.2 GENERAL LIGHTING CONTROL DEVICE REQUIREMENTS

- A. Line-Voltage Surge Protection: An integral part of the devices for 120- and 277-V solid-state equipment. For devices without integral line-voltage surge protection, field-mounting surge protection shall comply with IEEE C62.41 and with UL 1449.

2.3 OCCUPANCY SENSORS

- A. General
 - 1. Coordinate occupancy sensor locations, coverages and required quantities with manufacturer's recommendations. Coverage areas indicated on the Drawings are for minor motion (6 to 8 inches of hand movement). Provide additional occupancy sensors and control units as required to achieve complete minor motion coverage of the space indicated.
 - 2. Adjust occupancy sensors and test that complete minor motion coverage is obtained in accordance with Part 3. Provide written confirmation of testing to owner, architect and engineer.
 - 3. Provide occupancy sensors with a bypass switch to override the "ON" function in the event of sensor failure.
 - 4. Provide occupancy sensors with an LED indicator indicating when motion is being detected during testing and normal operation of the sensor.

5. Provide occupancy sensors and occupancy sensor control units from single manufacturer.
- B. Wall Switch Passive Infrared Occupancy Sensor
- C. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- D. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Wattstopper PW-100.
 2. Hubbell Building Automation SOM 101.
 3. Greengate OSW-P-0451-W.
 4. Sensorswitch WSD.
 5. Schneider Electric equal.
 6. Description: Wall mounted, 180° coverage, passive infrared sensing occupancy sensor.
 - a. Electrical Characteristics: Capable of switching up to 800W fluorescent or incandescent lighting loads at 120V and 1200 watts fluorescent loads at 277V.
 - b. Functions: Automatic ON/Automatic OFF, or Manual ON/Automatic OFF operation, field selectable. Integral manual override pushbutton switch.
 - c. Adjustments: User adjustable sensitivity and time delay. Time delay shall be adjustable from 30 seconds to 30 minutes.
 - d. Device Body: White, plastic with momentary on/off override pushbutton designed to mount in a standard switch box with "decora" style switch plate.
 7. Dual Level Switching: Provide occupancy sensor capable of controlling two switch legs independently where dual level switching is indicated.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Wattstopper PW-200.
 - 2) Hubbell Building Automation SOM-102.
 - 3) Greengate OSW-P-0451-DMV.

- 4) Sensorswitch WSD-2P.
- 5) Schneider Electric equal.

E. 360° Ceiling Mounted Dual Technology Occupancy Sensor

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Wattstopper DT 300
 - b. Hubbell Building Automation "OMNI-DT" Series.
 - c. Greengate OMC-DT-2000-R.
 - d. Sensorswitch CM-PDT-R.
 - e. Schneider Electric equal
3. Description: Ceiling mounted, 360° coverage, multi-tech sensing occupancy sensor.
 - a. Housing: White, thermoplastic, tamper resistant ceiling mount.
 - b. Functions: Automatic ON must sense motion from both ultrasonic and infrared sensing elements. Either technology shall maintain ON, with adjustable time delays.
 - c. Adjustments: User adjustable sensitivity adjustment shall be provided for each sensing technology. Time delay shall be adjustable from 15 seconds to 30 minutes.
 - d. Sensor shall operate on 24V DC power through control unit which supplies DC power to the sensor and provides relay contacts to control the lighting load and auxiliary contacts.
 - e. Manual override function.

F. 110° Wall Mounted Dual Technology Occupancy Sensor

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Wattstopper DT-200
 - b. Hubbell Building Automation "LO-DT" Series.
 - c. Sensorswitch WV-PDT-R/WV-BR.
 - d. Schneider Electric equal

3. Description: Wall mounted, 110° coverage, multi-tech occupancy sensor.
 - a. Housing: White, thermoplastic, tamper resistant with swivel bracket for wall or ceiling mounting.
 - b. Functions: Automatic ON must sense motion from both sensing elements. Either technology shall maintain ON, with adjustable time delays.
 - c. Adjustments: User adjustable sensitivity adjustment shall be provided for each sensing technology. Time delay shall be adjustable from 15 seconds to 15 minutes.
 - d. Sensor Orientation: Orient sensor in room such that sensor will not detect motion through open door which could cause false activation.
 - e. Sensor shall operate on 24V DC power through control unit which supplies DC power to the sensor and provides relay contacts to control the lighting load and auxiliary contacts.
 - f. Manual override function.

- G. 360° Ceiling Mounted Ultrasonic Occupancy Sensors
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Wattstopper "WT" Series.
 - b. Hubbell Building Automation "OMNI-US" Series.
 - c. Greengate OPC-U-2000.
 - d. Sensorswitch CM MPT-10.
 - e. Schneider Electric equal
 3. Description: Ceiling mounted, 360° coverage, ultrasonic or microphonics sensing occupancy sensor.
 - a. Housing: White, thermoplastic, tamper resistant.
 - b. Adjustments: Adjustments: User adjustable sensitivity and time delay. Time delay shall be adjustable from 15 seconds to 15 minutes.
 - c. Sensor shall operate on 24V DC power through control unit which supplies DC power to the sensor and provides relay contacts to control the lighting load and auxiliary contacts.
 - d. Manual override function.

- H. 360° Ceiling Mounted Passive Infrared Occupancy Sensor.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Wattstopper CI-200.
 - b. Hubbell Building Automation OMNI-IR.
 - c. Greengate OMC-P-04500-R.
 - d. Sensorswitch CM-9.
 - e. Schneider Electric equal
 3. Description: Ceiling mounted, 360° coverage, infrared sensing occupancy sensor.
 - a. Housing: White, thermoplastic, tamper resistant ceiling mount.
 - b. Adjustments: User adjustable sensitivity adjustment shall be provided for each sensing technology. Time delay shall be adjustable from 30 seconds to 30 minutes.
 - c. Sensor shall operate on 24V DC power through control unit which supplies DC power to the sensor and provides relay contacts to control the lighting load and auxiliary contacts.
 - d. Manual override function.
- I. Occupancy Sensor Control Units:
1. Description: Transformer and relay combined in single unit to provide 24DC power to sensors and provide 20A contact(s) for control of lighting loads at 120 or 277V. Control unit input power shall be from unswitched leg of lighting circuit it is controlling.
 - a. Control units shall be provided as required to power ceiling mounted occupancy sensors, control lighting loads and provide a minimum of one auxiliary contact.
 - b. Occupancy sensor control units shall mount external to 4" sq junction box in the ceiling space. Wiring between control unit and occupancy sensor shall be plenum rated.
 - c. Locate control unit in accessible location in gyp-board ceilings, adjacent to return air grilles, or provide access panel.
 - d. Additional auxiliary relay modules shall be provided as required to provide control of all

lighting circuits and additional auxiliary contacts as required.

- e. It is acceptable to provide controls and auxiliary contacts as required integral to the ceiling sensor, provided all required contacts are provided.
- f. Maximum of 3 sensors per power pack. Verify exact quantities required with manufacturer.

2.4 LIGHTING CONTACTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cutler-Hammer; Eaton Corporation.
 - 2. Square D Co.
 - 3. Siemens.
- B. Contactor
 - 1. Electrically-operated electrically-held unless otherwise indicated 600 volt, 30 ampere three pole with number of poles indicated.
 - 2. Provide contacts to be 100 percent, continuously rated for all types of ballast and tungsten lighting and resistance loads without the need for in-rush current derating.
 - 3. Provide NEMA type 1 enclosure unless otherwise indicated.
 - 4. Provide NEMA type 1 hinged cover cabinet enclosure sized as required for contactors as indicated on drawings. Mount switches and indicating lights required on front of enclosure. Install terminal strips for connection of all external control wiring connections.
 - 5. Provide solderless pressure wire terminals.
 - 6. Provide corrosion-resistant primer treatment with light gray baked acrylic enamel finish.
 - 7. Provide the following control and indicating devices:
 - a. Auxiliary contacts: One field convertible.
 - b. Auxiliary relay to convert maintained-contact type control circuit to momentary-contact type control circuit necessary for contactor control.
 - c. Green pilot light to indicate "power on" condition. Mount on front cover with legend plate.

PART 3 - EXECUTION

3.1 LIGHTING CONTACTOR INSTALLATION

- A. Install lighting contactors as indicated on plan. Install at accessible locations. Switch controls where provided shall be no higher than 54" or lower than 48".
- B. Demonstrate proper operation of all lighting control functions to the Owner and Engineer.

3.2 OUTDOOR PHOTOELECTRIC CONTROL INSTALLATION

- A. Mount photocell on roof or parapet to ½" GRS conduit, supported to building structure below. Coordinate roof penetration with roofing contractor.
- B. Install photoelectric control oriented in the northeast direction and not within any potential shadows.
- C. Adjust photocell sensitivity and delay to meet owner's requirements. Multiple adjustments may be required, as needed.

3.3 TIME CONTROLLER INSTALLATION

- A. Install time controller, near contactor control equipment or as indicated on plan. Install at accessible location.
- B. Program time controller as directed by the owner. Train owner in time clock programming.

3.4 OCCUPANCY SENSOR INSTALLATION

- A. Install wall mounted occupancy sensors as noted on plan. Arrange occupancy sensors with adjacent switch devices so that device plates line-up and are equally spaced.
- B. Install ceiling mounted sensors at approximate locations as indicated on plan. Sensor manufacturer shall provide quantity of sensors as required to provide complete coverage for rooms.
- C. Locate sensors such that motion through open doors will not falsely activate sensors.
- D. Do not locate ultrasonic sensors within six feet of supply air diffusers.

- E. Locate infrared sensors to avoid obstructions.
- F. Provide the services of a manufacturer's representative for commissioning of occupancy sensor installation. This shall include consultation on layout and location prior to installing sensors, testing of each sensor for compliance with Contract Documents and field adjustment and fine tuning after installation is complete. Provide written confirmation of testing to the Owner, Architect and Engineer.
- G. Field adjustments shall take place in the presence of the owner and the engineer. This shall include owner training on adjustment techniques for the occupancy sensors. The owner shall dictate the setting of the time delay in all sensors.

3.5 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 16 Section "Conductors and Cables".
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
- E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.6 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 16 Section "Electrical Identification."
- B. Label time switches and contactors with a unique designation.

3.7 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
 - 2. Operational Test: Verify actuation of each sensor and adjust time delays.
- B. Remove and replace lighting control devices where test results indicate that they do not comply with specified requirements.
- C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.8 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.

END OF SECTION 16145

SECTION 16195 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUMMARY.....1
1.3 SUBMITTALS.....2
1.4 QUALITY ASSURANCE.....2
1.5 COORDINATION.....2

PART 2 - PRODUCTS.....2
2.1 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS.....2
2.2 CONDUCTOR, COMMUNICATION AND CONTROL CABLE IDENTIFICATION
MATERIALS.....3
2.3 UNDERGROUND-LINE WARNING TAPE.....4
2.4 WARNING LABELS AND SIGNS.....4
2.5 INSTRUCTION SIGNS.....4
2.6 EQUIPMENT IDENTIFICATION LABELS.....5
2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS.....5
2.8 WIRING DEVICE IDENTIFICATION.....5

PART 3 - EXECUTION.....5
3.1 APPLICATION.....5
3.2 INSTALLATION.....9

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Identification for raceway and metal-clad cable.
 - 2. Identification for conductors and communication and control cable.
 - 3. Underground-line warning tape.
 - 4. Warning labels and signs.
 - 5. Instruction signs.
 - 6. Equipment identification labels.
 - 7. Miscellaneous identification products.

1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.
- C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and ANSI C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.145.

1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

- B. Color for Printed Legend:
 - 1. Power Circuits: Black letters on an orange field.
 - 2. Legend: Indicate system or service and voltage, if applicable.
 - C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
 - D. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
 - E. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
 - F. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.
- 2.2 CONDUCTOR, COMMUNICATION AND CONTROL CABLE IDENTIFICATION MATERIALS
- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
 - B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
 - C. Aluminum Wraparound Marker Labels: Cut from 0.014-inch- thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.
 - D. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking nylon tie fastener.
 - E. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.3 UNDERGROUND-LINE WARNING TAPE

- A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
 1. Not less than 6 inches wide by 4 mils thick.
 2. Compounded for permanent direct-burial service.
 3. Embedded continuous metallic strip or core.
 4. Printed legend shall indicate type of underground line.

2.4 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.
- C. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 7 by 10 inches.
- D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 10 by 14 inches.
- E. Warning label and sign shall include, but are not limited to, the following legends:
 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.5 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.
 1. Engraved legend with black letters on white face.
 2. Punched or drilled for mechanical fasteners.

3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.6 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. Black letters on a white background. Minimum letter height shall be 3/8 inch.
- B. Outdoor Equipment Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
 1. Minimum Width: 3/16 inch.
 2. Tensile Strength: 50 lb, minimum.
 3. Temperature Range: Minus 40 to plus 185 deg F.
 4. Color: Black, except where used for color-coding.
- B. Paint: Paint materials and application requirements are specified in Division 9 painting Sections.
- C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

2.8 WIRING DEVICE IDENTIFICATION

- A. Description: Self adhesive label with black upper case letters on clear polyester label, font size 7.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Raceways and Duct Banks More Than 600 V Concealed within Buildings: 4-inch- wide black stripes on 10-inch centers over orange background that extends full length of raceway or duct and is 12 inches wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- high black letters on 20-inch centers. Stop stripes at legends. Apply to the following finished surfaces:
 1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.

2. Wall surfaces directly external to raceways concealed within wall.
 3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.
- B. Accessible Raceways and Metal-Clad Cables More Than 600 V: Identify with "DANGER-HIGH VOLTAGE" in black letters at least 2 inches high, with self-adhesive vinyl labels. Repeat legend at 10-foot maximum intervals.
- C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 400 A: Identify with orange self-adhesive vinyl label.
- D. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:
1. Fire Alarm System: Red.
 2. Fire-Suppression Supervisory and Control System: Red and yellow.
 3. Combined Fire Alarm and Security System: Red and blue.
 4. Security System: Blue and yellow.
 5. Mechanical and Electrical Supervisory System: Green and blue.
 6. Telecommunication System: Green and yellow.
 7. Control Wiring: Green and red.
- E. Power-Circuit Conductor Identification: For primary conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use metal tags. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.
- F. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use color-coding conductor tape. Identify each ungrounded conductor according to source and circuit number as indicated on Drawings. Identify control circuits by control wire number as indicated on shop drawings.
- G. Branch-Circuit Conductor Identification: Mark junction box covers in indelible ink with the panel and breaker numbers of other circuits contained within.

- H. Conductor Identification: Locate at each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and each load connection or termination point.
- I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.
1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.
- J. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- K. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply baked-enamel warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.
 2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
- L. Provide a 3" by 5" yellow "Warning Arc Flash Hazard" label on the outside of panels in 'occupant areas' - Brady Type 99454 or equivalent from another manufacturer. Center the label horizontally and vertically on outside of door.
- M. Provide a 4" by 6" red "Danger Arc Flash and Shock Hazard" label on the outside of panels in areas open only to 'qualified personnel', and on the inside panel door of panels

in 'occupant areas' - Brady Type 99459. Center label on gutter areas of distribution panels, centered above or below the directory of panels, and otherwise centered in other applications. In all cases, label will be no lower than 48" or above 84" AFF

N. Instruction Signs:

1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer or load shedding.

O. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

- a. Indoor Equipment: Mechanically secured, Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where 2 lines of text are required, use labels 2 inches (50 mm) high. Labels shall be 2 1/2" high x 4 1/2" wide. Provide 3 lines of text. Line one shall have 1/2" letters spaced 1/2" down from top of label. Lines 2 and 3 shall have 1/4" letters. Each line shall be spaced 1/4" apart.
- b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
- c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

2. Equipment to Be Labeled:

- a. Panelboards, electrical cabinets, and enclosures.
- b. Access doors and panels for concealed electrical items.

- c. Electrical switchgear and switchboards.
 - d. Transformers.
 - e. Emergency system boxes and enclosures.
 - f. Motor-control centers.
 - g. Disconnect switches.
 - h. Enclosed circuit breakers.
 - i. Motor starters.
 - j. Push-button stations.
 - k. Power transfer equipment.
 - l. Contactors.
 - m. Remote-controlled switches, dimmer modules, and control devices.
 - n. Intercommunication and call system master and staff stations.
 - o. Fire-alarm control panel and annunciators.
 - p. Breakers at distribution panels.
- P. Wiring Device Identification Labels: On each faceplate install circuit designation label that is consistent with panelboard directories, and as-built plan drawings. Apply labels to receptacle faceplates centered below bottom outlet. Apply labels to toggle switch faceplates on backside.
- 3.2 INSTALLATION
- A. Verify identity of each item before installing identification products.
 - B. Location:
 - 1. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
 - 2. Conduit Markers: Provide identification for each power conduit two inches or larger.
 - C. Apply identification devices to surfaces that require finish after completing finish work.
 - D. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
 - E. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum

intervals in straight runs, and at 25-foot maximum intervals in congested areas.

- F. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
1. Color shall be factory applied or, for sizes larger than No. 10 AWG if authorities having jurisdiction permit, field applied.
 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White.
 - e. Ground: Green.
 3. Colors for 480/277-V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - d. Neutral: Gray.
 - e. Ground: Green.
 4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- G. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- H. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.
- I. Label information arrangement for 3 lines of text.
1. Line one shall describe the panel or equipment. Line one example: "DP-XX," "RP-XX," "T-XX," "EF-XX," etc.
 2. Line two shall describe the first disconnecting means feeding this panel or equipment. Line two example: "Fed from DP-XX," "Fed from RP-XX," etc.

3. Line three indicates that location of the disconnecting means as identified in line two. Line three example: "First Floor Elect. Rm #XXX."
4. Line four shall include "Via T-XX" when panel or equipment is fed from a transformer.

J. Examples:

RP-1A	EF-1	LP-1A
FED FROM	FED FROM	FED from
PP-2	PP-1	MDP
ELECTRICAL	MECHANICAL	ELECTRICAL
ROOM A100	ROOM F101	ROOM A100
VIA T-1A		

- K. Painted Identification: Prepare surface and apply paint according to Division 9 painting Sections.
- L. Degrease and clean surface to receive nameplates.
- M. Install nameplate and labels parallel to equipment lines.
- N. Secure nameplate to equipment front using screws.
- O. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.
- P. Identify conduit using field painting where required.
- Q. Paint red colored band on each fire alarm conduit and junction box.
- R. Paint bands 10 feet on center, and 4 inches minimum in width.
- S. Labels shall be neatly centered. Place labels in like positions on similar equipment.

END OF SECTION 16195

SECTION 16289 - SURGE PROTECTIVE DEVICES

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUMMARY.....1
1.3 RELATED SPECIFICATION.....2
1.4 REFERENCES.....2
1.5 SYSTEM DESCRIPTION.....2
1.6 MAIN DISTRIBUTION PANELBOARDS AND BRANCH CIRCUIT
PANELBOARDS.....3
1.7 DOCUMENTATION.....4
1.8 WARRANTY.....5

PART 2 - PRODUCTS.....5
2.1 MANUFACTURERS.....5
2.2 ACCESSORIES.....5

PART 3 - EXECUTION.....5
3.1 INSTALLATION.....5
3.2 FIELD QUALITY CONTROL.....6

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.
- B. Related Sections include the following:
 - 1. Division 16 Section "Electrical General Requirements."

1.2 SUMMARY

- A. These specifications describe the requirements for a high energy surge protective devices system (abbreviated as SPD in this specification and on all drawings). The specified system shall provide effective high energy surge current diversion and be suitable for application in ANSI/IEEE C62.41 Category A, B, and C environments, as tested by ANSI/IEEE C62.45. The system shall be connected in parallel with the protected system; no series connected elements shall be used, which could constitute a single point failure.

1.3 RELATED SPECIFICATION

- A. Main Distribution Switchboard Section 16441.
- B. Panelboards Section 16442.

1.4 REFERENCES

- A. The Transient Voltage Surge Suppression System shall be designed and manufactured to the following standards.
- B. American National Standards Institute and Institute of Electrical and Electronic Engineers (ANSI/IEEE, C62.1, C62.41 and C62.45).
- C. Federal Information Processing Standards Publication 94 (FIPS PUB 94).
- D. National Electrical Manufacturers Association (NEMA LS-1).
- E. National Fire Protection Association (NFPA 70, 75, and 78).
- F. Underwriters Laboratories (UL 1449, Third Edition, UL 1283).
- G. National Electric Code (NEC 285).

1.5 SYSTEM DESCRIPTION

- A. Environmental Requirements:
 - 1. Storage temperature range shall be -55 to +85 degrees C (-67 to +185 degrees F).
 - 2. Operating temperature range shall be -40 to +50 degrees C (-40 to +122 degrees F).
 - 3. Operation shall be reliable in an environment with 0% to 95% non-condensing relative humidity.
 - 4. The audible noise level of the specified system shall be less than 45 dBA at 5 feet (1.5 m).
- B. Transient voltage surge suppression system with integral EMI/RFI filtering (abbreviated as SPD in this specification and on all drawings). The specified system shall provide effective high energy surge current diversion and be suitable for application in ANSI/IEEE C62.41 Category A, B, and C environments, as tested by ANSI/IEEE C62.45. The system shall be connected in

parallel with the protected system; no series connected elements shall be used, which could constitute a single point failure.

- C. Provide documentation of specified system's UL 1449, Third Edition, listing and suppression ratings which shall be included as required product data submittal information.
- D. The SPD system may be mounted integral to the Main Distribution Panelboards or integral to the Electronic Grade Panelboards as indicated on the drawings and specified as follows:

1.6 MAIN DISTRIBUTION PANELBOARDS AND BRANCH CIRCUIT PANELBOARDS

A. Electrical Characteristics

- 1. Nominal Line Voltage:
 - a. 120/208 voltage, three phase, 4 wire plus ground, as indicated on drawings (MDP and SPD Branch Circuit Panelboards).
- 2. Maximum Continuous Line Current:
 - a. As noted on drawings.
- 3. Maximum Continuous Operating Voltage:
 - a. >115% of nominal.
- 4. Operating Frequency:
 - a. 47-63 Hz.
- 5. Protection Modes:
 - a. Line to line.
 - b. Line to neutral.
 - c. Line to ground.
 - d. Neutral to ground.
- 6. Connection Means:
 - a. Direct bus connection, parallel connection.
- 7. Main Distribution Panelboard Maximum Surge Current:
 - a. Maximum surge current shall be based on a single pulse, IEEE C62.41 standard 8 x 20 microsecond wave form. Device shall not suffer more than 10% deviation in clamping voltage at specified surge current.
 - 1) Per Phase Total: 240 kA.
 - 2) Per Mode: 120 kA.
- 8. Branch Circuit Panelboards Maximum Surge Current:
 - a. Maximum surge current shall be based on a single pulse, IEEE C62.41 standard 8 x 20 microsecond wave form. Device shall not suffer more than 10%

- deviation in clamping voltage at specified surge current.
- 1) Per Phase Total: 80 kA.
 - 2) Per Mode: 40 kA.
9. UL 1449 voltage suppression rating:
 - a. L-N, L-G, N-G: 700 volts for 208/120V systems.
 - b. L-L: 1500 volts for 208/120V systems.
 - c. L-N, L-G, N-G: 1200 volts for 480/277V systems.
 - d. L-L: 2000 volts for 480/277V systems.
 10. AC tracking filter with EMI/RFI filtering.
 11. EMI-RFI Noise Rejection Based on MIL-STD-E220A Methodology:
 - a. 100 KHZ : 50dB
 12. Surge Life Cycle:
 - a. Capable of surviving 1000 sequential category C3 combination wave surges as defined by ANSI/IEEE C62.41 and ANSI/IEE C62.45, without failing the specified UL 1449 suppression ratings.
 13. Internal Connections:
 - a. All internal wiring within the SPD device subject to surge currents shall be made of low impedance copper bus bar. Modular, parallel SPD design shall consist of 40mm metal oxide varistors individually fused at 200KAIC for each suppression mode.
- 1.7 DOCUMENTATION
- A. The manufacturer shall furnish an installation manual with installation, start up, and operating instructions for the specified system.
 - B. Electrical and mechanical drawings shall be provided by the manufacturer which show unit dimensions, weights, component and connection locations, mounting provisions, connection details, and wiring diagram.
 - C. Documentation of specified system's UL 1449 listing and clamping voltage ratings shall be included as required product data submittal information.
 - D. A list of recommended spare parts shall be supplied at the customer's request.

1.8 WARRANTY

- A. The manufacturer shall provide a full five-year warranty from date of shipment against any part failure when installed in compliance with manufacturer's written instructions, UL listing requirements, and any applicable national or local electrical codes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Square D (Base Bid).
- B. Siemens.
- C. Cutler Hammer.

2.2 ACCESSORIES

- A. Unit Status indicators
 - 1. Red and green LED indicators shall be provided on the front cover to redundantly indicate unit module status. The absence of the green light and the presence of the red light shall reliably indicate that one or more surge current diversion modules has failed and that service is needed to restore full operation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Service entrance suppressors shall be installed in the switchboard.
- B. Locate suppressor on load side of main disconnect device, as close as possible to the phase conductors and ground/neutral bar.
- C. A breaker shall be provided in the main distribution panelboard to directly connect the SPD unit. This breaker shall be directly integrated to the suppressor and switchboard bus using bolted bus bar connections.
- D. The suppressor and integral disconnect shall be installed to the switchboard using a direct bus bar connection. SPD to disconnect conductors shall be as short and straight as possible, less than 5 feet.

- E. All monitoring diagnostics features (indicator lights) shall be mounted on the front of the switchboard, adjacent to SPD.

3.2 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed the manufacturer.
- B. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.
- C. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.

END OF SECTION 16289

SECTION 16410 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUMMARY.....1
1.3 DEFINITIONS.....2
1.4 REFERENCES.....2
1.5 SUBMITTALS.....3
1.6 QUALITY ASSURANCE.....4
1.7 PROJECT CONDITIONS.....4
1.8 COORDINATION.....5
1.9 EXTRA MATERIALS.....5

PART 2 - PRODUCTS.....5
2.1 MANUFACTURERS.....5
2.2 FUSIBLE AND NONFUSIBLE SWITCHES.....5
2.3 TOGGLE DISCONNECT SWITCH.....6
2.4 MOLDED-CASE CIRCUIT BREAKERS.....6
2.5 ENCLOSURES.....7

PART 3 - EXECUTION.....7
3.1 EXAMINATION.....7
3.2 CONCRETE BASES.....7
3.3 INSTALLATION.....7
3.4 IDENTIFICATION.....8
3.5 FIELD QUALITY CONTROL.....9
3.6 ADJUSTING.....11
3.7 CLEANING.....11

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 16 Section "Fuses".

1.2 SUMMARY

- A. This Section includes the following individually mounted, enclosed switches and circuit breakers:
 - 1. Fusible switches.
 - 2. Nonfusible switches.

3. Molded-case circuit breakers.
4. Molded-case switches.
5. Enclosures.

1.3 DEFINITIONS

- A. GD: General duty.
- B. GFCI: Ground-fault circuit interrupter.
- C. HD: Heavy duty.
- D. RMS: Root mean square.
- E. SPDT: Single pole, double throw.

1.4 REFERENCES

- A. NECA 1: Practices for Good Workmanship in Electrical Contracting.
- B. NETA ATS: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- C. NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum).
- D. NEMA AB 1: Molded Case Circuit Breakers and Molded Case Switches.
- E. NEMA FU 1: Low Voltage Cartridge Fuses.
- F. NEMA KS 1: Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- G. NEMA PB1.1: General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.
- H. NEMA PB2.1: General Instructions for Proper Installation, Operation, and Maintenance of Deadfront Switchboards Rated 600 Volts or Less.
- I. NFPA 70: National Electrical Code.

1.5 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
1. Enclosure types and details for types other than NEMA 250, Type 1.
 2. Current and voltage ratings.
 3. Short-circuit current rating.
 4. UL listing for series rating of installed devices.
 5. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Manufacturer Seismic Qualification Certification: Submit certification that enclosed switches and circuit breakers, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Qualification Data: For testing agency.
- E. Field quality-control test reports including the following:
1. Test procedures used.
 2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

F. Manufacturer's field service report.

G. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Closeout Procedures," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current curves, including selectable ranges for each type of circuit breaker.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.

2. Altitude: Not exceeding 6600 feet.

1.8 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Spares: For the following:
 - a. Potential Transformer Fuses: 2 of each size and type.
 - b. Control-Power Fuses: 2 of each size and type
 - c. Fuses for Fusible Switches: Equal to 10 percent of amount installed for each size and type, but no fewer than 3 of each size and type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FUSIBLE AND NONFUSIBLE SWITCHES

- A. Manufacturers:
1. Square D (base bid - bid price shall include Square D equipment)
- B. Fusible Switch: NEMA KS 1, quick make, quick-break load interrupter enclosed knife switch Type HD, with clips or bolt pads to accommodate specified fuses, externally operable lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Nonfusible Switch: NEMA KS 1, quick make, quick-break load interrupter enclosed knife switch Type HD, externally operable lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

- D. Double Throw Safety Switch (Manual Transfer Switch): U. L. listed and suitable for use in accordance with Article 702 of the National Electrical Code. Designed for manual transfer of loads from one supply to another. Three pole with solid neutral. Externally operable handle padlockable in either position. Provide pad lock and two sets of keys.
- E. Accessories:
1. Provide early break auxiliary contacts in motor disconnect switches for motors that are fed from variable frequency controllers.
 2. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 3. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors.
 4. Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open.
 5. Switch shall be Service Entrance rated.

2.3 TOGGLE DISCONNECT SWITCH

- A. Manufacturers:
1. Double Pole:
 - a. Hubbell 1372.
 - b. Leviton 6808G-DAC.
 - c. Pass & Seymour 7812.
 - d. Bryant 30102.
 2. Three Pole:
 - a. Hubbell 1379.
 - b. Leviton 7810GD.
 - c. Pass & Seymour 7813.
 - d. Bryant 30103.
- B. Description: Heavy duty, 30A, 600 volt, double or three pole as required, single throw, motor rated switch without overload protection. Provide NEMA 1 enclosure and padlock attachment.

2.4 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers:
1. Square D/Group Schneider (base bid - bid price shall include Square D equipment).
- B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Mechanical style suitable for number, size, trip ratings, and conductor material.
2. Application Listing: Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
3. Enclosure: Provide handle capable of being locked in the open position with padlock.

2.5 ENCLOSURES

- A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.
 1. Indoor Dry Locations: NEMA 250, Type 1.
 2. Outdoor Locations: NEMA 250, Type 3R.
 3. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 4. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONCRETE BASES

- A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.
- B. Concrete base is specified in Division 16 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 3.

3.3 INSTALLATION

- A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.
- B. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated. Anchor floor-mounting switches to concrete base.

- C. Comply with mounting and anchoring requirements specified in Division 16 Section "Vibration and Seismic Controls for Electrical Systems."
- D. Install switches with off position down.
- E. Install NEMA KS 1 enclosed switch where indicated for motor loads $\frac{1}{2}$ HP and larger and equipment loads greater than 30A.
- F. Install toggle disconnect switch, surface mounted, where indicated for motor loads less than $\frac{1}{2}$ HP and equipment loads 30A. and less.
- G. Install fuses in fusible disconnect switches.
- H. Install flexible liquid tight conduit from toggle disconnect switch to portable equipment. Leave a 6'-0" (1830 mm) whip.
- I. Install flexible liquid tight conduit from toggle disconnect switch to stationary equipment.
- J. Install control wiring from early break contacts in motor disconnect switch to variable frequency controllers to shut down controller when switch is open.
- K. Install equipment on exterior foundation walls at least one inch (25 mm) from wall to permit vertical flow of air behind breaker and switch enclosures.
- L. Support enclosures independent of connecting conduit or raceway system.
- M. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.4 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section "Electrical Identification."
- B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate as specified in Division 16 Section "Electrical Identification."

- C. Provide adhesive label as specified in Division 26 Section "Electrical Identification" on inside door of each switch indicating UL fuse class and size for replacement.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Prepare for acceptance testing as follows:
 - 1. Inspect mechanical and electrical connections.
 - 2. Verify switch and relay type and labeling verification.
 - 3. Verify rating of installed fuses.
 - 4. Inspect proper installation of type, size, quantity, and arrangement of mounting or anchorage devices complying with manufacturer's certification.
- C. Testing Agency: Engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- D. Perform the following field tests and inspections and prepare test reports:
 - 1. Test mounting and anchorage devices according to requirements in Division 16 Section "Vibration and Seismic Controls for Electrical Systems."
 - 2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches. Certify compliance with test parameters.
 - 3. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.6 for molded-case circuit breakers . Test all NEMA AB1, molded case circuit breakers with thermal magnetic trip or auxiliary, solid-state trip units 100A and larger. Certify compliance with test parameters.
 - a. Visual and Mechanical Inspection
 - 1) Circuit breaker shall be checked for proper mounting and compare nameplate data to Drawings and Specifications.
 - 2) Operate circuit breaker to ensure smooth operation.
 - 3) Inspect case for cracks or other defects.
 - 4) Check internals on unsealed units.

b. Electrical Tests

- 1) Perform a contact resistance test.
- 2) Perform an insulation resistance test at 1000 volts dc from pole-to-pole and from each pole-to-ground with breaker closed and across open contacts of each phase.
- 3) Perform long time delay time-current characteristic tests by passing three hundred percent (300%) rated current through each pole separately. Record trip time. Make external adjustments as required to meet time current curves.
- 4) Determine short time pickup and delay by primary current injection.
- 5) Determine ground fault pickup and time delay by primary current injection.
- 6) Determine instantaneous pickup current by primary injection using run-up or pulse method.
- 7) Perform adjustments for final settings in accordance with coordination study.
- 8) For circuit breakers 800A and larger, verify all functions of trip unit by means of secondary injection in lieu of primary injection.

c. Test Values

- 1) Compare contact resistance or millivolt drop values to adjacent poles and similar breakers. Investigate deviations of more than fifty percent (50%). Investigate any value exceeding manufacturer's recommendations.
- 2) Insulation resistance shall not be less than 100 megohms.
- 3) Trip characteristic of breakers shall fall within manufacturer's published time-current characteristic tolerance band, including adjustment factors.
- 4) All trip times shall fall within N.E.T.A. Acceptance Testing Specifications, Table 10.7 Circuit breakers exceeding specified trip time at three hundred percent (300%) of pickup shall be tagged defective.
- 5) Instantaneous pickup values shall be within values shown on N.E.T.A. Acceptance Testing Specifications, Table 10.8 or manufacturer's recommendations.

4. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.6 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip and time delay settings to values as instructed by the Engineer.

3.7 CLEANING

- A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.
- B. Inspect exposed surfaces and repair damaged finishes.

END OF SECTION 16410

SECTION 16415 - TRANSFER SWITCHES

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUMMARY.....1
1.3 SUBMITTALS.....2
1.4 QUALITY ASSURANCE.....2

PART 2 - PRODUCTS.....4
2.1 MANUFACTURERS.....4
2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS.....4
2.3 AUTOMATIC TRANSFER SWITCH.....6
2.4 SOURCE QUALITY CONTROL.....9

PART 3 - EXECUTION.....9
3.1 INSTALLATION.....9
3.2 WIRING TO REMOTE COMPONENTS.....10
3.3 CONNECTIONS.....10
3.4 FIELD QUALITY CONTROL.....10
3.5 DEMONSTRATION.....12

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 SUMMARY

- A. This Section includes transfer switches rated 600 V and less, including the following:
 - 1. Automatic transfer switches.
 - 2. Bypass/isolation switches.
 - 3. Non-automatic transfer switches.
 - 4. Remote annunciation system.
 - 5. Remote annunciation and control system.

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Dimensioned plans, sections, and elevations showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
 - 1. Wiring Diagrams: Single-line diagram. Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: Submit under provision of Section "Electrical General Requirements". For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Closeout Procedures," include the following:
 - 1. Features and operating sequences, both automatic and manual.
 - 2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.
 - 3. Include instructions for operating equipment under emergency conditions.
 - 4. Document ratings of equipment and each major component.
 - 5. Include routine preventive maintenance and lubrication schedule.
 - 6. List special tools, maintenance materials, and replacement parts

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency

maintenance repairs within a response period of less than eight hours from time of notification.

- B. Testing Agency Qualifications: Refer to specification section "Electrical Testing".
- C. Source Limitations: Obtain automatic transfer switches, bypass/isolation switches, non-automatic transfer switches, remote annunciators, and remote annunciator and control panels through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, for emergency service under UL 1008, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.
- F. UL 1008 - Standard for Automatic Transfer Switches, unless requirements of those specifications are stricter.
- G. NFPA 70 - National Electrical Code, including use in emergency and standby systems in accordance with Articles 517, 700, 701 and 702
- H. NFPA 99 - Essential Electrical Systems for Health Care Facilities
- I. NFPA 110 - Standard for Emergency and Standby Power Systems
- J. IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems (Orange Book)
- K. IEEE Standard 241 - IEEE Recommended Practice for Electric Power Systems in Commercial Buildings (Gray Book)
- L. NEMA Standard ICS2-447 - AC Automatic Transfer Switches
- M. IEC - Standard for Automatic Transfer Switches

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Contactor Transfer Switches:
 - a. Emerson; ASCO Power Technologies, LP
 - b. Cummins Bridgway, Inc.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

- A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
- B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
 - 1. Coordinate ratings with overcurrent protective devices specified elsewhere and provide rating listed with manufacturer and model of overcurrent device provided in panel boards, switchboards and switchgear.
 - 2. Provide fault-current and withstand ratings in accordance with UL 1008 standard's 1½ and 3 cycle long-time ratings. Transfer switches which are not tested and labeled with 1½ and 3 cycle (any breaker) ratings and have series, or specific breaker ratings only, are not acceptable.
 - 3. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

- C. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels have communication capability matched with remote device.
- D. Solid-State Controls: Repetitive accuracy of all settings is plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
- E. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- F. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.
- G. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
 - 1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
 - 2. Switch Action: Double throw; mechanically held in both directions.
 - 3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.
- H. Neutral Terminal: Solid and fully rated, unless otherwise indicated.
- I. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.
- J. Heater: Equip switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater.

- K. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels have communication capability matched with remote device.
- L. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color code or by numbered or lettered wire and cable tape markers at terminations.
 - 1. Designated Terminals: Pressure type suitable for types and sizes of field wiring indicated.
 - 2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
 - 3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
- M. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.3 AUTOMATIC TRANSFER SWITCH

- A. Comply with Level 1 equipment according to NFPA 110.
- B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.
- C. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.
- D. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.
- E. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.
- F. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources

and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.

- G. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters is through wiring external to automatic transfer switch. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated. Relay contacts handling motor-control circuit inrush and seal currents are rated for actual currents to be encountered.
- H. AUTOMATIC TRANSFER-SWITCH FEATURES
1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
 2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
 3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
 4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes. Provides automatic defeat of delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
 5. Test Switch: Simulates normal-source failure.

6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
 - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
 - b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
10. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
11. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
 - a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
 - b. Push-button programming control with digital display of settings.
 - c. Integral battery operation of time switch when normal control power is not available.
12. Provide selective load disconnect control circuit (24 VDC output) to operate 0 to 5 minutes (field adjustable)

before transfer of the automatic transfer switch and to reset 0-5 minutes (field adjustable) after transfer, in either direction. The two time delays shall be independently adjustable. This circuit shall be supplied on all transfer switches. For switches that feed elevator loads, provide double-pole/double-throw output relay for interface purposes that is driven by above control circuitry.

13. Transfer inhibit: Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal.

2.4 SOURCE QUALITY CONTROL

- A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Floor-Mounted Switch: Anchor to floor by bolting.
 1. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 2 inches (50 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated. Cast anchor-bolt inserts into bases. Comply with Division 3 Section "Cast-in-Place Concrete."
- B. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.
- C. Identify components according to Division 16 Section "Electrical Identification".

3.2 WIRING TO REMOTE COMPONENTS

- A. Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

3.3 CONNECTIONS

- A. Ground equipment according to Division 16 Section "Grounding and Bonding."
- B. Connect wiring according to Division 16 Section "Conductors and Cables."
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect , test, and adjust components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Testing: Perform the following field quality control tests in accordance with Division 16 section "Electrical Testing."
 - 1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
 - 2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.22.3. Certify compliance with test parameters.
 - 3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

- a. Check for electrical continuity of circuits and for short circuits.
 - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
 - c. Verify that manual transfer warnings are properly placed.
 - d. Perform manual transfer operation.
4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
- a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
 - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
 - c. Verify time-delay settings.
 - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
 - e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
 - f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
 - g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
- a. Verify grounding connections and locations and ratings of sensors.
 - b. Observe reaction of circuit-interrupting devices when simulated fault current is applied at sensors.
- C. Coordinate tests with tests of generator and run them concurrently.
- D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag

to each tested component indicating satisfactory completion of tests.

- E. Remove and replace malfunctioning units and retest as specified above.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 1 Section "Closeout Procedures."

- 1. Coordinate this training with that for generator equipment.

END OF SECTION 16415

SECTION 16420 - ENCLOSED CONTROLLERS

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUMMARY.....1
1.3 SUBMITTALS.....2
1.4 REFERENCES.....3
1.5 QUALITY ASSURANCE.....4
1.6 DELIVERY, STORAGE, AND HANDLING.....5
1.7 PROJECT RECORD DOCUMENTS.....5
1.8 PROJECT CONDITIONS.....6
1.9 COORDINATION.....6
1.10 EXTRA MATERIALS6

PART 2 - PRODUCTS.....7
2.1 MANUFACTURERS.....7
2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS.....7
2.3 ENCLOSURES.....8
2.4 ACCESSORIES.....8
2.5 FACTORY FINISHES.....8

PART 3 - EXECUTION.....8
3.1 EXAMINATION.....8
3.2 APPLICATIONS.....9
3.3 INSTALLATION.....9
3.4 CONCRETE BASES.....9
3.5 IDENTIFICATION.....10
3.6 CONTROL WIRING INSTALLATION.....10
3.7 CONNECTIONS.....10
3.8 FIELD QUALITY CONTROL.....10
3.9 ADJUSTING.....11
3.10 DEMONSTRATION11

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes ac, enclosed controllers rated 600 V and less, of the following types:
 - 1. Across-the-line, manual and magnetic controllers.

2. Reduced-voltage controllers.
3. Multispeed controllers.

B. Related Sections include the following:

1. Division 16 Section "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.
2. Division 15 Section "Variable Frequency Controllers" for general-purpose, ac, adjustable-frequency, pulse-width-modulated controllers for use on constant torque loads in ranges up to 200 hp.

1.3 SUBMITTALS

- A. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each enclosed controller.
 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Each installed unit's type and details.
 - b. Nameplate legends.
 - c. Short-circuit current rating of integrated unit.
 - d. UL listing for series rating of overcurrent protective devices in combination controllers.
 - e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination controllers.
 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around enclosed controllers where pipe and ducts are prohibited. Show enclosed controller layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
- D. Manufacturer Seismic Qualification Certification: Submit certification that enclosed controllers, accessories, and components will withstand seismic forces defined in Division

26 Section "Electrical Supports and Seismic Restraints."
Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Qualification Data: For manufacturer and testing agency.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Closeout Procedures," include the following:

1. Routine maintenance requirements for enclosed controllers and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

H. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

I. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

1.4 REFERENCES

- A. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

- B. ANSI/UL 198C - High-Intensity Capacity Fuses; Current-Limiting Types.
- C. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service.
- D. FS W-F-870 - Fuseholders (For Plug and Enclosed Cartridge Fuses).
- E. FS W-S-865 - Switch, Box, (Enclosed), Surface-Mounted.
- F. NECA 402-2000 - Recommended Practice for Installing and Maintaining Motor Control Centers.
- G. NEMA AB 1 - Molded Case Circuit Breakers.
- H. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.
- I. NEMA KS 1 - Enclosed Switches.
- J. ANSI/NFPA 70 - National Electrical Code.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.
- C. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing

agency acceptable to authorities having jurisdiction, and marked for intended use.

- E. Comply with NFPA 70.
- F. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed controllers, minimum clearances between enclosed controllers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prior to beginning work on any system, verify all existing conditions that affect the work and coordinate with all other trade Contractors. Determine that the work can be installed as indicated or immediately report to the Architect/Engineer errors, inconsistencies or ambiguities.
- B. Deliver products to site under provisions of Section 26 0100. Store and protect products under provisions of Section 26 0100.
- C. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- D. Handle in accordance with manufacturer's written instructions. Lift large equipment only with lugs provided for the purpose. Handle carefully to avoid damage to motor control center components, enclosure, and finish.
- E. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.7 PROJECT RECORD DOCUMENTS

- A. Accurately record actual locations of each contactor and indicate circuits controlled. Submit under provisions of 16010.

1.8 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
1. Notify Construction Manager no fewer than three days in advance of proposed interruption of electrical service.
 2. Indicate method of providing temporary utilities.
 3. Do not proceed with interruption of electrical service without Construction Manager's written permission.

1.9 COORDINATION

- A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."
- D. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.
- E. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.10 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Spare Fuses: Furnish one spare for every five installed, but no fewer than one set of three of each type and rating.
 2. Indicating Lights: Two of each type installed.

3. Keys: Furnish 2 of each to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Square D (base bid - bid price shall include Square D equipment).

2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS

- A. Manual Controller: NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF," "ON," or "TRIPPED." Provide manual controller for 120 volt or 208 volt operation, as indicated on the drawings.
 1. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.
- B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated. Provide magnetic controller for 120 volt or 208 volt operation, as indicated on the drawings.
 1. Control Circuit: 120 V; obtained from integral control power transformer with sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
 2. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 20 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
- C. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.
 1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL.

2.3 ENCLOSURES

- A. Description: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.
 - 1. Outdoor Locations: NEMA 250, Type 3R.
 - 2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 - 3. Other Wet or Damp Indoor Locations: NEMA 250, Type 3R.
 - 4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2.4 ACCESSORIES

- A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
- B. Push-Button Stations, Pilot Lights: NEMA ICS 2, heavy-duty type.
- C. Indicating Lights: Run (Red), off or ready (Green).
- D. Auxiliary Contacts: Provide two normally open (N.O.) and two normally closed (N.C.) contacts.
- E. Selector Switch: NEMA ISC 2, mounted in front cover to read "hand/off/auto," provide auxiliary contact for auto position monitoring.
- F. Control Relays: Auxiliary and adjustable time-delay relays.
- G. Phase-Failure and Undervoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable undervoltage setting.

2.5 FACTORY FINISHES

- A. Finish: Manufacturer's standard gray paint applied to factory-assembled and -tested enclosed controllers before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.
- B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

- A. See Division 26 Section "Basic Electrical Materials and Methods" for general installation requirements.
- B. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks.
- C. Install freestanding equipment on concrete bases.
- D. Comply with mounting and anchoring requirements specified in Division 16 Section "Electrical Supports and Seismic Restraints."
- E. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 16 Section "Fuses."
- F. Install motor control equipment and contactors in accordance with manufacturer's instructions.
- G. Select and install heater elements in motor starters to match installed motor characteristics.
- H. Motor Data: Provide neatly typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

3.4 CONCRETE BASES

- A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

- B. Concrete base is specified in Division 16 Section "Basic Electrical Materials and Methods," and concrete materials and installation requirements are specified in Division 3.

3.5 IDENTIFICATION

- A. Identify enclosed controller, components, and control wiring according to Division 16 Section "Electrical Identification."

3.6 CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed controllers according to Division 16 Section "Conductors and Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
 - 1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
 - 2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.7 CONNECTIONS

- A. Conduit installation requirements are specified in other Division 16 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.
- B. Ground equipment according to Division 16 Section "Grounding and Bonding."

3.8 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 2. Assist in field testing of equipment including pretesting and adjusting of solid-state controllers.
 3. Report results in writing.
- C. Testing: Perform the following field quality control tests in accordance with Division 16 section "Electrical Testing"
1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS, "Motor Control - Motor Starters." Certify compliance with test parameters.
 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- 3.9 ADJUSTING
- A. Set field-adjustable switches and circuit-breaker trip ranges.
- 3.10 DEMONSTRATION
- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers. Refer to Division 1 Section "Closeout Procedures."

END OF SECTION 16420

SECTION 16442 - PANELBOARDS

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUMMARY.....1
1.3 DEFINITIONS.....2
1.4 SUBMITTALS.....2
1.5 QUALITY ASSURANCE.....3
1.6 PROJECT CONDITIONS.....4
1.7 COORDINATION.....4
1.8 EXTRA MATERIALS.....5

PART 2 - PRODUCTS.....5
2.1 MANUFACTURERS.....5
2.2 MANUFACTURED UNITS.....5
2.3 PANELBOARD SHORT-CIRCUIT RATING.....6
2.4 DISTRIBUTION PANELBOARDS.....6
2.5 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS.....7
2.6 SURGE PROTECTIVE DEVICE PANELBOARDS.....7
2.7 OVERCURRENT PROTECTIVE DEVICES.....9
2.8 ACCESSORY COMPONENTS AND FEATURES.....10

PART 3 - EXECUTION.....10
3.1 INSTALLATION.....10
3.2 IDENTIFICATION.....11
3.3 CONNECTIONS.....12
3.4 FIELD QUALITY CONTROL.....12
3.5 CLEANING.....13

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.
 - 3. Surge Protective Device panelboards.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. RFI: Radio-frequency interference.
- D. RMS: Root mean square.
- E. SPDT: Single pole, double throw.

1.4 SUBMITTALS

- A. Product Data: For each type of panelboard, overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Enclosure types and details for types other than NEMA 250, Type 1.
 - b. Bus configuration, current, and voltage ratings.
 - c. Short-circuit current rating of panelboards and overcurrent protective devices.
 - d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Manufacturer Seismic Qualification Certification: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Electrical Supports and Seismic Restraints." Include the following:
 - 1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device

when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Field quality-control test reports including the following:
1. Test procedures used.
 2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
- F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data" include the following:
1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 2. Time-current curves, including selectable ranges for each type of overcurrent protective device.
- 1.5 QUALITY ASSURANCE
- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.
1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.
- B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.
- C. Product Options: Drawings indicate size, profiles, and dimensional requirements of panelboards and are based on the

specific system indicated. Refer to Division 1 Section "Product Requirements."

- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with NEMA PB 1.
- F. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Ambient Temperature: Not exceeding 104 deg F.
 - 2. Altitude: Not exceeding 6600 feet.
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet.
- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Construction Manager's written permission.

1.7 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Keys: Six spares for each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:
 - a. Square D (base bid - bid price shall include Square D equipment).
 2. Surge Protective Device Panelboards:
 - a. Square D (base bid - bid price shall include Square D equipment).

2.2 MANUFACTURED UNITS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Electrical Supports and Seismic Restraints."
- B. Enclosures: Mounting as noted on panel schedules. NEMA PB 1, Type 1.
1. Rated for environmental conditions at installed location.
 - a. Outdoor Locations: NEMA 250, Type 3R.
 - b. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - c. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.
 2. Cabinet Front: Flush or surface cabinet as noted on the Drawings, with front concealed trim clamps, piano type hinged dead front cover, hinged door, and flush lock all keyed alike.
 3. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.
 4. Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.
- C. Cabinet Front: Flush or surface cabinet as noted on the Drawings.
1. Eaton LTDD (Piano hinge trim)
 2. Square D - Continuous piano hinge trim.

3. Siemens - Figure 4 hinge to box w/piano hinge.

D. Phase and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.
3. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors; insulated from box as called out on panel schedules.

E. Conductor Connectors: Suitable for use with conductor material.

1. Main and Neutral Lugs: Mechanical type.
2. Ground Lugs and Bus Configured Terminators: Compression type.
3. Feed-Through Lugs: Mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
4. Double Lugs: Mechanical type mounted at location of main incoming lugs.

F. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches.

G. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

2.3 PANELBOARD SHORT-CIRCUIT RATING

- A. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.4 DISTRIBUTION PANELBOARDS

- A. Main bus bars, neutral and ground, shall be copper and sized in accordance with U.L. Standards to limit temperature rise on any current carrying part to the maximums as indicated in UL67.

- B. Doors: Secured with vault-type latch with tumbler lock; keyed alike. Omit for fused-switch panelboards.

- C. Main Overcurrent Protective Devices: Circuit breaker.

- D. Branch Overcurrent Protective Devices:

1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
 2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
 3. Fused switches.
- E. Short Circuit Rating: 50,000 AIC min. for panelboard, unless indicated otherwise on the drawings.
- F. Enclosure Size: Enclosure shall be sized to provide adequate conduit knockout space and gutter wire-bending space for all future conduits and cables. Enclosures that are too small to accommodate future conduits and cables shall be replaced at the Contractor's expense.
- 2.5 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS
- A. Main bus bars, neutral and ground, shall be copper and sized in accordance with U.L. Standards to limit temperature rise on any current carrying part to the maximums as indicated in UL67.
- B. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- C. Short circuit rating: 25,000 AIC min. for panelboard. 22,000 AIC min for 240 Vac or 25,000 AIC min. at 480 Vac for circuit breakers.
- D. Circuit breakers used for switching fluorescent lighting or for protecting air conditioning compressors shall be so listed.
- E. Circuit breakers used for feeding electrical heat tracing shall include ground fault equipment protection rated to trip at 30 ma.
- 2.6 SURGE PROTECTIVE DEVICE PANELBOARDS
- A. Surge Protection Device Description: Sine-wave tracking type with the following features and accessories:
1. MOV technology for each suppression mode.
 2. Fuses, rated at 200-kA interrupting capacity. Provide fusing for each suppression path.

3. Fabrication using bolted compression lugs for internal wiring. No plug-in component modules, quick disconnect terminals or printed circuit boards shall be used in current-carrying paths.
 4. Direct bus bar mounting arrangement with copper bus bars for bolted connections to phase buses, neutral bus, and ground bus.
 5. LED indicator lights for power and protection status for each phase mounted in panelboard front cover:
 - a. Green indicates fully operational circuit.
 - b. Red indicates loss of protection.
 6. EMI-RFI Noise Rejection: based on MIL-STD-E220A, 50-ohm standard Insertion Loss Test:
 - a. 34dB at 100 kHz.
 - b. 51dB at 1 MHz.
 - c. 54dB at 10 MHz.
 - d. 48dB at 100 MHz.
 7. Redundant suppression circuits.
 8. Redundant replaceable modules.
- B. Peak Single-Impulse Surge Current Rating: 80 kA per phase; 40 kA per mode based on a single pulse, IEEE C62.41 standard 8 x 20 microsecond waveform. Device shall not suffer more than 10% deviation in clamping voltage at specified surge current..
- C. Minimum Repetitive Surge Current Capability: 5,000 impulse per mode in accordance with ANSI/IEEE C62.41 and ANSI/IEEE C62.45-1992 utilizing a Category C3 bi-wave at one minute intervals without suffering either performance degradation or more than 10% deviation of specified UL 1449 Suppression Voltage Ratings at specified surge current.
- D. Connection Means: Bus mounted, parallel connection.
- E. Protection modes and UL 1449 Third Edition Listed and Recognized Component SVR for grounded wye circuits with voltages of 208Y/120, 3-phase, 4-wire circuits shall not exceed the following:
 1. Line to Neutral: 700 V for 208Y/120.
 2. Line to Ground: 700 V for 208Y/120.
 3. Neutral to Ground: 700 V for 208Y/120.
 4. Line to Line: 1500 V for 208Y/120.
- F. Protection modes and UL 1449 Second Edition Listed and Recognized Component SVR for 240/120-V, single-phase, 3-wire circuits shall not exceed the following:

1. Line to Neutral: 700 V.
2. Line to Ground: 700 V.
3. Neutral to Ground: 700 V.
4. Line to Line: 1500 V

G. Protection modes and UL 1449 SVR for 240/120-V, 3-phase, 4-wire circuits with high leg shall be as follows:

1. Line to Neutral: 700 V, 1500 V from high leg.
2. Line to Ground: 700 V.
3. Neutral to Ground: 700 V.
4. Line to Line: 1500 V, 1500 V from high leg

H. Protection modes and UL 1449 Second Edition Listed and Recognized Component SVR for voltages of 240, or 480, 3-phase, 3-wire, delta circuits shall not exceed the following:

1. Line to Line: 2000 V for 240 V.
2. Line to Ground: 2000 V for 240 V.

2.7 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger with restricted access cover.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting with restricted access cover.
3. Electronic trip-unit circuit breakers shall have RMS sensing; field-replaceable rating plug; and with the following field-adjustable settings with restricted access cover:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity.
6. All settings to be determined and adjusted by the electrical testing agency. Coordinate settings with manufacturer's circuit breaker curves.

- B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
 3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 4. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
 5. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
 6. Do not use tandem circuit breakers.
 7. Provide circuit breakers U.L. listed as type GFEPFI for all self regulating heating (snow melting and heat trace) cables branch circuits.
 8. Provide lock on devices for circuit breakers when called out on panel schedules with "LOD" designation.
 9. Provide ground fault interrupt 5ma circuit breaker when called out on panel schedules with "GFI" designation.
 10. Provide shunt trip breakers when called out on panel schedules with "STB" designation.
 11. Provide smart controllable circuit breakers when called out on panel schedules with "SMT" designation.
- C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
- D. Fuses are specified in Division 16 Section "Fuses."

2.8 ACCESSORY COMPONENTS AND FEATURES

- A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.

- B. Comply with mounting and anchoring requirements specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- C. Mount top of trim 74 inches above finished floor, unless otherwise indicated.
- D. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.
- E. Install overcurrent protective devices and controllers.
 - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- F. Install filler plates in unused spaces.
- G. Stub four 1-inch empty conduits from recessed panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- H. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- I. Color code circuit breakers and disconnect switches of fire alarm systems and emergency circuits with red paint. Provide lock-on clips on the circuit breaker handles.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Electrical Identification."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads or created by retrofitting. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable. Coordinate final directory room names and numbers with (owner) (facility engineer).
- C. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 CONNECTIONS

- A. Ground equipment according to Division 16 Section "Grounding and Bonding."
- B. Connect wiring according to Division 16 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Testing: Perform the following field quality control tests in accordance with Division 26 section "Electrical Testing"
 - 1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters. Perform electrical tests on all breakers and switches 200A and above or that constitute a component of an emergency distribution system. Main circuit breakers in branch circuit panelboards 225A and below are not required to be tested.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
 - 1. Measure as directed during period of normal system loading.
 - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 - 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

- D. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scanning of each panelboard. Remove panel fronts so joints and connections are accessible to portable scanner.
1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 2. Record of Infrared Scanning: Prepare a certified report that identifies panelboards checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 CLEANING

- A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 16442

SECTION 16491 - FUSES

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUMMARY.....1
1.3 SUBMITTALS.....1
1.4 QUALITY ASSURANCE.....2
1.5 PROJECT CONDITIONS.....2
1.6 COORDINATION.....3
1.7 EXTRA MATERIALS.....3

PART 2 - PRODUCTS.....3
2.1 MANUFACTURERS.....3
2.2 CARTRIDGE FUSES.....3
2.3 FLUORESCENT AND H.I.D. LIGHTING BALLAST FUSES.....3

PART 3 - EXECUTION.....4
3.1 EXAMINATION.....4
3.2 INSTALLATION.....4
3.3 IDENTIFICATION.....4

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Cartridge fuses rated 600 V and less for use in switches, switchboards, and controllers.

1.3 SUBMITTALS

- A. Product Data: Include the following for each fuse type indicated:
 - 1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 2. Let-through current curves for fuses with current-limiting characteristics.
 - 3. Time-current curves, coordination charts and tables, and related data.

4. Fuse size for elevator feeders and elevator disconnect switches.

B. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

1. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.

2. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

C. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:

a. Let-through current curves for fuses with current-limiting characteristics.

b. Time-current curves, coordination charts and tables, and related data.

c. Ambient temperature adjustment information.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with:

1. NEMA FU 1 - Low Voltage Cartridge Fuses.

2. NFPA 70 - National Electrical Code.

3. UL 198C - High-Interrupting-Capacity Fuses, Current-Limiting Types.

4. UL 198E - Class R Fuses.

5. UL 512 - Fuseholders.

1.5 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Quantity equal to 10% percent of each fuse type and size, but no fewer than 3 of each type and size.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Bussman, Inc.
 - 2. Eagle Electric Mfg. Co., Inc.; Cooper Industries, Inc.
 - 3. Ferraz Shawmut, Inc.
 - 4. Tracor, Inc.; Littelfuse, Inc. Subsidiary.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.
 - 1. Service Entrance: Class L, time delay.
 - 2. Feeders: Class J, time delay.
 - 3. Motor Branch Circuits: Class RK5, time delay.
 - 4. Other Branch Circuits: Class J, time delay.

2.3 FLUORESCENT AND H.I.D. LIGHTING BALLAST FUSES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Bussman, Inc. - GLR fuses with HLR holder.
 - 2. Tracor, Inc.; Littelfuse, Inc. Subsidiary - LGR fuses with LHR-000 holder.
 - 3. Ferraz Shawmut, Inc. - SLR fuses.
- B. Provide each fluorescent and HID lighting ballast with individual protection on the line side.

- C. Provide fuse and holder mounted within or as part of the fixture.
- D. Provide fuse size and type recommended by the fixture manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Fuses shall be shipped separately. Any fuses shipped installed in equipment, shall be replaced by the Electrical Contractor with new fuses as specified above prior to energization at no additional expense to Owner. All fuses shall be stored in moisture free packaging at job site and shall be installed immediately prior to energization of the circuit in which it is applied.
- B. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuses.

3.3 IDENTIFICATION

- A. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION 16491

SECTION 16511 - INTERIOR LIGHTING

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUMMARY.....1
1.3 DEFINITIONS.....2
1.4 SUBMITTALS.....2
1.5 QUALITY ASSURANCE.....4
1.6 COORDINATION.....4
1.7 WARRANTY.....4
1.8 EXTRA MATERIALS.....5

PART 2 - PRODUCTS.....5
2.1 MANUFACTURERS.....5
2.2 FIXTURES AND COMPONENTS, GENERAL.....6
2.3 LIGHTING FIXTURES.....7
2.4 FLUORESCENT LAMP BALLASTS.....7
2.5 EXIT SIGNS.....9
2.6 EMERGENCY LIGHTING UNITS.....9
2.7 FLUORESCENT EMERGENCY BATTERY UNITS.....10
2.8 EMERGENCY LOAD TRANSFER DEVICE.....10
2.9 FLUORESCENT LAMPS.....11
2.10 FIXTURE SUPPORT COMPONENTS11
2.11 FINISHES12
2.12 FLUORESCENT FIXTURE RETROFIT MATERIALS12
2.13 SOURCE QUALITY CONTROL12

PART 3 - EXECUTION.....13
3.1 INSTALLATION.....13
3.2 CONNECTIONS.....14
3.3 FIELD QUALITY CONTROL.....15
3.4 ADJUSTING.....16
3.5 CLEANING.....16

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Interior lighting fixtures with lamps and ballasts.

2. Lighting fixtures mounted on exterior building surfaces.
3. Emergency lighting units.
4. Exit signs.
5. Accessories, including lighting fixture retrofitting.

B. Related Sections include the following:

1. Division 16 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.
2. Division 16 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

- A. BF: Ballast factor. Ratio of light output of a given lamp(s) operated by the subject ballast to the light output of the same lamp(s) when operated on an ANSI reference circuit.
- B. CRI: Color rendering index.
- C. CU: Coefficient of utilization.
- D. LER: Luminaire efficiency rating, which is calculated according to NEMA LE 5. This value can be estimated from photometric data using the following formula:
 1. LER is equal to the product of total rated lamp lumens times BF times luminaire efficiency, divided by input watts.
- E. RCR: Room cavity ratio.

1.4 SUBMITTALS

- A. Submit under provisions of Section 16010.
- B. Product Data: For each type of lighting fixture scheduled, arranged in order of fixture designation. Submit as one package, bound together. Include data on features, accessories, finishes, and the following:
 1. Physical description of fixture, including dimensions and verification of indicated parameters.
 2. Emergency lighting unit battery and charger.
 3. Fluorescent and high-intensity-discharge ballasts.
 4. Air and Thermal Performance Data: For air-handling fixtures. Furnish data required in "Submittals" Article in Division 15 Section "Diffusers, Registers, and Grilles."

5. Sound Performance Data: For air-handling fixtures. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Division 15 Section "Diffusers, Registers and Grilles."
 6. Lamps.
 7. Photometric performance data.
- C. Shop Drawings: Show details of nonstandard or custom fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
- D. Wiring Diagrams: Power, signal, and control wiring.
- E. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
1. Suspended ceiling components.
 2. Structural members to which lighting-fixture suspension systems will be attached.
 3. Other items in finished ceiling, including the following:
 - a. Air outlets and inlets.
 - b. Speakers.
 - c. Sprinklers.
 - d. Access panels.
 4. Perimeter moldings.
- F. Samples for Verification: For interior lighting fixtures designated for sample submission in the Interior Lighting Fixture Schedule.
1. Lamps: Specified units installed.
 2. Ballast: 120-V models of specified ballast types.
 3. Accessories: Cords and plugs.
- G. Product Certificates: For each type of ballast for dimmer-controlled fixtures, signed by product manufacturer.
- H. Source quality-control test reports.
- I. Field quality-control test reports.
- J. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
1. Catalog data for each fixture. Include the diffuser, ballast, and lamps installed in that fixture.

K. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with:

1. NFPA 70 - National Electrical Code.
2. NECA/IESNA 500-1998 - Recommended Practice for Installing Indoor Commercial Lighting Systems.
3. NECA/IESNA 502-1999 - Recommended Practice for Installing Industrial Lighting Systems.
4. Resource Conservation and Recovery Act (RCRA), May 1994.
5. Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).
6. Code of Federal Regulations (47 CFR 37342).
7. Michigan Department of State Police, Fire Marshall Division Policy Number 11-06 "Plastic Materials as Interior Finishes" pertaining to the use of plastic lenses in lighting fixtures for health care facilities.
8. Michigan Department of Community Industry Services requirements that all lamps shall be protected from breakage. Exposed lamps are not acceptable.

C. FMG Compliance: Fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.

D. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

1.6 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.7 WARRANTY

A. Special Warranty for Emergency Lighting Unit Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace

components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion at each project. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.

B. Special Warranty for Fluorescent Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Electronic Ballasts: Five years from date of Substantial Completion at each project.

C. Manufacturer's Special Warranty for T8 Fluorescent Lamps: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: One year from date of Substantial Completion at each project.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: 100 of each type and rating installed (LED tube lamps only, model as specified on drawings).

2. Plastic Diffusers and Lenses: 10 of each type and rating installed.

3. Fluorescent Emergency Battery Units: 3 of each type and rating installed.

4. Drivers for LED lamps, 20 of each type and rating installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 FIXTURES AND COMPONENTS, GENERAL

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.
- C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- D. HID Fixtures: Comply with UL 1572. Where LER is specified, test according to NEMA LE 5B.
- E. Metal Parts: Free of burrs and sharp corners and edges.
- F. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- H. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
 - 4. Laminated Silver Metallized Film: 90 percent.
- I. Plastic Diffusers, Covers, and Globes:
 - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least 0.125 inch minimum unless different thickness is scheduled.
 - b. UV stabilized.
 - 2. Glass: Annealed crystal glass, unless otherwise indicated.
- J. Electromagnetic-Interference Filters: A component of fixture assembly. Suppress conducted electromagnetic-interference as required by MIL-STD-461D. Fabricate lighting fixtures with one filter on each ballast indicated to require a filter.

- K. Air-Handling Fluorescent Fixtures: For use with plenum ceiling for air return and heat extraction and for attaching an air-diffuser-boot assembly specified in Division 15 Section "Diffusers, Registers, and Grilles."
1. Air Supply Units: Slots in one or both side trims join with air-diffuser-boot assemblies.
 2. Heat Removal Units: Air path leads through lamp cavity.
 3. Combination Heat Removal and Air Supply Unit: Heat is removed through lamp cavity at both ends of the fixture door with air supply same as for air supply units.
 4. Dampers: Operable from outside fixture for control of return-air volume.
 5. Static Fixtures: Air supply slots are blanked off, and fixture appearance matches active units.
- L. General: Install ballasts, lamps, and specified accessories at factory. Replace and install any damaged lamps on project site.

2.3 LIGHTING FIXTURES

- A. As indicated on the drawings.

2.4 FLUORESCENT LAMP BALLASTS

- A. Description: Include the following features, unless otherwise indicated:
1. Designed for type and quantity of lamps indicated at full light output except for emergency lamps powered by in-fixture battery-packs.
 2. Externally fused with slow-blow type rated between 2.65 and 3.0 times the line current.
- B. Program rapid start electronic ballasts for linear lamps shall include the following features, unless otherwise indicated:
1. Products:
 - a. Advance.
 - b. Universal Lighting.
 2. Comply with NEMA C82.11.
 3. Ballast Type: Programmed rapid start, unless otherwise indicated.
 4. Programmed Start: Ballasts with two-step lamp starting to extend life of frequently started lamps.
 5. Sound Rating: A.
 6. Total harmonic distortion rating of less than 10 percent according to NEMA C82.11. Input current third harmonic content shall not exceed 10%.

7. Lamp end-of-life detection and shutdown circuit.
 8. Transient Voltage Protection: IEEE C62.41, Category A.
 9. Operating Frequency: 25 kHz or higher, and operate without visible flicker.
 10. Lamp Current Crest Factor: Less than 1.7.
 11. Parallel Lamp Circuits: Multiple lamp ballasts connected to maintain full light output on surviving lamps if one or more lamps fail.
 12. Power factor shall be 90% minimum.
 13. Ballast factor shall be .875 to 1.00.
- C. Electromagnetic ballasts for linear lamps shall have the following features, unless otherwise indicated:
1. Products:
 - a. Advance.
 - b. Universal Lighting Technologies
 2. Comply with NEMA C82.1.
 3. Type: Energy-saving, high power factor, Class P, automatic-reset thermal protection.
 4. Ballast Manufacturer Certification: Indicated by label.
 5. Provide lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
 6. Provide ballast suitable for lamps specified.
 7. Ballast shall not exceed sound level above Class A.
- D. Ballasts for dimmer-controlled fixtures shall comply with general and fixture-related requirements above for electronic ballasts and the following features:
1. Products:
 - a. Advance: Mark 10.
 - b. Lutron.
 2. Dimming Range: 100 to 5 percent of rated lamp lumens.
 3. Ballast Input Watts: Can be reduced to 20 percent of normal.
 4. Compatibility: Certified by manufacturer for use with specific dimming system indicated.
 5. Provide ballast suitable for specified lamp type.
- E. Ballasts for Low-Temperature Environments:
1. Temperatures 0 deg F and Higher: Electronic or electromagnetic type rated for 0 deg F minus 17 deg C starting temperature.
 2. Temperatures Minus 20 deg F (Minus 29 deg C) and Higher: Electromagnetic type designed for use with high-output lamps.

- F. Ballasts for Low Electromagnetic-Interference Environments: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for consumer equipment.

2.5 EXIT SIGNS

- A. General: Comply with UL 924; for sign colors and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
1. Lamps for AC Operation: Incandescent, 2 for each fixture, 50,000 hours of rated lamp life.
 2. Lamps for AC Operation: Fluorescent, 2 for each fixture, 20,000 hours of rated lamp life.
 3. Lamps for AC Operation: Light-emitting diodes, 70,000 hours minimum of rated lamp life.
 4. Additional Lamps for DC Operation: Two minimum, bayonet-base type, for connection to external dc source.
- C. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
1. Battery: Sealed, maintenance-free, nickel-cadmium type with special warranty.
 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 3. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
- D. Provide edge lit signs with a mirror plaque background.

2.6 EMERGENCY LIGHTING UNITS

- A. General: Self-contained units complying with UL 924.
1. Battery: Sealed, maintenance-free, lead-acid type with minimum 10-year nominal life and special warranty.
 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from

battery, and battery is automatically recharged and floated on charger.

4. Wire Guard: Where indicated, heavy-chrome-plated wire guard protects lamp heads or fixtures.
5. Integral Time-Delay Relay: Holds unit on for fixed interval when power is restored after an outage; time delay permits high-intensity-discharge lamps to restrike and develop adequate output.

2.7 FLUORESCENT EMERGENCY BATTERY UNITS

A. Internal Type: Self-contained, modular, battery-inverter unit factory mounted within fixture body. Comply with UL 924.

1. Emergency Connection: Operate one fluorescent lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
2. Night Light Connection: Emergency Light Fixtures shall NOT be connected as Night Lights.
3. Test Switch and Light-Emitting-Diode Indicator Light: Visible and accessible without opening fixture or entering ceiling space. Install remote test switch and plate in adjacent ceiling tile.
4. Battery: Sealed, maintenance-free, nickel-cadmium type with minimum seven-year nominal life.
5. Charger: Fully automatic, solid-state, constant-current type.
6. Lamp Ratings:

<u>Lamp Type</u>	<u>Minimum Lumen Output</u> <u>(two lamps)</u>
F28T8	1400
F54T5HO	1400

7. Universal transformer to operate at 120 volt or 277 volt.
8. Products, linear fluorescent:
 - a. Lithonia PS1400 (with quick disconnect).
 - b. Equal by Bodine, Dual Lite or Iota (with quick disconnect that matches the Lithonia PS1400). Do not bid if quick disconnect is not identical to the Lithonia PS1400.

2.8 EMERGENCY LOAD TRANSFER DEVICE

A. Manufacturers:

1. Nine-24, Inc.: BLTC Series.
2. Bodine GTD Series.
3. Dual Lite.

4. LVS.
5. Side-Lite.

- B. Description: Localized load transfer switch to sense normal presence of normal power for switched circuits and switch luminaire over to emergency source upon loss of normal source. Device shall be installed integral to luminaire or mounted remotely as application required.
- C. U.L. 924 Listed.
- D. Integral test switch and indicating lamps to indicate status.

2.9 FLUORESCENT LAMPS

- A. Low-Mercury Lamps: Comply with Federal toxic characteristic leaching procedure test, and yield less than 0.2 mg of mercury per liter, when tested according to NEMA LL 1.
- B. T5HO rapid start low-mercury lamps, rated 54 W maximum, nominal length of 45.2 inches 1148 mm, 4600 initial lumens (minimum), CRI greater than 80, color temperature 4100 K, and average rated life of 30,000 hours, unless otherwise indicated.
- C. **T8 rapid-start low-mercury lamps, rated 28 W maximum, 2650 initial lumens (minimum), CRI of 80 (minimum), color temperature of 4100 K, and average rated life of 80,000 hours at 3 hours operation per start, unless otherwise indicated.**
- D. T8 rapid-start low-mercury lamps, rated 17 W maximum, nominal length of 24 inches 610 mm, 1300 initial lumens (minimum), CRI of 80 (minimum), color temperature of 4100 K, and average rated life of 60,000 hours at 3 hours operation per start, unless otherwise indicated
- E. Fluorescent Lamp Manufacturers:
 1. Osram Sylvania.
 2. General Electric.
 3. Philips.

2.10 FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Electrical Supports" for channel- and angle-iron supports and nonmetallic channel and angle supports.

- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated, 12 gage.
- E. Wires For Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.
- F. Rod Hangers: 3/16-inch- minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.
- H. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.

2.11 FINISHES

- A. Fixtures: Manufacturers' standard, unless otherwise indicated.
 - 1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.
 - 2. Metallic Finish: Corrosion resistant.

2.12 FLUORESCENT FIXTURE RETROFIT MATERIALS

- A. Comply with UL 1598 listing requirements.
 - 1. Reflector Kit: UL 1598, Type I. Suitable for two- to four-lamp, surface-mounted or recessed lighting fixtures by improving reflectivity of fixture surfaces. No electrical parts are to be changed.
 - 2. Ballast and Lamp Change Kit: UL 1598, Type II. Suitable for changing existing ballast, lamps, and sockets as scheduled.

2.13 SOURCE QUALITY CONTROL

- A. Provide services of a qualified, independent testing and inspecting agency to factory test fixtures with ballasts and lamps; certify results for electrical ratings and photometric data.

- B. Factory test fixtures with ballasts and lamps; certify results for electrical ratings and photometric data.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturers instructions.
- B. Locate recessed ceiling luminaires as indicated on reflected ceiling plan.
- C. Fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- D. Support for Fixtures in or on Grid-Type Suspended Ceilings: Use grid for support.
 - 1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches from fixture corners.
 - 2. Support Clips: Fasten to fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
 - 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
- E. Support luminaires independent of ceiling framing. Support recessed grid luminaires from two opposite corners directly to structure. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
- F. Exposed Grid Ceilings: Support surface mounted luminaires on grid ceiling directly from building structure.
- G. Install recessed luminaires to permit removal from below.
- H. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.
- I. Suspended Fixture Support: As follows:
 - 1. Install suspended luminaires and exit signs using pendants supported from swivel hangers except where noted to use chain hangers. Provide pendant length required to suspend luminaire at indicated height.

2. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 3. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
 4. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
 5. Continuous Rows: Suspend from cable.
- J. Air-Handling Fixtures: Install with dampers closed and ready for adjustment.
- K. Adjust aimable fixtures to provide required light intensities.
- L. Install surface mounted luminaires and exit signs plumb and adjust to align with building lines and with each other. Secure to prohibit movement.
- M. Where fluorescent fixtures are shown with dual switches, connect all inner lamps to one switch and all outer lamps to the other switch. Dim the inner lamps where a dimmer switch is shown.
- N. Connect night light fixtures and emergency lighting fixtures to the hot (unswitched) side of lighting circuits.
- O. Provide green grounding conductors back to the panel ground for lighting circuits. Raceways shall not be used as grounding conductors.
- P. Fixtures shall have their exterior labels removed and shall be thoroughly cleaned. Non-functioning lamps shall be replaced.
- Q. Mount fluorescent emergency lighting battery packs in accordance with the manufacturer's instructions. Locate the remote test/monitor modules identically so that they are visible and they form a straight line when viewed from the end of the corridor or room. Where a suspended ceiling exists, center the modules in adjacent ceiling tiles.
- R. Mount sealed beam emergency lighting units where shown and aim their lamps to light the egress path as uniformly as possible.
- 3.2 CONNECTIONS
- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If

manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

- B. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
- C. Bond products and metal accessories to branch circuit equipment grounding conductor.
- D. Connect luminaires to branch circuit outlet boxes provided under Section 16130 using 1/2" flexible conduit.

3.3 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Examine each luminaire to determine suitability for lamps specified.
- C. Verify normal operation of each fixture after installation.
- D. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify normal transfer to battery power source and retransfer to normal.
- E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.
- F. Corroded Fixtures: During warranty period, replace fixtures that show any signs of corrosion.
- G. Check for variance in lamp color temperature throughout project.
- H. Spot check for lamp output level from start up through 10 minute duration and make rotation.
- I. All fluorescent and H.I.D. lamps shall be allowed to run a minimum of 100 hours, continuously, prior to punchlist or any dimming.
- J. A visual inspection shall be performed to verify cleanliness and alignment of the fixtures, misalignment and light leaks

shall be corrected, and rattles due to ventilation system vibration shall be eliminated.

3.4 ADJUSTING

- A. Aim and adjust luminaires as directed by the Architect/Engineer.
- B. Adjust exit sign directional arrows as indicated on Drawings.
- C. Relamp luminaires that have failed lamps at Substantial Completion.
- D. Adjust all "low end trim" settings of dimming switches prior to punchlist.
- E. Adjust and calibrate all dimming system controls until the system works as designed. Contact the Architect/Engineer when dimming is complete and demonstrate operation to owner's representative and Architect/Engineer.

3.5 CLEANING

- A. Clean electrical parts to remove conductive and deleterious materials.
- B. Remove dirt and debris from enclosures and lenses.
- C. Clean photometric control surfaces as recommended by manufacturer.
- D. Clean finishes and touch up damage.

END OF SECTION 16511

SECTION 16521 - EXTERIOR LIGHTING

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUMMARY.....1
1.3 DEFINITIONS.....2
1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION.....2
1.5 SUBMITTALS.....2
1.6 QUALITY ASSURANCE.....4
1.7 DELIVERY, STORAGE, AND HANDLING.....4
1.8 WARRANTY.....5

PART 2 - PRODUCTS.....5
2.1 MANUFACTURERS.....5
2.2 LUMINAIRES, GENERAL REQUIREMENTS.....6
2.3 FLUORESCENT BALLASTS AND LAMPS.....8
2.4 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS.....8
2.5 ALUMINUM POLES.....9
2.6 POLE ACCESSORIES.....10

PART 3 - EXECUTION.....11
3.1 LUMINAIRE INSTALLATION.....11
3.2 POLE INSTALLATION.....11
3.3 BOLLARD LUMINAIRE INSTALLATION.....12
3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES...13
3.5 CORROSION PREVENTION.....13
3.6 GROUNDING.....13
3.7 FIELD QUALITY CONTROL.....13
3.8 DEMONSTRATION.....14

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Exterior luminaires with lamps and ballasts.
 - 2. Luminaire-mounted photoelectric relays.
 - 3. Poles and accessories.
 - 4. Luminaire lowering devices.

- B. Related Sections include the following:
 - 1. Division 26 Section "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.3 DEFINITIONS

- A. CRI: Color-rendering index.
- B. HID: High-intensity discharge.
- C. Luminaire: Complete lighting fixture, including ballast housing if provided.
- D. Pole: Luminaire support structure, including tower used for large area illumination.
- E. Standard: Same definition as "Pole" above.

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

- A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4.
- B. Live Load: Single load of 500 lbf, distributed as stated in AASHTO LTS-4.
- C. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-4.
- D. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-4.
 - 1. Wind speed for calculating wind load for poles exceeding 50 feet in height is 70 mph
 - 2. Wind speed for calculating wind load for poles 50 feet or less in height is 70 mph.

1.5 SUBMITTALS

- A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.

2. Details of attaching luminaires and accessories.
 3. Details of installation and construction.
 4. Luminaire materials.
 5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
 - a. For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
 - b. Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 6. Photoelectric relays.
 7. Ballasts, including energy-efficiency data.
 8. Lamps, including life, output, and energy-efficiency data.
 9. Materials, dimensions, and finishes of poles.
 10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
 11. Anchor bolts for poles.
 12. Manufactured pole foundations.
- B. Shop Drawings:
1. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
 2. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
 3. Wiring Diagrams: Power and control wiring.
- C. Samples for Verification: For products designated for sample submission in Exterior Lighting Device Schedule. Each sample shall include lamps and ballasts.
- D. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4 and that load imposed by luminaire has been included in design.
- E. Qualification Data: For agencies providing photometric

data for lighting fixtures.

- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For luminaires and poles luminaire lowering devices to include in emergency, operation, and maintenance manuals.
- H. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with IEEE C2, "National Electrical Safety Code."
- E. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Package aluminum poles for shipping according to ASTM B 660.
- B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- C. Handle wood poles so they will not be damaged. Do not use pointed tools that can indent pole surface more than 1/4 inch deep. Do not apply tools to section of pole to be installed below ground line.

- D. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation. Handle poles with web fabric straps.
- E. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Warranty shall include parts and labor.
 - 1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
 - 2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
 - 3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
 - 4. Warranty Period for Lamps: Replace lamps and fuses that fail within 5 years from date of Substantial Completion.
 - 5. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - 2. Basis of Design Product: The design of each item of exterior luminaire and its support is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.2 LUMINAIRES, GENERAL REQUIREMENTS

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
- B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- G. Exposed Hardware Material: Stainless steel.
- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- J. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
- K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

- L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- M. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: As selected from manufacturer's standard catalog of colors.
 - b. Color: Match Architect's sample of custom color.
 - c. Color: As selected by Architect from manufacturer's full range.
- N. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
 3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
 4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically

deposited color coating 0.018 mm or thicker) complying with AAMA 611.

a. Color: as specified on fixture schedule.

2.3 FLUORESCENT BALLASTS AND LAMPS

- A. Low-Temperature Ballast Capability: Rated by its manufacturer for reliable starting and operation of indicated lamp(s) at temperatures minus 20 deg F and higher.
- B. Ballast Characteristics:
1. Power Factor: 90 percent, minimum.
 2. Sound Rating: A.
 3. Total Harmonic Distortion Rating: Less than 10 percent.
 4. Electromagnetic Ballasts: Comply with ANSI C82.1, energy-saving, high power factor, Class P, automatic-reset thermal protection.
 5. Case Temperature for Compact Lamp Ballasts: 65 deg C, maximum.
 6. Transient-Voltage Protection: Comply with IEEE C62.41 Category A or better.
- C. Low-Temperature Lamp Capability: Rated for reliable starting and operation with ballast provided at temperatures minus 20 deg and higher.
- D. Fluorescent Lamps: Low-mercury type. Comply with the EPA's toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.

2.4 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

- A. Structural Characteristics: Comply with AASHTO LTS-4.
1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
 2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
- B. Luminaire Attachment Provisions: Comply with luminaire

manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.

- C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
 - 1. Materials: Shall not cause galvanic action at contact points.
 - 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
 - 3. Anchor-Bolt Template: Plywood or steel.
- D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete."
- E. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.

2.5 ALUMINUM POLES

- A. Poles: Seamless, extruded structural tube complying with ASTM B 429, Alloy 6063-T6 with access handhole in pole wall.
- B. Poles: ASTM B 209, 5052-H34 marine sheet alloy with access handhole in pole wall.
 - 1. Shape: Square, straight.
 - 2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- D. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

- E. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
 - 1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
 - 2. Finish: Same as pole.

- F. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

- G. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 - 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
 - 3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
 - 4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
 - a. Color: Dark bronze.

2.6 POLE ACCESSORIES

- A. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

- B. Vibration Dampener: For all steel lighting poles taller than 15', provide factory or field installed vibration dampening device to eliminate second mode or higher resonance that can occur with low velocity steady state winds. Vibration dampeners shall be installed inside of the poles. Dampening method shall be steel chain encased in a plastic tube approximately 2/3 the length of the pole.

Coordinate all requirements with pole manufacturer.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

- A. Install exterior lighting system per N.E.C.A./I.E.S.N.A. 501-2006.
- B. Install lamps in each luminaire.
- C. Fasten luminaire to indicated structural supports.
 - 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- D. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources.

3.2 POLE INSTALLATION

- A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
- B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:
 - 1. Fire Hydrants and Storm Drainage Piping: 60 inches.
 - 2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet.
 - 3. Trees: 15 feet.
- C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 3 Section "Cast-in-Place Concrete."
- D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
 - 1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
 - 2. Grout void between pole base and foundation. Use

nonshrink or expanding concrete grout firmly packed to fill space.

3. Install base covers, unless otherwise indicated.
 4. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
- E. Embedded Poles with Tamped Earth Backfill: Set poles to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
1. Dig holes large enough to permit use of tampers in the full depth of hole.
 2. Backfill in 6-inch layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.
- F. Embedded Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
1. Make holes 6 inches in diameter larger than pole diameter.
 2. Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi at 28 days, and finish in a dome above finished grade.
 3. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through concrete dome. Arrange to drain condensation from interior of pole.
 4. Cure concrete a minimum of 72 hours before performing work on pole.
- G. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch below top of concrete slab.
- H. Raise and set poles using web fabric slings (not chain or cable).

3.3 BOLLARD LUMINAIRE INSTALLATION

- A. Align units for optimum directional alignment of light distribution.
- B. Install on concrete base with top 4 inches above finished grade or surface at bollard location. Cast conduit into

base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 3 Section "Cast-in-Place Concrete."

3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

- A. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 3 Section "Cast-in-Place Concrete."

3.5 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Division 16 Section "Raceways and Boxes." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.6 GROUNDING

- A. Ground metal poles and support structures according to Division 16 Section "Grounding and Bonding."
 - 1. Install grounding electrode for each pole, unless otherwise indicated.
 - 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
- B. Ground nonmetallic poles and support structures according to Division 16 Section "Grounding and Bonding."
 - 1. Install grounding electrode for each pole.
 - 2. Install grounding conductor and conductor protector.
 - 3. Ground metallic components of pole accessories and foundations.

3.7 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing

circuits with normal power source.

1. Verify operation of photoelectric controls.

C. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):

- a. IESNA LM-5, "Photometric Measurements of Area and Sports Lighting."
- b. IESNA LM-50, "Photometric Measurements of Roadway Lighting Installations."
- c. IESNA LM-52, "Photometric Measurements of Roadway Sign Installations."
- d. IESNA LM-64, "Photometric Measurements of Parking Areas."
- e. IESNA LM-72, "Directional Positioning of Photometric Data."

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaire lowering devices. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 16521

SECTION 16721 - FIRE ALARM

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SECTION INCLUDES.....2
1.3 REFERENCES.....2
1.4 REGULATORY REQUIREMENTS.....2
1.5 SUMMARY.....3
1.6 SYSTEM DESCRIPTION.....3
1.7 SYSTEM FUNCTIONS.....4
1.8 SUBMITTALS.....7
1.9 PROJECT RECORD DOCUMENTS.....8
1.10 OPERATION, MAINTENANCE DATA, AND CALCULATIONS8
1.11 DELIVERY, STORAGE, AND HANDLING8
1.12 EXTRA MATERIALS9

PART 2 - PRODUCTS.....9
2.1 MANUFACTURERS.....9
2.2 FIRE ALARM CONTROL PANEL (FACP).....9
2.3 REMOTE FIRE ALARM ANNUNCIATOR PANEL.....11
2.4 EMERGENCY POWER SUPPLY.....11
2.5 SMOKE DETECTORS, INTELLIGENT ADDRESSABLE.....11
2.6 THERMAL DETECTOR, INTELLIGENT ADDRESSABLE.....12
2.7 DUCT SMOKE DETECTORS.....12
2.8 DUCT SMOKE DETECTOR REMOTE ALARM INDICATORS.....13
2.9 MANUAL STATIONS, INTELLIGENT.....13
2.10 ADDRESSABLE INTERFACE MODULE13
2.11 ADDRESSABLE CONTROL MODULE14
2.12 AUDIO VISUAL DEVICES14
2.13 AUXILIARY DEVICES15
2.14 WIRE AND CABLE15

PART 3 - EXECUTION.....16
3.1 WARRANTY.....16
3.2 TESTS AND REPORTS.....16
3.3 INSTALLATION.....17

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

- B. Related Sections include the following:
 - 1. Division 16 Section "Electrical General Requirements."

1.2 SECTION INCLUDES

- A. Fire alarm and smoke detection systems. This section intends to describe a Protected Premises Fire Alarm System. The control panel shall be intelligent device addressable, analog detecting, low voltage and modular with multiplex communication techniques, in full compliance with all applicable codes and guidelines. The features and system capacities contained in this specification shall be furnished as part of this project.
- B. The system as described shall be installed, tested, and delivered to the Owner in first class condition. The system shall include all the required hardware and software to accomplish the requirements of this specification and the contract documents, whether or not specifically itemized herein.
- C. All equipment furnished shall be new and include the latest state of the art products from a single manufacturer, engaged in the manufacturing and sale of fire detection devices for over ten years. The equipment manufacturer shall have an installed base of existing systems as a reference.

1.3 REFERENCES

- A. NFPA 72 - National Fire Alarm Code.
- B. NFPA 101 - Life Safety Code.
- C. U.L. 1971 - Standard for Safety Signaling Devices for the Hearing Impaired.

1.4 REGULATORY REQUIREMENTS

- A. System: UL (FPED) and FM listed.
- B. Conform to requirements of NFPA 101.
- C. A.D.A. Federal guidelines.
- D. Conform to State of Michigan Fire Code.

E. Conform to International Building Code.

1.5 SUMMARY

A. The Fire Alarm System shall consist of all necessary hardware equipment and software programming to perform the following functions:

1. Fire Alarm and Detection Operations.
2. Remote Monitoring of Sprinkler Systems.
3. Remote Manual and Automatic Control of all Door Hold-open Devices, and other auxiliary functions indicated on the drawings.

1.6 SYSTEM DESCRIPTION

A. General: Complete, zoned, noncoded, addressable, microprocessor-based fire detection and alarm system with manual and automatic alarm initiation, addressable analog initiating devices, and automatic alert.

B. The fire alarm system shall allow for loading and editing special instructions and operating sequences as required. The system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation. All software operations shall be stored in a non-volatile programmable memory within the fire alarm control panel (FACP).

C. Resident software shall allow for full configuration of initiating circuits so that additional hardware shall not be necessary to accommodate future changes.

D. Resident software shall allow for configuration of notification appliance and control circuits so that additional hardware shall not be necessary to accommodate changes.

E. The system shall have the capability of recalling alarms and trouble conditions in chronological order for the purpose of recreating an event history.

F. Signal Transmission: Notification appliance circuits shall be NFPA Style Y, Class B. Signaling line circuits shall be NFPA Style 4, Class B.

- G. Data Communication Transmission Between Control Units: Style 7, Class A.

1.7 SYSTEM FUNCTIONS

- A. Signal Initiation: The manual or automatic operation of an alarm-Initiating or supervisory-operating device shall cause the FACP to transmit an appropriate signal including:
1. General alarm.
 2. System trouble.
 3. Valve tamper supervisory.
 4. Door release.
 5. Fan shutdown.
 6. Release electrically held door locks.
 7. A general alarm shall be initiated by:
 8. Water-flow alarm switch operation.
 9. Smoke detection. Alarm verification is required for all smoke detector zones.
 10. Manual station operation.
 11. Heat detector operation.
- B. General Alarm: A system general alarm shall:
1. Indicate the general alarm condition at the FACP.
 2. Identify the device that is the source of the alarm at the FACP.
 3. Display the alarm on an 80 character LCD display. The system alarm LED shall flash on the control panel until the alarm has been acknowledged. Once acknowledged, this same LED shall latch on. A subsequent alarm received from another zone shall flash the system alarm LED on the control unit. The display shall show the new alarm information.
 4. Sound a pulsing alarm tone within the FACP until the event has been acknowledged.
 5. Operate audible and visible alarm notification signals throughout the building.
 6. Sound a continuous fire alarm signal until silenced by the alarm silence switch at the FACP.
 7. Flash all visible alarm notification appliances continuously until the System Reset Switch is operated. Any subsequent zone alarm shall reactivate the alarm notification appliances.
 8. Close fire and smoke doors normally held open by magnetic door holders.

9. Stop supply and return fans serving zone where alarm is initiated.
 10. Close smoke dampers on system serving zone where alarm is initiated.
 11. Transmit the alarm to the proprietary supervising station.
- C. A supervisory alarm shall be initiated by:
1. Sprinkler valve tamper switch operation.
- D. Loss of primary power at the FACP shall sound a trouble signal at the FACP and shall indicate at the FACP when the system is operating on an alternate power supply.
- E. Circuit Supervision: Circuit faults shall be indicated by means of both a zone and a trouble signal at the FACP.
- F. Annunciation: Manual and automatic operation of alarm and supervisory initiating devices shall be annunciated on the FACP, indicating the location and type of device.
- G. FACP Alphanumeric Display: Shall display plain-language description of alarms, trouble signals, supervisory signals, monitoring actions, system and component status, and system commands.
- H. Independent System Monitoring: Supervise each independent smoke detector, fire suppression system and duct detector, for both normal operation and trouble.
- I. Alarm Silencing: If the "Alarm Silence" button is pressed, all audio alarm signals shall cease operation.
- J. System Reset: The "System Reset" button shall be used to return the system to its normal state after an alarm condition has been remedied.
- K. Activation of an auxiliary bypass switch shall override the selected automatic functions.
- L. Auxiliary manual controls shall be supervised so that an "off normal" position of any switch shall cause an "off normal" system trouble. The "off normal" status shall be clearly identified in plain-language on the FACP.
- M. Recording of Events: Record all alarm, supervisory, and trouble events in non-volatile memory.

N. Smoke Sensor Sensitivity Adjustment:

1. Authorized operation of controls at the FACP shall cause the selection of specific addressable smoke sensors for adjustment, display of their current status and sensitivity settings, and control of changes in those settings.
2. Remote Controllability: Individually monitor sensors at the FACP for calibration, sensitivity, and alarm condition, and individually adjust for sensitivity from the FACP. The alarm decision for each sensor shall be determined by the control unit. The control unit shall determine the condition of each sensor by comparing the sensor value to the stored values.

O. The actuation of the "enable one person test" program at the FACP shall activate the "One Person Testing" mode of the system which shall cause the following to occur:

1. The city circuit connection shall be bypassed.
2. Control relay functions shall be bypassed.
3. The FACP shall show a trouble condition.
4. The alarm activation of any initiation device shall cause the audible notification appliances to code a number of pulses to match the zone number.
5. The FACP shall automatically reset after signaling is complete.
6. Any momentary opening of an initiating or notification appliance circuit wiring shall cause the audible signals to sound for 4 seconds indicating the trouble condition.
7. The system shall have the capacity of 8 programmable, passcode protected, one person testing groups, such that only a portion of the system need be disabled during testing.

P. Power Requirements

1. The FACP shall receive 120 VAC power via a dedicated 20A branch circuit breaker provided with a red lock-on device.
2. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 120 VAC power in a normal supervisory mode for a period of 24 hours with 15 minutes of alarm operation at the end of this period. The system shall automatically transfer to battery standby upon power failure. All battery charging and recharging operations shall be automatic.
3. All circuits requiring system operating power shall be 24 VDC and shall be individually fused at the control panel.

4. The incoming power to the system shall be supervised so that any power failure must be audibly and visibly indicated at the control panel. A green "power on" LED shall be displayed continuously while incoming power is present.
 5. The system batteries shall be supervised so that a low battery condition or disconnection of the battery shall be audibly and visibly indicated at the FACP and the command center.
- Q. The system shall support 100% of addressable devices in alarm or operated at the same time, under both primary (AC) and secondary (battery) power conditions.

1.8 SUBMITTALS

- A. Bidders will be required to submit shop drawings and product data during the construction phase of each project. Provide the following submittals for review:
1. Complete description data indicating UL listing for all network components. Include dimensioned plans and elevations showing minimum clearances and installed features and devices.
 2. Complete sequence of operation of all functions of the network that is project specific.
 3. A list of every address of every device connected to a panel that is provided for purposes of alarm initiating, status monitoring, supervised notification appliance circuits, and auxiliary control.
 4. A listing of the manufacturer's representatives responsible for installation coordination and service.
 5. Location of all controls, alarm actuating devices and notification appliance devices as shown on drawings.
 6. Wiring diagrams from manufacturer differentiating between factory-and field- installed wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Indicate components for both field and factory wiring. Provide complete diagrams for all components and interfaces including equipment supplied by others.
 7. Operation and maintenance data for inclusion in Operating and Maintenance Manual specified in Division 1. Include data for each type product, including all features and operating sequences, both automatic and manual. Include recommendations for spare parts to be stocked at the

site. Provide the names, addresses, and telephone numbers of service organizations that carry stock of repair parts for the system to be furnished.

8. The manufacturer shall provide calculations for battery size as applicable. Battery size shall be a minimum 125% of the calculated requirement.
9. Provide calculations for control modules indicating circuit loading with 20% spare capacity.

- B. Submission to Authority Having Jurisdiction: In addition to routine submission of the above material, make an identical submission to the authority having jurisdiction. Include copies of annotated Contract Drawings as required to depict component locations to facilitate review. Upon receipt of comments from the Authority, submit them for review. Make resubmissions if required to make clarifications or revisions to obtain approval.

1.9 PROJECT RECORD DOCUMENTS

- A. Submit as built drawings locating devices and conductor runs.
- B. Record of field tests of system.
- C. Submit manufacturer's certificate that system meets or exceeds specified requirements.

1.10 OPERATION, MAINTENANCE DATA, AND CALCULATIONS

- A. Provide to the Owner's representative operating instructions, maintenance, and repair procedures.
- B. After installation, include manufacturer representative's letter stating that system is operational.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Delivery, storage and handling of products will take place under the contract terms of each project in the construction phase of each project.

1.12 EXTRA MATERIALS

- A. Provide spare parts to the Owner's representative as noted below:
 - 1. Two keys of each type (for each project).
 - 2. Two smoke detectors (for each project).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. National Time & Signal (Provide a new 902 FACP at Hillside and Woodcreek). Include all costs in bid.
- B. Siemens Fire Alarm (Expand the existing Cerberus FACP at Longacre as indicated/required). Include all costs in bid.
- C. Hillside and Woodcreek both have existing National Time & Signal 7000 FACP's. The 7000 panels at Hillside and Woodcreek shall be turned over to the Owner at the end of the project.

2.2 FIRE ALARM CONTROL PANEL (FACP).

- A. General: Comply with UL 864, "Control Units for Fire-Protective Signaling Systems."
- B. Cabinet: Lockable steel enclosure. Arrange unit so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control unit, provide exactly matching modular unit enclosures. Accommodate all components and allow ample gutter space for interconnection of units as well as field wiring. Identify each enclosure by an engraved, red-laminated, phenolic resin nameplate. Lettering on the enclosure nameplate shall not be less than 1-inch high.
- C. Systems: Alarm and supervisory systems are separate and independent in the FACP. The alarm-initiating zone boards in the FACP consist of plug-in modules. Construction requiring removal of field wiring for module replacement is not acceptable.

- D. Control Modules: Types and capacities required to perform all functions of the fire alarm systems plus 20% for future expansion. Local visible, and audible signals notify of alarm, supervisory, and trouble conditions
- E. Zones: Provide for all alarm and supervisory zones indicated.
- F. Resetting: Provide the necessary controls to prevent the resetting of any alarm, supervisory, or trouble signal while the alarm or trouble condition still exists.
- G. Alphanumeric Display and System Controls: Arrange to provide the basic interface between human operator at FACP and addressable system components, including annunciation, supervision, and control. A display with a minimum of 80 characters displays alarm, supervisory, and component status messages and indicates control commands to be entered into the system for control of smoke detector sensitivity and other parameters. Arrange keypad for use in entering and executing control commands.
- H. System power supplies including necessary transformers, regulators, filters and surge protection required for system operation.
- I. System processor, with internal operating system to process incoming alarm signals and issue output commands required as a result of the alarm signals and issue output. Total system response time shall not exceed 2.5 seconds on a system configured to the 3000 point capacity. All system processors shall be supervised by individual watchdog circuitry furnishing automatic restart after loss of activity. Systems with single watchdog circuits for all processors will not be accepted unless furnished with a standby CPU.
- J. A limited energy output circuit for operation of direct current (DC) audible or visual devices, leased line or city tie, shall be provided by a controllable signal module.
- K. Where control of operations requiring switching functions is indicated, there shall be provided a software controlled relay module.
 - 1. Motherboards shall be furnished as the system bus furnishing systems communications to the various plug in modules necessary for system operations.

- L. Remote Station Signal Transmitter: Electrically supervised, capable of monitoring alarm and trouble signals from the fire alarm system over a communication means to remote central station receiver (Security Corporation). The electrical contractor/National Time & Signal (Siemens Fire Alarm at Longacre) shall coordinate all requirements with Jeff Brandt at Security Corporation: 248-374-5792. Note: Both National Time & Signal and Security Corporation shall be sub-contracted by the electrical contractor. Include all costs in bid.

2.3 REMOTE FIRE ALARM ANNUNCIATOR PANEL

- A. Provide remote annunciation and control using an 80 character, back-lit, alphanumeric, LCD readout. Alarm indication shall be identical to that at the main FACP including tone alert. Provide a minimum of four programmable control switches, alarm silence and system reset.
- B. Provide brushed aluminum trim plate.

2.4 EMERGENCY POWER SUPPLY

- A. General: Components include battery, charger, and an automatic transfer switch.
- B. Battery: Sealed lead-acid or nickel cadmium type. Provide sufficient capacity to operate the complete alarm system in normal or supervisory (non-alarm) mode for a period of 24 hours. Following this period of operation on battery power, the battery shall have sufficient capacity to operate all components of the system, including all alarm indicating devices in alarm of supervisory mode for a period of 15 minutes.
- C. Magnetic door holders are not served by emergency battery power. Magnetic door holders are released after 15 seconds when normal power fails.

2.5 SMOKE DETECTORS, INTELLIGENT ADDRESSABLE

- A. Furnish and install where indicated on the drawings intelligent analog smoke detectors with features and characteristics as follows:

1. Photoelectric detectors shall be listed for use as open area protective coverage, in duct installation and shall be insensitive to air velocity changes.
 - a. The control panel shall provide a sensitivity readout for all detectors without removal from the pluggable base. Detectors not listed for sensitivity testing and logging from the control panel are not acceptable.
 - b. Detectors shall be operational with relay bases (as applicable), audible bases, and remote indicating LED's, programmable by the control panel and controlled by the detector electronics.
 - B. Provide smoke detectors above fire alarm control panel, remote annunciator panels, and remote notification appliance power supply panels.
 - C. Provide smoke detectors with auxiliary set of contacts where required.
- 2.6 THERMAL DETECTOR, INTELLIGENT ADDRESSABLE
- A. The intelligent thermal detectors shall be of the rate compensated fixed temperature type and shall be listed by Underwriters Laboratories, Inc. The intelligent thermal detectors shall be individually annunciated on the control panel. The intelligent thermal detectors shall contain an integral alarm lamp.
- 2.7 DUCT SMOKE DETECTORS
- A. The air duct detector shall be listed by Underwriters Laboratories, Inc. The air duct detector shall operate on a cross-sectional air sampling principle to overcome stratification and the skin effect. The air duct detector shall consist of a standard (intelligent/analog) photoelectric detector mounted in an air duct sampling assembly and sampling tube that protrudes across the duct of the ventilating system. The air duct detector shall retain the features of the intelligent/analog photoelectric detector, and be installed in the ventilating duct as indicated in the manufacturer's instructions. Provide with addressable control module. Relay based duct detectors not acceptable.

- B. The duct mounted detector shall have an auxiliary set of contacts in order for the temperature controls contractor to tie in the starter of the fans. Contacts shall be rated 1A, 120V.

2.8 DUCT SMOKE DETECTOR REMOTE ALARM INDICATORS

- A. Provide remote alarm indicator station for duct smoke detectors located above ceilings or in other locations above 10 feet and/or not readily accessible.
- B. Provide LED alarm indicator designed for mounting in a single gang coverplate.

2.9 MANUAL STATIONS, INTELLIGENT

- A. Provide single action intelligent manual stations where shown on the drawings, to be flush or surface mounted as required.
 - 1. The manual stations shall be addressable and identifiable by the fire alarm control panel.
 - a. Address assignments shall be set mechanically or electronically and reside within the station in non volatile memory.

2.10 ADDRESSABLE INTERFACE MODULE

- A. Provide for integration of compatible two wire and shorting style contact devices into the analog signaling circuit. Intelligent analog signaling circuit interface module shall have the following capabilities:
 - 1. Communication interaction with the analog signaling circuit having the capability of reporting alarm or trouble conditions from the devices monitored.
 - 2. Compatibility with ionization, photoelectric, and linear beam style smoke detectors, heat detectors, and all listed contact type devices.
 - 3. The module shall be addressable and identifiable by the control panel.
 - a. Address assignments shall be set mechanically or electronically and reside within the module in non volatile memory.
 - 4. Water Flow Switches: The water flow switches shall be provided by the mechanical contractor and wired by the electrical contractor. The switches shall be connected to

the fire alarm system through the use of addressable interface modules.

5. Tamper Switches: The tamper switches shall be provided by the mechanical contractor and wired by the electrical contractor. The switches shall be connected to the fire alarm system through the use of addressable interface modules.
6. Provide addressable interface modules to uniquely identify each flow and tamper switch.

2.11 ADDRESSABLE CONTROL MODULE

- A. Provide for integration of auxiliary control functions into the analog signaling circuit. Intelligent analog signaling circuit control module shall have the following capabilities:
 1. Communication interaction with the analog signaling circuit having the capability of initiating a control function to an auxiliary device based on a specified event.
 2. Provide NO/NC contact pairs rated at 2 amps 120 VAC or 24 VDC.

2.12 AUDIO VISUAL DEVICES

- A. Alarm Strobes (Visual): Visual alarm signals shall be furnished with minimum light intensity of 15cd average (horizontal and vertical distribution listed in accordance with UL 1971) and meet A.D.A. 75cd minimum intensity at horizontal and vertical axis and shall comply with the following:
 1. Xenon strobe with minimum repetition rate of 1 HZ, not exceeding 2 HZ and a maximum duty cycle of 40% with a pulse duration of .2 seconds.
 2. Unfiltered or clear white light not exceeding 1000 candela.
 3. Visual signals shall be mounted at 96 inches above finish floor level, or six inches below ceiling level whichever is lower in accordance with NFPA 72, 1996. Provide wall mounted or ceiling mounted devices, as indicated on plans.
 4. Visual signals shall flash in synchronization in all corridors and in rooms where more than one strobe is installed.

- B. Alarm Horns: The alarm horns shall be of the polarized 24 VDC type. The mechanisms shall contain an aerospace grade aluminum diaphragm, tempered and polished armature, and tungsten contact point, all housed in a red die-cast frame and grill assembly. Horns shall have an integral strobe light that will flash during an alarm. Horns shall have a minimum sound level of 93 dB at 10 feet.
- C. Combination notification appliances (horn/strobe) consist of factory-combined, audible and visual notification units in a single mounting assembly. Provide wall mounted or ceiling mounted devices, as indicated on plans.
- D. Audible devices shall be furnished to provide minimum of 15 db above ambient sound levels. Maximum sound levels shall not exceed 120 db, provisions shall be made to adjust the audible levels accordingly.

2.13 AUXILIARY DEVICES

- A. Door Release: Magnetic door holder with integral diodes to reduce buzzing, 24 VDC coil voltage.

2.14 WIRE AND CABLE

- A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with NFPA 70, Article 760.
- B. Signaling Line Circuits: Twisted, shielded pair, size as recommended by system manufacturer.
 - 1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70 Article 760, Classification CI, for power-limited fire alarm signal service. UL listed as Type FPL, and complying with requirements in UL 1424 and in UL 2196 for a 2-hour rating.
- C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
 - 1. Low-Voltage Circuits: No. 16 AWG, minimum.
 - 2. Line-Voltage Circuits: No. 12 AWG, minimum

PART 3 - EXECUTION

3.1 WARRANTY

- A. All equipment and systems shall be warranted by the contractor for a period of two years following acceptance. The warranty shall include parts, labor, prompt field service, pick-up and delivery.
- B. Provide two years testing and maintenance, which shall consist of:
 - 1. Regularly and systematically examining all detectors, manual stations, panels, relays, pressure switches and accessories pertaining to the system.
 - 2. Regularly and systematically examine, adjust and clear all the electrical and mechanical components of water flow switches.
 - 3. Tests and written reports which certify that all initiating devices have been tested and which indicate the result of the inspection test as required by the authority having jurisdiction.

3.2 TESTS AND REPORTS

- A. The contractor shall perform all electrical and mechanical tests required by the equipment manufacturer's certification form. In addition, they shall measure and adjust each of the ionization detectors to the maximum stable sensitivity setting. This must be performed with the detector at its operational location and under normal operational environmental conditions in the area. Bench settings are not acceptable. All test and report costs shall be in the unit price established for each device. A checkout report shall be prepared by the installation technicians and submitted in triplicate, one copy of which will be registered with the equipment manufacturer. The report shall include, but not be limited to:
 - 1. A complete list of equipment installed and wired.
 - 2. Indication that all equipment is properly installed and functions and conforms with these specifications.
 - 3. Test of individual zones as applicable.
 - 4. Serial numbers, locations by zone and model number for each installed detector.

5. Voltage (sensitivity) settings for each ionization and photoelectric detector as measured in place with the HVAC system operating.
 6. Response time on thermostats and flame detectors (if used).
 7. Technician's name, certificate number and date.
- B. After completion of all the tests and adjustments listed above, the contractor shall submit the following information to the Architect:
1. "As-built" conduit layout diagrams including wire color code and/or tag number.
 2. Complete "as-built" wiring diagrams.
 3. Detailed catalog data on all installed system components.
 4. Copy of the test report.
- C. Final tests and inspection shall be held in the presence of engineer. The contractor shall supply personnel and required auxiliary equipment for this test without additional cost.
- D. The completed smoke detection system shall be tested to insure that it is operating properly. Acceptance of the system shall also require a demonstration of the stability of the system. This shall be adequately demonstrated if the system operates for a ninety (90) day test period.
- E. Before final acceptance of work, the contractor shall deliver five copies of a composite "Operating and Shop Maintenance Manual." Each manual shall contain, but not be limited to: a statement of guarantee including date of termination and name and phone number of the person to be called in the event of equipment failure.
- F. Individual factory issued manuals shall contain all technical information on each piece of equipment installed. In the event such manuals are not obtainable from the factory, it shall be the responsibility of the contractor to compile and include them. Advertising brochures or operational instructions shall not be used in lieu of the required technical manuals.
- 3.3 INSTALLATION
- A. Control and other panels shall be mounted with sufficient clearance for observation and testing.

- B. All fire alarm junction boxes must be clearly marked for easy identification as indicated in 16195. All wiring shall be in conduit unless noted otherwise on the contract documents or in the specifications. Flexible connectors shall be used for all devices mounted in suspended lay-in ceiling panels. All conduit, mounting boxes, junction boxes and panels shall be securely hung and fastened with appropriate fittings to insure positive grounding throughout the entire system.
- C. Fire alarm pull stations and horns installed in finished areas shall be mounted semi-flush and may be surface mounted in non-finished areas. Smoke detectors and thermal detectors shall be mounted on a recess mounted junction box in finished areas and to surface mounted junction boxes in non-finished areas.
- D. No wiring other than that directly associated with fire alarm detection, alarm or auxiliary fire protection functions shall be permitted in fire alarm conduits. Wiring splices are to be avoided to the extent possible, and if needed they must be made only in junction boxes and shall be crimp connected. Transposing or changing color coding of wires shall not be permitted. Wire nut-type connections are not acceptable. All conductors in conduit containing more than one wire shall be labeled on each end with "E-Z markers" or equivalent. Conductors in cabinets shall be carefully formed and harnessed so that each drops off directly opposite to its terminal. Cabinet terminals shall be numbered and coded. All controls, function switches, etc., shall be clearly labeled on all equipment panels. All wiring shall be checked and tested to insure that there are no grounds, opens or shorts.
- E. Install manual station flush mounted with operating handle 48 inches maximum above floor. Install audible and visual signal devices no more than 96 inches above highest floor level within the space or 6 inches below the ceiling, whichever is lower.
- F. Mount outlet box for electric door holder to withstand 80 pounds pulling force.
- G. Make conduit and wiring connections to door release devices, sprinkler flow switches, sprinkler valve tamper switches, panels, duct smoke detectors, and other auxiliary supervised devices.
- H. Automatic Detector Installation: NFPA 72.

- I. All gymnasiums and locker rooms fire alarm devices shall be provided with protective wire guards.
- J. Fire alarm system cable shall be plenum rated, with red outer coloring. All cable drops to devices shall be in conduit (concealed in walls). Cabling installed in open ceiling spaces shall be type FPLP, low smoke, fire resistant, with red coloring. Cabling shall be per manufacturer's recommendation, and shall be able to power the strobes and horn/strobes together, or independently.
- K. Install fire alarm cable in ceiling spaces to avoid damage. Use bridle rings and other similar means of support (lay-in ceiling areas).
- L. Cabling to the Fire Alarm Control Panel and drops to devices shall be in recessed conduit.
- M. Fire alarm cabling in exposed ceiling spaces and above drywall ceiling areas shall be in conduit. Conduit used for fire alarm system shall have couplings and junction boxes painted red.

END OF SECTION 16721

SECTION 16726 - SCHOOL INTERCOM AND PROGRAM EQUIPMENT

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUMMARY.....1
1.3 SUBMITTALS.....2
1.4 QUALITY ASSURANCE.....2
1.5 COORDINATION.....3

PART 2 - PRODUCTS.....3
2.1 MANUFACTURERS.....3
2.2 SUPPLIER AND SYSTEM INTEGRATOR:.....3
2.3 PUBLIC ADDRESS SYSTEM CONSOLE/EQUIPMENT.....4
2.4 FUNCTIONAL DESCRIPTION OF INTERCOM SYSTEM.....10
2.5 EQUIPMENT AND MATERIALS.....11
2.6 MASTER CONTROL STATION.....11
2.7 PAGING AMPLIFIERS.....11
2.8 P.A. CALL STATION.....12
2.9 CEILING AND WALL MOUNTED SPEAKERS.....12
2.10 CONDUCTORS AND CABLES13

PART 3 - EXECUTION.....13
3.1 INSTALLATION.....13
3.2 GROUNDING.....14
3.3 SYSTEM PROGRAMMING.....15
3.4 FIELD QUALITY CONTROL.....15
3.5 STARTUP SERVICE.....16
3.6 ADJUSTING.....16
3.7 DEMONSTRATION.....17
3.8 WARRANTY.....17

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. General Scope

- 1. **REPLACE** the existing public address system, including new speakers and cable. **PROVIDE ALL NEW** cable as required for a complete operating system.
- 2. Provide complete and fully functional systems with devices and components as required and as indicated.

System as shown and as specified represents design intent and is not reflective of installed quantities and miscellaneous components, except as minimums.

1.3 SUBMITTALS

- A. Product Data: For the following:
 - 1. Wall and ceiling mounted speaker assemblies.
 - 2. Outdoor speakers.
 - 3. Public address/intercom system.
 - 4. Controls, amplifiers, and terminal equipment.
 - 5. Power supplies.
 - 6. Wiring.
- B. Shop Drawings:
 - 1. Equipment Details: Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location of each field connection.
 - 2. Station-Arrangement Details: Scaled drawings for built-in equipment.
 - 3. Wiring Diagrams: Power, signal, and control wiring. Include the following:
 - a. Identify terminals to facilitate installation, operation, and maintenance.
 - b. Single-line diagram showing interconnection of components.
 - c. Cabling diagram showing cable routing.
- C. Qualification Data: For Installer.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For school intercom and program equipment to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Sections, include the following:
 - 1. Record of final matching transformer-tap settings and signal ground-resistance measurement certified by Installer.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

1. Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use. All PA components shall be UL approved or listed under this specification. Systems that do not carry UL approval or listing will not be acceptable under this specification.
- C. Comply with NFPA 70.
- D. Comply with UL 50.
- E. The contractor shall be an established communications contractor that has had and currently maintains a locally run and operated business for at least five (5) years. The contractor shall utilize a duly authorized distributor of the equipment supplied for this project location with full manufacturer's five (5) year warranty.
- F. The contractor shall show satisfactory evidence, upon request, that the supplier maintains a fully equipped service organization capable of furnishing adequate inspection and service to the system.

1.5 COORDINATION

- A. Coordinate layout and installation of system components, such as ceiling mounted speaker microphones and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products from the manufacturers specified.

2.2 SUPPLIER AND SYSTEM INTEGRATOR:

- A. Provide products through the following:

1. IComm (contact Joe Samborski at 248-960-3700): shall provide the new Rauland P.A. equipment. Note: Rauland equipment is the District standard.

B. Provide a new Public Address System as required at each school. Provide new components as indicated on drawings. Provide all new components for a complete, fully functional system.

2.3 PUBLIC ADDRESS SYSTEM CONSOLE/EQUIPMENT

A. The Administrative Communications System shall be a Rauland Model Telecenter ICS. The system shall consist of a central equipment cabinet, analog card, telephone interface card (coordinate requirements with the Technology Contractor), one or more switching cards as required by number of remote stations in the system (plus 25% spare capacity), power supply, one or more power amplifiers as required, two Administration Control Consoles (ACC), remote station loudspeaker assemblies, mounting rack/cabinet and all associated material, hardware, and wiring as required for a complete system.

1. This section includes a fully operational IP platform (Rauland Telecenter Campus) for district and school internal communications system incorporating school safety notifications and general communications including but not limited to the following:

2. The platform shall provide complete internal communications employing state of the art IP Technology including the minimum functions listed.

3. Two-way Loud Speaking Internal Intercommunications.

4. Bell Event announcement, provide multiple bell schedules working in various building zones with different corresponding bell tones. This shall permit the Owner to use different bell schedules for various groups of students within combinations of rooms in the buildings.

5. Emergency announcement that will override any pre-programmed zones assuring that all Emergency/Lockdown etc., are heard at each and every speaker location.

6. Capability of playing prerecorded emergency announcements that can simply be activated by a simple Soft Key or via a dedicated call-switch.

7. Atomic Time Synchronization with Class Change Tones utilizing multiple, programmable schedules for each zone.

8. District wide, Emergency, All and zone live voice paging

9. District wide, emergency, all and zone paging for pre-recorded audio - tones, music and voice.
10. Web-based, permission driven user interface.
11. The system shall support a minimum of 1000 level priorities which shall be user definable, allowing each end point to place a minimum of 5 different priority calls at the same time.
12. Any authorized administrator shall be able to call from outside the school into any classroom, zone or entire school directly via the School District supplied SIP enabled Telephone Network. This shall allow remote monitoring, call-in annunciation and two-way conversation from outside the facility as well as paging into the system. (Compliance with NEMA Standard SB-40 for emergency communications in K-12 Schools)
13. Authorized system users shall be able to create a minimum of twenty (20) automated sequences for each school with instructions, emails and relay activations and replay them. Automated message strings shall be, manually played from a single-button access on the console, on a SIP connected telephone, a button or from the web interface.
14. Authorized system users shall be able to create a minimum of 5 automated emergency sequences (including All Clear) which include tones, voice messages, relay activations and replay them. Emergency Sequences shall be initiated from a Console, a SIP phone, a panic button or from the web interface.
15. Paging and two-way loudspeaking features shall be accessible from any system console or SIP connected telephone.
16. The platform shall synchronize its system time to the network time server or a web-based time server.
17. Each single school installation shall be locally survivable for intercom, paging, bells, and emergencies such as lockdown, even when the district connection is unavailable.
18. This specification establishes a minimum level of quality, features, and performance for individual components as well as the integrated system
19. The system shall provide, as a minimum, the following features and functions:
 - a. Allow administrative intercom system functions to be accessed through DTMF telephone instruments.
 - b. Microprocessor-based equipment of modular design, using plug-in connections between all modules. Field

- cabling shall be terminated in a labeled punch block arrangement to simplify servicing.
- c. Allow DTMF-type telephones to call individual classroom speakers, zone page, all call page, emergency page, and activate other alarm and time tones.
 - d. Three simultaneous communication paths:
 - 1) Direct dialing, two-way communications between locations equipped with an ACC or DTMF telephone and any room station equipped with a speaker or telephone handset.
 - 2) A second intercom channel between ACCs when multiple ACCs are used in the system.
 - 3) Simultaneous program distribution directed from any ACC without interrupting intercom channels.
20. One Central Control Unit (CCU) containing all the electronics required to handle all the functions of up to 64 remote stations in a wall cabinet model and 240 remote stations in a floor rack model.
21. The capability to originate emergency calls that take precedence over all routine calls. Emergency calls may be programmed from any call-in switch, or a normal call may be converted to emergency by holding the call-in switch in the CALL position for 1.5 seconds.
22. A single queue mode capability that places all incoming calls into a single common queue and allows directing all incoming calls to the ACC and DTMF telephones during limited staff operation.
23. System check with self-diagnosis and a watchdog timer.
24. System support for up to four ACCs, each having identical functions and control features, and each of which can be programmed for specific secretarial or administrative operations.
25. Automatic gain control on intercom speech to maintain constant speech level.
26. Built-in battery backup for internal system clock to maintain correct time while system is unpowered. All other programmed data is stored in nonvolatile EEPROM memory and is retained indefinitely.
27. Automatic preannounce tone over any loudspeaker selected for two-way communications. A privacy tone will sound whenever a loudspeaker is being monitored, with capabilities to stop the tone from the ACC as desired.
28. Distribution of paging announcements from any ACC or DTMF telephone to speaker and ACC locations on an all call,

- zone, and multiple zone basis, to any of the eight paging zones.
29. User-programmability of room stations and loudspeakers to any of eight available paging zones, class change zones, or no zones at all.
 30. Unique system tones for emergency and civil emergency pages with distribution of emergency announcements from an ACC or DTMF telephone to all locations equipped with ACCs or loudspeakers. Emergency announcements will automatically override all other programs.
 31. Custodial call tone to all speakers.
 32. Audio program distribution (microphone, tape, tuner, or auxiliary) capability to selected remote stations, specified zones, or all remote stations equipped with audio loudspeakers.
 33. Provisions for intercom communications in facilities having unshielded, twisted-pair cable from each speaker location.
 34. Provision for optional line supervision of an open circuit condition.
 35. Shall synchronize internal system clock to an external master clock.
 36. Provision for handset use at remote stations.
 37. Provisions to override remote sound systems during all call or emergency paging.
 38. Provision for distribution of door open alarm to all or selected zones by closure of single switch contact.
 39. Provide transfer of current call to another ACC.
 40. Call holding capability.
 41. Forwarding of calls assigned to a particular ACC to another ACC for call coverage.
 42. Last number redial.
 43. Speed dial access to specific remote stations.
 44. Defeat of call-in tones at any ACC.
 45. Ability to clear all calls registered on the ACC queue.
 46. Scroll display of waiting calls and select calls to be answered in any order.
 47. Ability to display ACC's number using ACC keypad.
 48. Call waiting indication: Steady display for normal calls, flashing display for emergency calls in order of priority.
 49. Call-in reminder in which unanswered calls repeat until answered.
 50. Provide LCD of current call/calls waiting. Current time is displayed when the ACC is in an idle state. The alphanumeric readout of incoming calls will be sorted by

- room number and queue position. The number of calls waiting will also be displayed in order of priority.
51. Sequential review of all incoming calls/calls waiting at each ACC with 100 percent call retention.
 52. One VOX handset (for private communications), built-in microphone, speaker and PUSH TO TALK button on each ACC for intercom communications.
 53. Ability for external input points to be annunciated at the ACC.
 54. Selective monitoring of audio program sources by the ACC before or during distribution.
 55. Initiation of manual time tones by any ACC or DTMF telephone.
 56. Access code restriction of ACC system programming to protect the system configuration.
 57. Ability for any ACC to direct a program to any one, group of, or all remote stations.
 58. Built-in diagnostic software for each ACC.
 59. Easy, menu-driven programming.
 60. ACC-keypad programmable system functions, including:
 - a. Architectural alphanumeric room numbers.
 - b. Five call-in priority levels.
 - c. 12-hour or 24-hour clock display when ACC is in idle state.
 - d. 256 events, eight time schedules, eight zones and eight user-programmable tones.
 61. Factory-programmable function keys for specific system operations.
 62. Ability for each remote station to be programmed to annunciate at any one or all ACC's.
 63. Automatic distribution of user-programmable time signals activated by a built-in master time clock (P.A. master clock shall be tied to/controlled by the National Time & Signal MC100 master clock). Two hundred fifty-six programmable events are available which can be programmed to eight zones and eight schedules from an ACC.
 64. Programming room stations, zones, or multiple zones to receive the program source on a selected room basis from the ACC, with the ability to view rooms receiving program material on the ACC display.
 65. Allow external DTMF telephones to automatically select and access room stations for communications (for future provisions).
 66. Input ports for monitoring external signals to activate TC2100 functions such as off-hour door alert, emergency tones and night transfer.

67. Output ports for activation of external equipment in response to ICS functions such as clock synchronization, all call override, and telephone or CO port off-hook to the ICS.
68. An RS-232 port for interface to a PC for remote diagnostics, remote programming, system information, saving and reloading of system programming, and hard copy output of all system.
69. An RS-485 port for long distance serial communication.
70. A built-in analog tone generator providing seven tones including chime.
71. Provide an ICS unit with two (2) ACC as indicated on the drawings. Provide all interface components to interface to the telephone system, and the AM/FM tuner/cassette, and CD player.
72. The public address system console unit shall be able to support dialing or non-dialing future telephone handsets.
73. Public Address System Console shall signal class change tones via the speaker system. Time schedules shall be programmed per the Owner's direction. Time correction shall be via internal master clock, which shall be controlled by the building master clock. Coordinate work with clock manufacturer (National Time & Signal MC100).

B. Miscellaneous:

1. Rauland AM/FM tuner/CD player shall be mount in the rack containing the ICS head end.
2. Provide all interface components to interface the P.A. system to the Information delivery system. ALL systems shall be synchronized together to form one complete system. This contractor shall be responsible to provide all equipment necessary to complete the above function.
3. Provide 1 desk microphone and relay for audio all call. Provide all hardware needed.
 - a. Microphone:
 - 1) Description: Desk type low impedance microphone with push-to-talk switch.

C. Execution:

1. Install all equipment per manufacturer's specifications. Prior to any programming, the contractor shall meet with the Owner for final approval of all system operations. Provide eight (8) hours of in service to the Owner on both operation of the system and programming. The contractor shall provide the program software as required for the system.

2.4 FUNCTIONAL DESCRIPTION OF INTERCOM SYSTEM

- A. The system shall be capable of multiple open voice intercom paths used for intercom, paging, program distribution, or emergency paging. The system shall be initially equipped with one intercom speech path.
- B. Provide a separate circuit for each classroom and administrative office so each room can be individually addressed with bi-directional communications.
- C. All field wiring shall be individually supervised for opens or shorts to each call station and security device.
- D. Arming and disarming functions shall be performed by dial-up via the Administrative Telephone(s).
- E. The audio channel(s) shall be priority driven allowing for the highest priority signal type access to a voice channel. The system shall be user programmable to allocate, upon demand, the audio channel(s) to facilitate simultaneous intercom conversations, pages, program distributions, or combination thereof.
 - 1. Facilities for up to 6 call-in priority levels.
 - 2. Every point shall support a programmable priority level.
 - 3. Distribution of paging announcements can be made from any administrative control console, telephone, or dedicated microphone set-up.
 - 4. Emergency announcements shall have the highest priority over any other system function.
 - 5. System shall support general announcements made from a conventional microphone to facilitate reading a script and the participation of multiple announcers.
 - 6. Keying the microphone shall automatically mute all other audio programs at a lower priority in the system and transmit the microphone audio to All Rooms or specific speaker zones, as programmed into the system software.
 - 7. Corridor speakers and outside horns shall be combined into groups of owner's preference.
 - 8. Facilities to provide automatic emergency instructions to be broadcast to the entire school when an alarm is tripped. The emergency instructions are preprogrammed and require no user intervention.
 - 9. Facilities to page one or more area-wide pocket pagers when a call is placed for a specific call priority or call priorities. The pocket pager will display the calling room number and a numeric call priority.

2.5 EQUIPMENT AND MATERIALS

- A. Coordinate features to form an integrated system. Coordinate components with existing systems where required. Match system voltages. Match components and interconnections for optimum performance of specified functions.
- B. Expansion Capability: Increase number of stations in the future by 25 percent above those indicated without adding any internal or external components or main trunk cable conductors.
- C. Equipment: Modular type using solid-state components, fully rated for continuous duty, unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.
- D. Waterproof Equipment: Listed and labeled for duty outdoors or in damp locations.

2.6 MASTER CONTROL STATION

- A. Micro-processor based desktop console with LCD display.
- B. The console shall be equipped with 12-digit keypad and telephone handset to allow private conversations.
- C. Provide built-in microphone and speaker shall provide for push-to-talk intercom conversations.
- D. Incoming calls shall be enunciated on a 16-character LCD backlit digital display sorted by priority and order received.
- E. The console shall also provide the ability for the operator to place on hold, or clear any incoming calls registered in the system from the console keypad.
- F. The console shall retain the last room number dialed until another room number is dialed or previous call is cancelled.

2.7 PAGING AMPLIFIERS

- A. Minimum Output Power: Provide sufficient power to all corridor/classroom speakers to be tapped at 1 watt each; all outdoor speakers to be tapped at 5 watts each. Provide a minimum of 30% "headroom" amplifier power to full load status.

- B. Total Harmonic Distortion: Less than 1 percent at rated output power with load equivalent to total quantity of stations connected in all call mode.
- C. They shall be designed to operate on a line voltage of 115 AC. One amplifier shall be provided for each audio channel.
- D. Minimum Signal to Noise Ratio: 60 dB, at rated output.
- E. Frequency Response: Within plus or minus 2dB from 50 to 12,000 Hz.
- F. Amplifier Protection: Prevent damage from shorted or open circuit.

2.8 P.A. CALL STATION

- A. Rauland model as required, Call Switch, single gang flush mounted with stainless steel faceplate. Single normal call button. Provide wiring as required by the manufacturer.

2.9 CEILING AND WALL MOUNTED SPEAKERS

- A. Classroom Speakers - PA speakers shall have the following coverall characteristics:
 - 1. Diameter: 8".
 - 2. Frequency Response: 60-16000 Hz.
 - 3. Power: 15 Watts.
 - 4. Magnet Weight: 10 ounces.
 - 5. Single voice coil.
 - a. The unit shall come with a transformer having taps of 1/2, 1, 2 and 4 watts. All speakers shall be tapped at 1 watt. Provide Quam Solution 1 assembly, with enclosure and support rail.
- B. Flush mounted Wall speakers: Provide an 8" speaker as above with Quam System 1 with backbox and matching grille.
- C. Maintenance areas and outside horns (flush): Provide a Quam System 6VP flush mounted horn with multitap line matching transformer. Provide same for outside horns (weatherproof). with a Soundolier VP-161APF baffle (painted brown) and required back box.
- D. Wall Mounted Volume Control: Provide a control that offers step attenuation via an autotransformer. The control shall work with either 25 volt or 70 volt lines and be rated at a minimum of 10 watts.

- E. Surface Mounted Horn Speaker (in ceiling space) - Horn loudspeakers shall be a System 6VP surface mount horn with multitap line matching transformer. Provide with each unit a with baffle and required back box in Gymnasiums.
- F. Corridor Speakers: Provide same as classroom speakers.
- G. Surface mounted (wall or exposed ceiling speakers): Provide same as classroom speaker, with required mounting grill for System 1 square surface mounted enclosure.

2.10 CONDUCTORS AND CABLES

- A. Conductors: Jacketed, twisted pair and twisted multipair, untinned solid copper. Sizes as recommended by system manufacturer, but not smaller than No. 22 AWG.
- B. Insulation: Thermoplastic, not less than 1/32 inch thick.
- C. Shielding: For speaker-microphone leads and elsewhere where recommended by manufacturer; No. 34 AWG tinned, soft-copper strands formed into a braid or equivalent foil.
 - 1. Minimum Shielding Coverage on Conductors: 60 percent.
- D. Plenum Cable: Listed and labeled for plenum use.
- E. Coordinate use of existing wiring with new equipment. Verify interoperability.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Wiring Method: Install wiring in raceways except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum-board partitions where cable wiring method may be used. Use plenum cable in environmental air spaces, including plenum ceilings. Conceal cables and raceways except in unfinished spaces.
- B. Install exposed cables parallel and perpendicular to surfaces or exposed structural members, and follow surface contours. Secure and support cables by J- hooks or similar fittings designed and installed to avoid damage to cables. Secure cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, or fittings.

- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess. Use lacing bars in cabinets.
- D. Control-Circuit Wiring: Install number and size of conductors as recommended by system manufacturer for control functions indicated.
- E. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches for speaker microphones and adjacent parallel power and telephone wiring. Separate other school intercom and program equipment conductors as recommended by equipment manufacturer.
- F. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
- G. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.
- H. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.
- I. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.
- J. Connect wiring according to Division 16 Section "Conductors and Cables."
- K. Provide installation of all equipment specified, including all miscellaneous parts and labor for a complete, fully functioning system.

3.2 GROUNDING

- A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

3.3 SYSTEM PROGRAMMING

- A. Programming: Fully train Owner on available programming options. Record Owner's decisions and set up initial system program. Prepare a written record of decisions, implementation methodology, and final results.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Schedule tests with at least seven days' advance notice of test performance.
 - 2. After installing school intercom and program equipment and after electrical circuitry has been energized, test for compliance with requirements.
 - 3. Operational Test: Test originating station-to-station, all-call, and page messages at each intercom station. Verify proper routing and volume levels and that system is free of noise and distortion. Test each available message path from each station on system.
 - 4. Frequency Response Test: Determine frequency response of two transmission paths, including all-call and paging, by transmitting and recording audio tones. Minimum acceptable performance is within 3 dB from 150 to 2500 Hz.
 - 5. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:
 - a. Disconnect speaker microphone and replace it in the circuit with a signal generator using a 1000-Hz signal. Measure signal-to-noise ratio at paging speakers.
 - b. Repeat test for three speaker microphones, one master station microphone, and for each separately controlled zone of paging loudspeakers.
 - c. Minimum acceptable ratio is 45 dB.
 - 6. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 150, 200, 400, 1000, and 2500 Hz into each intercom, paging, and all-call amplifier. For each frequency, measure distortion in the paging and all-call amplifier

outputs. Maximum acceptable distortion at any frequency is 5 percent total harmonics.

7. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each paging zone. Maximum permissible variation in level is plus or minus 3 dB; in levels between adjacent zones, plus or minus 5 dB.
8. Power Output Test: Measure electrical power output of each paging amplifier at normal gain settings of 150, 1000, and 2500 Hz. Maximum variation in power output at these frequencies is plus or minus 3 dB.
9. Signal Ground Test: Measure and report ground resistance at system signal ground. Comply with testing requirements in Division 16 Section "Grounding and Bonding."

C. Retesting: Correct deficiencies and retest. Prepare a written record of tests.

D. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging and independent room speaker-line matching transformers.

E. Prepare written test reports.

1. Include a record of final speaker-line matching transformer-tap settings, and signal ground-resistance measurement certified by Installer.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service and initial system programming.

B. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.

C. Complete installation and startup checks according to manufacturer's written instructions.

3.6 ADJUSTING

A. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.

- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose, without additional cost.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain school intercom and program equipment. Refer to Division 1 Section "Demonstration and Training."
 - 1. Train Owner's maintenance personnel on programming equipment for starting up and shutting down, pre-recorded messages, bell scheduling, troubleshooting, servicing, and maintaining equipment.

3.8 WARRANTY

- A. Provide one year warranty on equipment other than Rauland. Include coverage of travel, parts and service.

END OF SECTION

SECTION 16730 - CLOCK AND PROGRAM SYSTEM

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SUBMITTALS.....1
1.3 OPERATION AND MAINTENANCE DATA.....2
1.4 ENVIRONMENTAL REQUIREMENTS.....2

PART 2 - PRODUCTS.....2
2.1 MANUFACTURERS.....2
2.2 CLOCK AND PROGRAM SYSTEM.....2
2.3 MASTER CLOCK UNIT.....3
2.4 INDICATING CLOCKS.....3

PART 3 - EXECUTION.....3
3.1 INSTALLATION.....3
3.2 MANUFACTURER'S FIELD SERVICES.....4
3.3 DEMONSTRATION.....4
3.4 WARRANTY.....4

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Related Sections include the following:
 - 1. Division 16 Section "Electrical General Requirements."

1.2 SUBMITTALS

- A. Submit under provisions of Section 16010.
- B. Shop Drawings: Indicate wiring diagrams and interconnection diagrams.
- C. Product Data: Provide for each item of equipment; show specified ratings and physical dimensions.

1.3 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 16010.
- B. Operation Data: Include the following:
 - 1. Instructions for starting and operating clock system.
 - 2. Instructions for operating system under unusual conditions following power failure or other condition requiring resetting of clocks.
 - 3. Operating limits which may result in hazardous or unsafe conditions, or in equipment damage.
 - 4. Routine preventive maintenance schedule.
- C. Maintenance Data: Include the following:
 - 1. List special tools, maintenance materials, and replacement parts.
 - 2. Repair instructions for procedures to check, repair, and test equipment during typical malfunctions.
 - 3. Recommended cleaning methods, frequency, and materials.

1.4 ENVIRONMENTAL REQUIREMENTS

- A. Do not install products until building is enclosed.
- B. Maintain conditions to manufacturer's instructions during and after installation of clock system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. National Time & Signal.

2.2 CLOCK AND PROGRAM SYSTEM

- A. Description: Provide time standard signal for indicating clocks, time period audible signals.
- B. Configuration: Synchronous wired.
- C. System Indicating Clock Capacity: quantity as shown on the drawings with 20% spare capacity.
- D. System Control Relay Capacity: as required.

E. Program Circuit Capacity: 4.

2.3 MASTER CLOCK UNIT

A. Manufacturer and Model:

1. Existing National Time & Signal MC-100 (District Standard).

B. Description: Programmable Master clock for maintaining standard time and transmitting time, correcting, and program control signals. Expand/modify the existing MC-100 master clock or other National Time master clock model that exists at each school. Field verify existing conditions. Relocate existing master clock at Longacre and extend existing clock circuiting to new location as required.

2.4 INDICATING CLOCKS

A. Manufacturer and Model:

1. National Time & Signal model 030-12EX for single face 12" recessed clocks. Other models: 030-15EX (15" clocks in corridors) and 030-18EX (18" clocks in large spaces).

B. Description: Round analog indicating clock, synchronous motor type.

C. Finish and Color: Black color hands on white color face, steel housing with white color enamel finish trim.

D. Voltage: 120V or 24V, 60 Hz (FIELD VERIFY EXISTING VOLTAGE and match for new clocks).

E. Size: Single faced clocks: 12 inch (unless otherwise indicated on drawings).

F. Backboxes: Provide per manufacturer's requirements.

G. Provide wireguards for gymnasium applications.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide wireguards for clocks in gymnasiums.

3.2 MANUFACTURER'S FIELD SERVICES

A. Prepare and start systems.

3.3 DEMONSTRATION

A. Provide system demonstration covering all aspects of operation, maintenance and warranty service procedures.

3.4 WARRANTY

A. Provide two year warranty. Include coverage of travel, parts and service.

END OF SECTION 16730

SECTION 16999 - ELECTRICAL TESTING

PART 1 - GENERAL.....1
1.1 RELATED DOCUMENTS.....1
1.2 SECTION INCLUDES.....1
1.3 REFERENCES.....2
1.4 QUALIFICATIONS.....2
1.5 PERFORMANCE REQUIREMENTS.....3
1.6 TEST INSTRUMENT CALIBRATION.....4
1.7 TEST REPORTS.....5

PART 2 - PRODUCTS.....5

PART 3 - EXECUTION.....6
3.1 THERMOGRAPHIC SURVEY.....6

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Related Sections include the following:
 - 1. Division 16 Section "Electrical General Requirements."
 - 2. Division 16 Section "Conductors and Cables."
 - 3. Division 16 Section "Grounding and Bonding."
 - 4. Division 16 Section "Enclosed Switches."
 - 5. Division 16 Section "Enclosed Controllers."
 - 6. Division 16 Section "Dry-Type Transformers"
 - 7. Division 16 Section "Panelboards."
 - 8. Division 16 Section "Switchboards."

1.2 SECTION INCLUDES

- A. The Electrical Contractor shall engage the services of a recognized corporately independent N.E.T.A. certified testing firm for the purpose of performing inspections and tests as herein specified
- B. The testing firm shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections.

- C. It is the intent of these tests to assure that all tested electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design Specifications.
- D. The test and inspections shall determine suitability for energization.
- E. Equipment to be tested and inspected shall be the new equipment shown on the one line diagram and schedules as required by part three of each individual Specification Section. In addition, all equipment that is part of an emergency distribution system shall be tested.

1.3 REFERENCES

- A. All inspections and tests shall be in accordance with the latest version of the following codes and standards except as provided otherwise herein.
 - 1. National Electrical Manufacturer's Association - NEMA
 - 2. American Society for Testing and Materials - ASTM
 - 3. Institute of Electrical and Electronic Engineers - IEEE
 - 4. InterNational Electrical Testing Association - NETA Acceptance Testing Specifications - ATS-1996
 - 5. InterNational Electrical Testing Association - NETA Maintenance Testing Specifications-MTS-1997
 - 6. American National Standards Institute - ANSI C2: National Electrical Safety Code
 - 7. State and Local Codes and Ordinances
 - 8. Insulated Cable Engineers Association - ICEA
 - 9. Association of Edison Illuminating Companies - AEIC
 - 10. Occupational Safety and Health Administration
 - 11. National Fire Protection Association - NFPA
 - a. ANSI/NFPA 70: National Electrical Code
 - b. ANSI/NFPA 70B: Electrical Equipment Maintenance
 - c. NFPA 70E: Electrical Safety Requirements for Employee Workplaces
 - d. ANSI/NFPA 101: Life Safety Code

1.4 QUALIFICATIONS

- A. The testing firm shall be a corporately independent testing organization, which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm.

- B. The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.
- C. The lead, on site, technical person and at least 50% of the on site crew shall be currently certified by the InterNational Electrical Testing Association (NETA).
- D. The testing firm shall only utilize technicians who are regularly employed by the firm on a full-time basis for testing services.
- E. The Contractor shall submit proof of the above qualifications with bid proposal.
- F. The terms used herewithin such as Test Agency, Test Contractor, Testing Laboratory, or Contractor Test Company, shall be construed to mean the testing organization.
- G. Acceptable Testing Firms:
 - 1. Northern Electrical Testing; Phone (248) 689-8980.
 - 2. Utilities Instrumentation Services; Phone (734) 482-1450.
 - 3. Emerson/High Voltage Maintenance Corporation; Phone (734) 524-0409.
 - 4. Power Plus Engineering; Phone (248) 344-0200.
 - 5. Magna; Phone (248) 486-7370.

1.5 PERFORMANCE REQUIREMENTS

- A. The Electrical Contractor shall supply a suitable and stable source of electrical power to each test site. The testing firm shall specify the power requirements.
- B. The Electrical Contractor shall notify the testing firm when equipment becomes available for acceptance tests. Work shall be coordinated to expedite project scheduling.
- C. The testing firm shall notify the Owner's Representative prior to commencement of any testing.
- D. Any system, material or workmanship, which is found defective on the basis of acceptance tests, shall be reported to the Engineer. The Electrical Contractor shall correct all defects.
- E. The testing organization shall maintain a written record of all tests and shall assemble and certify a final test report.
- F. Safety and Precautions

1. Safety practices shall include, but are not limited to, the following requirements:
 - a. Occupational Safety and Health Act.
 - b. Accident Prevention Manual for Industrial Operations, National Safety Council.
 - c. Applicable state and local safety operating procedures.
 - d. NETA Safety/Accident Prevention Program.
 - e. Owner's safety practices.
 - f. National Fire Protection Association - NFPA 70E.
 - g. American National Standards for Personnel Protection.
2. All tests shall be performed with apparatus de-energized except where otherwise specifically required.
3. The testing organization shall have a designated safety representative on the project to supervise operations with respect to safety.

1.6 TEST INSTRUMENT CALIBRATION

A. Test Instrument Calibration

1. The testing firm shall have a calibration program, which assures that all applicable test instruments are maintained within rated accuracy.
2. The accuracy shall be directly traceable to the National Institute of Standards and Technology.
3. Instruments shall be calibrated in accordance with the following frequency schedule:
 - a. Field instruments: Analog - 6 months maximum Digital - 12 months maximum
 - b. Laboratory instruments: 12 months
 - c. Leased specialty equipment: 12 months
(Where accuracy is guaranteed by Lessor)
4. Dated calibration labels shall be visible on all test equipment.
5. Records must be kept up-to-date which show date and results of instruments calibrated or tested.
6. An up-to-date instrument calibration instruction and procedures shall be maintained for each test instrument.
7. Calibrating standard shall be of higher accuracy than that of the instrument tested.

B. Field Test Instrument Standards

1. All equipment used for testing and calibration procedures shall exhibit the following characteristics:
 - a. Maintained in good visual and mechanical condition.
 - b. Maintained in safe, operating condition.

C. Suitability of Test Equipment

1. All test equipment shall be in good mechanical and electrical condition.
2. Selection of metering equipment should be based on knowledge of the waveform of the variable being measured. Digital multi-meters may be average of RMS sensing and may include or exclude the dc component. When the variable contains harmonics of dc offset and, in general, any deviation from a pure sine wave, average sensing, average measuring RMS scaled meters may be misleading. Use of RMS measuring meters is recommended.
3. Field test metering used to check power system meter calibration must have any accuracy higher than that of the instrument being checked.
4. Accuracy of metering in test equipment shall be appropriate for the test being performed.
5. Waveshape and frequency of test equipment output waveforms shall be appropriate for the test and tested equipment.

1.7 TEST REPORTS

- A. A test report shall be generated for each piece of major equipment or groups of equipment and shall include the following:
 1. A list of visual and mechanical inspections required by Division 16 Specification Sections in a checklist or similar format.
 2. Test reports, including test values where applicable, for all required electrical tests. Clearly indicate where test values fall outside of the limits of recommended values.
 3. Summary and interpretation of test results detailing problems located and recommended corrective measures.
 4. Record of infrared scan and photos showing potential problem locations.
 5. Signed and dated by the testing firm field superintendent stating that all required tests have been completed.
- B. Test reports shall be furnished to the Architect/Engineer within 14 days of the completion each test on an ongoing basis. Original copies of the reports shall be furnished directly to the Architect/Engineer by the testing company prior to formal submittal via the Contractors.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.1 THERMOGRAPHIC SURVEY

- A. Visual and Mechanical Inspection
 - 1. Remove all necessary covers prior to scanning.
 - 2. Inspect for physical, electrical, and mechanical condition.
- B. Equipment to be Scanned
 - 1. All components of the distribution system down to and including branch circuit panelboards and motor control centers. Return 3 months after equipment has been energized and loaded to do a final scan of all equipment.
- C. Provide report indicating the following:
 - 1. Problem area (location of "hot spot").
 - 2. Temperature rise between "hot spot" and normal or reference area.
 - 3. Cause of heat rise.
 - 4. Phase unbalance, if present.
 - 5. Areas scanned.
- D. Test Parameters
 - 1. Scanning distribution system with ability to detect 1°C between subject area and reference at 30°C.
 - 2. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
 - 3. Infrared surveys should be performed during periods of maximum possible loading but not less than twenty percent (20%) of rated load of the electrical equipment being inspected.
- E. Test Results
 - 1. Interpretation of temperature gradients requires an experienced technician. Some general guidelines are:
 - a. Temperature gradients of 3°C to 7°C indicate possible deficiency and warrant investigation.
 - b. Temperature gradients of 7°C to 15°C indicate deficiency; repair as time permits.
 - c. Temperature gradients of 16°C and above indicate major deficiency; repair immediately.

END OF SECTION 16999