

December 6, 2018

PROJECT MANUAL

City of Joliet, Illinois



Eastside Wastewater Treatment Plant Phosphorus Removal Project

IEPA Loan No. L174760

City Contract No. 2351-0219

Joliet, Illinois

Volume 2 of 3 (Division 03 to Division 27) Bid Set



Donohue & Associates, Inc.
125 South Wacker Drive, Suite 1850
Chicago, IL 60606
312.236.9147 | donohue-associates.com

Donohue Project No.: 13320

PROJECT MANUAL

CITY OF JOLIET

EASTSIDE WASTEWATER TREATMENT PLANT
PHOSPHORUS REMOVAL PROJECT

JOLIET, ILLINOIS



Jeffrey L. Willis
12/6/18
EXPIRES: 11/30/19



Michael Stohl
12/06/2018
EXPIRES: 11/30/2019



Steven R. Weiss
12/6/2018
EXPIRES: 11/30/2020



Robert Eldon Rock
12/06/18
exp. 08/31/19



Paul M. Shadrake
12/6/2018
Expires 11/30/2019



Eric P. Cockerill
12/6/2018
EXPIRES: 11/30/2019



Timothy J. Bates
12/6/18
Exp: 11/30/20

125 South Wacker Drive, Suite
Chicago, IL 60606
Phone: 312-236-9147

www.donohue-associates.com

Project No. 13320

**PROJECT MANUAL
CITY OF JOLIET**

**EASTSIDE WWTP PHOSPHORUS REMOVAL
DESIGN AND BIDDING
IEPA LOAN NO. L174760
CITY CONTRACT NO 2351-0219**

JOLIET, ILLINOIS

TABLE OF CONTENTS

VOLUME 1

INVITATION TO BID.....	00 11 16-1 to 00 11 16-2
INSTRUCTIONS TO BIDDERS	00 21 13-1 to 00 21 13-11
AFFIRMATIVE ACTION FOR EQUAL EMPLOYMENT OPPORTUNITIES....	00 30 10-1 plus attachment
CERTIFICATION OF NON-SEGREGATED FACILITIES	00 30 20-1 plus attachment
NOTICE OF NON-DISCRIMINATION IN EMPLOYMENT	00 30 30-1 plus attachment
CERTIFICATION REGARDING DEBARMENT, SUSPENSION AND OTHER RESPONSIBILITY MATTERS	00 30 40-1 plus attachment
PREVAILING WAGE REQUIREMENTS	00 30 50-1 plus attachment
STATE OF ILLINOIS LOAN GENERAL CONDITIONS	00 30 60-1 plus attachment
DISADVANTAGED BUSINESS ENTERPRISE POLICY	00 30 70-1 plus attachment
BIDDER CERTIFICATIONS REGARDING THE USE OF AMERICAN IRON AND STEELPRODUCTS.....	00 30 80-1 plus attachments
CITY OF JOLIET AFFIDAVITS	00 30 90-1 to 00 30 90-16
BID FORM.....	00 41 33-1 to 00 41 33-9
BID BOND.....	00 43 13-1 to 00 43 13-2
AGREEMENT.....	00 52 33-1 to 00 52 33-8
NOTICE OF INTENT TO AWARD	00 52 90-1 to 00 52 90-2
NOTICE OF AWARD.....	00 53 00-1 to 00 53 00-2
NOTICE TO PROCEED.....	00 55 00-1
PERFORMANCE BOND.....	00 61 00-1 to 00 61 00-3
PAYMENT BOND.....	00 61 50-1 to 00 61 50-3
GENERAL CONDITIONS	00 72 00-1 to 00 72 00-65
SUPPLEMENTARY CONDITIONS	00 80 00-1 to 00 80 00-19
GEOTECHNICAL AND SOILS INVESTIGATION REPORTS	

TECHNICAL SPECIFICATIONS

DIVISION 01 – GENERAL REQUIREMENTS

Section 01 11 00 – Summary of Work	01 11 00-1 to 01 11 00-6
Section 01 21 00 – Allowances	01 21 00-1
Section 01 22 00 – Unit Prices	01 22 00-1 to 01 22 00-2
Section 01 29 73 – Schedule of Values	01 29 73-1 to 01 29 73-2
Section 01 31 19 – Project Meetings	01 31 19-1 to 01 31 19-3
Section 01 32 16 – Progress Schedule (Bar Chart Method)	01 32 16-1 to 01 32 16-3
Section 01 32 33 – Photographic Documentation	01 32 33-1 to 01 32 33-2
Section 01 33 00 – Submittal Procedures.....	01 33 00-1 to 01 33 00-6
Section 01 35 16 – Alteration Project Procedures.....	01 35 16-1 to 01 35 16-6
Section 01 45 29 – Testing Laboratory Services.....	01 45 29-1 to 01 45 29-2
Section 01 52 00 – Construction Facilities	01 52 00-1 to 01 52 00-5
Section 01 55 26 – Traffic Control	01 55 26-1 to 01 55 26-4
Section 01 57 19 – Temporary Environmental Controls.....	01 57 19-1 to 01 57 19-4
Section 01 61 00 – Common Product Requirements	01 61 00-1 to 01 61 00-5
Section 01 74 00 – Cleaning and Waste Management	01 74 00-1 to 01 74 00-3
Section 01 78 23 – Operation and Maintenance Data.....	01 78 23-1 to 01 78 23-18
Section 01 78 39 – Project Record Documents	01 78 39-1 to 01 78 39-3
Section 01 79 10 – Systems Demonstrations	01 79 10-1 to 01 79 10-4
Section 01 79 20 – Electrical System Demonstrations	01 79 20-1
Section 01 79 30 – Instructional Services.....	01 79 30-1 to 01 79 30-4

DIVISION 02 – EXISTING CONDITIONS – NOT USED

END OF VOLUME 1

**PROJECT MANUAL
CITY OF JOLIET**

**EASTSIDE WWTP
PHOSPHORUS REMOVAL AND EXPANSION
IEPA LOAN NO. L174760
CITY CONTRACT NO 2351-0219**

JOLIET, ILLINOIS

TABLE OF CONTENTS

VOLUME 2

TECHNICAL SPECIFICATIONS (CONTINUED)

DIVISION 03 – CONCRETE

Section 03 20 00 – Concrete Reinforcing	03 20 00-1 to 03 20 00-4
Section 03 30 00 – Cast-In-Place Concrete	03 30 00-1 to 03 30 00-14
Section 03 35 00 – Polished Concrete Finishing	03 35 00-1 to 03 35 00-5
Section 03 40 00 – Precast Concrete	03 40 00-1 to 03 40 00-6
Section 03 62 00 – Non Shrink Grouting.....	03 62 00-1 to 03 62 00-2

DIVISION 04 – MASONRY

Section 04 21 13 – Brick Masonry	04 21 13-1 to 04 21 13-6
Section 04 22 00 – Concrete Unit Masonry.....	04 22 00-1 to 04 22 00-6
Section 04 41 00 – Stone Masonry.....	04 41 00-1 to 04 41 00-5

DIVISION 05 – METALS

Section 05 12 00 – Structural Steel Framing	05 12 00-1 to 05 12 00-5
Section 05 21 00 – Steel Joist Framing	05 21 00-1 to 05 21 00-3
Section 05 30 00 – Metal Decking	05 30 00-1 to 05 30 00-4
Section 05 40 00 – Cold-Formed Metal Framing	05 40 00-1 to 05 40 00-2
Section 05 50 00 – Metal Fabrications	05 50 00-1 to 05 50 00-8
Section 05 52 00 – Metal Railing.....	05 52 00-1 to 05 52 00-3
Section 05 53 00 – Bar Grating	05 53 00-1 to 05 53 00-3

DIVISION 06 – WOOD, PLASTICS, AND COMPOSITES

Section 06 10 00 – Rough Carpentry.....	06 10 00-1 to 06 10 00-7
Section 06 20 00 – Finish Carpentry.....	06 20 00-1 to 06 20 00-5
Section 06 40 20 – Interior Architectural Woodwork.....	06 40 20-1 to 06 40 20-9
Section 06 40 30 – Wood Casework.....	06 40 30-1 to 06 40 30-7
Section 06 55 00 – Fiberglass Reinforced Grating.....	06 55 00-1 to 06 55 00-3

DIVISION 07 – THERMAL AND MOISTURE PROTECTION

Section 07 21 00 – Thermal Insulation.....	07 21 00-1 to 07 21 00-3
Section 07 21 19 – Foamed-In-Place Insulation.....	07 21 19-1 to 07 21 19-2
Section 07 26 20 – Liquid Applied Air/Vapor Barrier System	07 26 20-1 to 07 26 20-6

Section 07 41 10 – Metal Roof and Wall Panels	07 41 10-1 to 07 41 10-12
Section 07 54 00 – Thermoplastic Membrane Roofing.....	07 54 00-1 to 07 54 00-13
Section 07 62 00 – Sheet Metal Flashing and Trim.....	07 62 00-1 to 07 62 00-3
Section 07 71 33 – Gutters and Downspouts.....	07 71 33-1 to 07 71 33-2
Section 07 92 00 – Joint Sealants	07 92 00-1 to 07 92 00-7

DIVISION 08 – OPENINGS

Section 08 11 13 – Hollow Metal Doors and Frames.....	08 11 13-1 to 08 11 13-5
Section 08 11 16 – Aluminum Doors and Frames.....	08 11 16-1 to 08 11 16-5
Section 08 16 13 – Fiberglass Doors and Frames	08 16 13-1 to 08 16 13-3
Section 08 21 10 – Flush Wood Doors	08 21 10-1 to 08 21 10-4
Section 08 33 23 – Overhead Coiling Doors	08 33 23-1 to 08 33 23-4
Section 08 41 10 – Aluminum Framed Entrances and Storefronts	08 41 10-1 to 08 41 10-9
Section 08 71 00 – Door Hardware.....	08 71 00-1 to 08 71 00-7
Section 08 81 00 – Glass Glazing.....	08 81 00-1 to 08 81 00-5

DIVISION 09 – FINISHES

Section 09 26 00 – Gypsum Board Assemblies	09 26 00-1 to 09 26 00-8
Section 09 30 13 – Ceramic Tiling.....	09 30 13-1 to 09 30 13-4
Section 09 51 00 – Acoustical Ceilings	09 51 00-1 to 09 51 00-2
Section 09 67 26 – Quartz Flooring	09 67 26-1 to 09 67 26-4
Section 09 68 13 – Tile Carpeting Coatings.....	09 68 13-1 to 09 68 13-4
Section 09 84 13 – Fixed Sound-Absorptive Panels	09 84 13-1 to 09 84 13-2
Section 09 91 00 – Painting.....	09 91 00-1 to 09 91 00-12
Section 09 96 00 – High-Performance Coatings	09 96 00-1 to 09 96 00-12
Section 09 96 50 – High-Performance Epoxy Coatings.....	09 96 50-1 to 09 96 50-4

DIVISION 10 – SPECIALTIES

Section 10 11 10 – Plaque and Building Identification Lettering	10 11 10-1 to 10 11 10-2
Section 10 14 00 – Signage	10 14 00-1 to 10 14 00-3
Section 10 21 13 – Toilet Compartments.....	10 21 13-1 to 10 21 13-3
Section 10 28 13 – Toilet Room Accessories.....	10 28 13-1 to 10 28 13-7
Section 10 44 16 – Fire Extinguishers	10 44 16-1 to 10 44 16-3
Section 10 51 00 – Metal Lockers.....	10 51 00-1 to 10 51 00-6

DIVISION 11 – EQUIPMENT

Section 11 45 10 – Kitchen and Laundry Appliances	11 45 10-1 to 11 45 10-3
Section 11 52 00 – Audio Visual Systems.....	11 52 00-1 to 11 52 00-4

DIVISION 12 – FURNISHINGS

Section 12 34 50 – Modular Steel Laboratory Casework.....	12 34 50-1 to 12 34 50-9
Section 12 48 10 – Entrance Mats.....	12 48 10-1 to 12 48 10-2
Section 12 49 40 – Shades	12 49 40-1 to 12 49 40-4
Section 12 51 00 – Office Furniture	12 51 00-1 to 12 51 00-10

DIVISION 14 – CONVEYING EQUIPMENT

Section 14 65 00 – Hoisting Equipment.....	14 65 00-1 to 14 65 00-2
--	--------------------------

DIVISION 21 – FIRE SUPPRESSION

Section 21 10 00 – Water-Base Fire-Suppression Systems 21 10 00-1 to 21 10 00-9

DIVISION 22 – PLUMBING

Section 22 00 05 – Plumbing Systems 22 00 05-1 to 22 00 05-29
 Section 22 12 23.13 – Water Storage Pressure Tank 22 12 23.13-1 to 22 12 23.13-3
 Section 22 12 23.16 – Break Tank..... 22 12 23.16-1 to 22 12 23.16-2
 Section 22 33 36 – Booster Pump System..... 22 33 36-1 to 22 33 36-7

DIVISION 23 – HEATING, VENTILATING, AND AIR CONDITIONING

Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC 23 05 93-1 to 23 05 93-3
 Section 23 07 00 – HVAC Insulation..... 23 07 00-1 to 23 07 00-5
 Section 23 09 23 – Direct Digital Control Systems for HVAC 23 09 23-1 to 23 09 23-41
 Section 23 11 23 – Facility Natural Gas Piping 23 11 23-1 to 23 11 23-5
 Section 23 21 13 – Hydronic Piping..... 23 21 13-1 to 23 21 13-5
 Section 23 21 16 – Hydronic Specialties..... 23 21 16-1 to 23 21 16-3
 Section 23 21 23 – Heating System Pumps..... 23 21 23-1 to 23 21 23-4
 Section 23 23 00 – Refrigerant Piping Systems 23 23 00-1 to 23 23 00-5
 Section 23 31 13 – Metal Ducts..... 23 31 13-1 to 23 31 13-6
 Section 23 31 16 – Thermoset Fiberglass-Reinforced Plastic Ducts... 23 31 16-1 to 23 31 16-8
 Section 23 31 17 – Preinsulated Buried Duct Systems 23 31 17-1 to 23 31 17-4
 Section 23 33 00 – Air Duct Accessories 23 33 00-1 to 23 33 00-4
 Section 23 34 23 – HVAC Power Ventilators 23 34 23-1 to 23 34 23-6
 Section 23 36 16 – Variable-Air-Volume Units 23 36 16-1 to 23 36 16-3
 Section 23 37 00 – Air Outlets and Inlets..... 23 37 00-1 to 23 37 00-4
 Section 23 74 33 – Dedicated Outdoor-Air Units..... 23 74 33-1 to 23 74 33-6
 Section 23 75 16 – Custom-Packaged Rooftop Air Conditioning Units 23 75 16-1 to 23 75 16-7
 Section 23 75 23 – Custom-Packaged Outdoor Heating and Ventilating
 Make-up Air Units..... 23 75 23-1 to 23 75 23-7
 Section 23 81 29 – Variable Refrigerant Flow HVAC Systems 23 81 29-1 to 23 81 29-10
 Section 23 82 00 – Convection Heating and Cooling Units 23 82 00-1 to 23 82 00-3
 Section 23 82 40 – Electric Heating Terminals..... 23 82 40-1 to 23 82 40-3

DIVISION 26 – ELECTRICAL

Section 26 05 19 – Low-Voltage Conductors and Cables..... 26 05 19-1 to 26 05 19-8
 Section 26 05 26 – Grounding and Bonding for Electrical Systems 26 05 26-1 to 26 05 26-6
 Section 26 05 29 – Hangers and Supports for Electrical Systems 26 05 29-1 to 26 05 29-4
 Section 26 05 33.13 – Cabinets and Boxes for Electrical Systems
 26 05 33.13-1 to 26 05 33.13-8
 Section 26 05 33.16 – Conduit for Electrical Systems..... 26 05 33.16-1 to 26 05 33.16-8
 Section 26 05 43 – Underground Ducts and Manholes for Electrical
 Systems 26 05 43-1 to 26 05 43-7
 Section 26 05 53 – Identification for Electrical Systems 26 05 53-1 to 26 05 53-5
 Section 26 05 73 – Power System Studies 26 05 73-1 to 26 05 73-4
 Section 26 05 84 – Electric Motors 26 05 84-1 to 26 05 84-6
 Section 26 22 00 – Low-Voltage Transformers 26 22 00-1 to 26 22 00-4
 Section 26 24 16 – Panelboards..... 26 24 16-1 to 26 24 16-4
 Section 26 24 19 – Motor-Control Centers..... 26 24 19-1 to 26 24 19-9
 Section 26 27 26 – Wiring Devices..... 26 27 26-1 to 26 27 26-5
 Section 26 28 00 – Low-Voltage Circuit Protection Devices 26 28 00-1 to 26 28 00-3
 Section 26 29 23 – Variable Frequency Drive Equipment 26 29 23-1 to 26 29 23-6
 Section 26 32 09 – Portable Generator Connection Cabinet 26 32 09-1 to 26 32 09-3
 Section 26 36 00 – Transfer Switches 26 36 00-1 to 26 36 00-4

Section 26 43 13 – Surge Protection Devices for Low-Voltage Electrical Power Circuits	26 43 13-1 to 26 43 13-5
.....	
Section 26 51 00 – Interior Lighting	26 51 00-1 to 26 51 00-7
Section 26 56 00 – Exterior Lighting.....	26 56 00-1 to 26 56 00-5

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

Section 28 15 00 – Access Control Systems.....	28 15 00-1 to 28 15 00-4
Section 28 46 00 – Fire Alarm Systems.....	28 46 00-1 to 28 46 00-10

END OF VOLUME 2

**PROJECT MANUAL
CITY OF JOLIET**

**EASTSIDE WWTP
PHOSPHORUS REMOVAL AND EXPANSION
IEPA LOAN NO. L174760
CITY CONTRACT NO 2351-0219**

JOLIET, ILLINOIS

TABLE OF CONTENTS

VOLUME 3

TECHNICAL SPECIFICATIONS (CONTINUED)

DIVISION 31 – EARTHWORK

Section 31 10 00 – Site Clearing	31 10 00-1 to 31 10 00-3
Section 31 22 00 – Grading.....	31 22 00-1 to 31 22 00-4
Section 31 23 00 – Excavation and Fill.....	31 23 00-1 to 31 23 00-5
Section 31 23 33 – Trenching and Backfilling	31 23 33-1 to 31 23 33-7
Section 31 25 00 – Erosion Control and Site Stabilization.....	31 25 00-1 to 31 25 00-6

DIVISION 32 – EXTERIOR IMPROVEMENTS

Section 32 11 23 – Aggregate Base Courses	32 11 23-1 to 32 11 23-2
Section 32 12 16 – Asphalt Paving.....	32 12 16-1 to 32 12 16-5
Section 32 12 18 – Rejuvenator	32 12 18-1 to 32 12 18-6
Section 32 14 13.19 – Permeable Concrete Paving.....	32 14 13-1 to 32 14 13-10
Section 32 16 23 – Sidewalks	32 16 23-1 to 32 16 23-5
Section 32 17 43 – Pavement Snow Melting System	32 17 43-1 to 32 17 43-3
Section 32 31 19 – Ornamental Steel Fence and Gates.....	32 31 19-1 to 32 31 19-10
Section 32 92 19 – Seeding	32 92 19-1 to 32 92 19-10
Section 32 93 00 – Planting and Fine Grading.....	32 93 00-1 to 32 93 00-20

DIVISION 33 – UTILITIES

Section 33 05 10 – Site Utilities	33 05 10-1 to 33 05 10-6
Section 33 11 16 – Site Water Distribution Piping.....	33 11 16-1 to 33 11 16-6
Section 33 13 00 – Disinfecting of Water Utility Distribution	33 13 00-1 to 33 13 00-3
Section 33 31 13 – Sewerage Piping.....	33 31 13-1 to 33 31 13-4
Section 33 39 00 – Manholes and Inlets.....	33 39 00-1 to 33 39 00-6

DIVISION 40 – PROCESS INTEGRATION

Section 40 05 05 – Process Piping.....	40 05 05-1 to 40 05 05-8
Section 40 05 06 – Couplings, Adapters, and Specials for Process Piping	40 05 06-1 to 40 05 06-3
Section 40 05 07 – Pipe Hangers, Supports and Anchors.....	40 05 07-1 to 40 05 07-9
Section 40 05 09 – Wall Pipes, Floor Pipes, and Pipe Sleeves	40 05 09-1 to 40 05 09-2
Section 40 05 10 – Testing Piping Systems.....	40 05 10-1 to 40 05 10-4
Section 40 05 15.19 – Rubber Expansion Joints.....	40 05 15.19-1 to 40 05 15.19-2
Section 40 05 19 – Ductile Iron Process Pipe	40 05 19-1 to 40 05 19-7
Section 40 05 23 – Stainless Steel Process Pipe.....	40 05 23-1 to 40 05 23-7

Section 40 05 31.13 – Polyvinyl Chloride Process Pipe	40 05 31.13-1 to 40 05 31.13-3
Section 40 05 31.23 – Chlorinated Polyvinyl Chloride (CPVC) Piping	40 05 31.23-1 to 40 05 31.23-4
Section 40 05 53 – Process Valves	40 05 53-1 to 40 05 53-18
Section 40 05 59 – Stainless Steel Gates	40 05 59-1 to 40 05 59-10
Section 40 05 97 – Piping and Equipment Identification.....	40 05 97-1 to 40 05 97-7
Section 40 41 00 – Process Piping and Equipment Heat Tracing.....	40 41 00-1 to 40 41 00-4
Section 40 42 13 – Mechanical Insulation and Jacket.....	40 42 13-1 to 40 42 13-3
Section 40 61 13 – Process Control System – General Provisions.....	40 61 13-1 to 40 61 13-10
Section 40 61 20 – Process Control System Configuration Services..	40 61 20-1 to 40 61 20-10
Section 40 61 21 – Process Control System - Testing	40 61 21-1 to 40 61 21-4
Section 40 61 26 – Process Control System - Training	40 61 26-1 to 40 61 26-2
Section 40 61 30 – Process Control System – O&M Data.....	40 61 30-1 to 40 61 30-3
Section 40 61 93 – Process Control System – I/O List.....	40 61 93-1 to 40 61 93-3
Section 40 61 96 – Process Control Descriptions	40 61 96-1 to 40 61 96-32
Section 40 62 00 – Computer System Hardware and Ancillaries.....	40 62 00-1 to 40 62 00-5
Section 40 63 43 – Programmable Logic Controllers	40 63 43-1 to 40 63 43-4
Section 40 66 00 – Network and Communication Equipment.....	40 66 00-1 to 40 66 00-18
Section 40 67 00 – Control Panels	40 67 00-1 to 40 67 00-8
Section 40 67 63 – Uninterruptible Power Supply	40 67 63-1 to 40 67 63-3
Section 40 70 00 – Instrumentation of Process Systems.....	40 70 00-1 to 40 70 00-6
Section 40 71 00 – Flow Measurement.....	40 71 00-1 to 40 71 00-4
Section 40 72 00 – Level Measurement.....	40 72 00-1 to 40 72 00-5
Section 40 73 00 – Pressure, Strain, and Force Measurement	40 73 00-1 to 40 73 00-6
Section 40 74 00 – Temperature Measurement	40 74 00-1 to 40 74 00-3
Section 40 75 00 – Process Liquid Analytical Measurement	40 75 00-1 to 40 75 00-5
Section 40 76 00 – Process Gas Analytical Measurement	40 76 00-1 to 40 76 00-5
Section 40 78 00 – Panel Mounted Instruments.....	40 78 00-1 to 40 78 00-10
Section 40 79 00 – Miscellaneous Control System Field Devices.....	40 79 00-1 to 40 79 00-3

DIVISION 41 – MATERIAL PROCESSING AND HANDLING EQUIPMENT – NOT USED

DIVISION 42 – PROCESS HEATING, COOLING, AND DRYING EQUIPMENT – NOT USED

DIVISION 43 – PROCESS GAS AND LIQUID HANDLING, PURIFICATION, AND STORAGE EQUIPMENT

Section 43 23 57 – Progressive Cavity Pumping Equipment	43 23 57-1 to 43 23 57-7
Section 43 25 13 – Submersible Centrifugal Pumping Equipment	43 25 13-1 to 43 25 13-9
Section 43 41 43 – Chemical Storage Tanks	43 41 43-1 to 43 41 43-9

DIVISION 44 – POLLUTION AND WASTE CONTROL EQUIPMENT

Section 44 31 21 – Odor Control Biofilters	44 31 21-1 to 44 31 21-11
--	---------------------------

DIVISION 46 – WATER AND WASTEWATER EQUIPMENT

Section 46 33 33 – Polymer Prep, Age and Feed Equipment.....	46 33 33-1 to 46 33 33-11
Section 46 33 44 – Peristaltic Chemical Feed Equipment	46 33 44-1 to 46 33 44-9
Section 46 41 17 – Static Mixer	46 41 17-1 to 46 41 17-2
Section 46 41 23 – Submersible Mixing Equipment	46 41 23-1 to 46 41 23-8
Section 46 51 33 – Flexible Membrane Disc Diffusers	46 51 33-1 to 46 51 33-10
Section 46 76 21 – Sludge Thickening Equipment.....	46 76 21-1 to 46 76 21-17
Section 46 76 33 – Trailer Mounted Centrifuge Dewatering System.	46 76 33-1 to 46 76 33-19

DIVISION 48 – ELECTRICAL POWER GENERATION EQUIPMENT – NOT USED

APPENDIX

END OF TABLE OF CONTENTS

DIVISION 3
CONCRETE

SECTION 03 20 00
CONCRETE REINFORCING

PART 1 – GENERAL

1.01 SUMMARY

- A. Provide concrete reinforcement where shown on the Drawings, as specified herein, and as needed for a complete and proper installation.

1.02 REFERENCES

- A. ACI: American Concrete Institute
- B. AWS: American Welding Society
- C. ASTM: American Society for Testing and Materials
- D. CRSI: Concrete Reinforcing Steel Institute

1.03 SUBMITTALS

A. Shop Drawings:

- 1. Conform to ACI SP-66 showing bending diagrams, assembly diagrams, location diagrams, splicing and laps of bars, shapes, dimensions, and details for reinforcing, and stirrup spacing, accessories, and additional reinforcing at openings.
- 2. Unless otherwise approved by Engineer, reinforcing for each individual structure shall be submitted separately.

B. Product Data:

- 1. Dowel Bar Splicer System, Reinforcing Bar Splicer, and Dowel Adhesive manufacturer's product data.

C. Submit in accordance with Section 01 33 00.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver reinforcement to site bundled and tagged.

B. Use necessary precautions to maintain identification after bundles are broken.

C. Store in a manner to prevent excessive rusting and fouling with dirt, grease, and other bond-breaking coatings.

1.05 IEPA LOAN REQUIRED DOCUMENTATION – AMERICAN IRON & STEEL

A. Pursuant to the IEPA loan being used to finance the project, the Contractor and his/her suppliers shall comply with Section 436 of federal H.R. 3547, which are requirements regarding the use of American iron and steel products. These requirements apply to and are binding to the manufacturer of the products specified in the Section.

B. The manufacturer shall provide with the shop drawing submittal one (1) signed and dated original of the fully completed Certification Letter (a sample copy of which is provided on

page A-00 30-80-3 of this manual). Said form shall demonstrate compliance with Section 436 of federal H.R. 3547.

PART 2 – PRODUCTS

2.01 REINFORCEMENT MATERIALS AND ACCESSORIES

- A. Deformed Steel Bars: ASTM A615, Grade 60. Bars to be welded shall conform to ASTM A706 low alloy.
- B. Smooth Dowels: Plastic or epoxy coated plain steel bars, ASTM A615, Grade 60.
- C. Welded Wire Fabric: ASTM A185.
- D. Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcement in place:
 - 1. Comply with CRSI recommendations.
 - 2. For slabs on grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
 - 3. Exterior exposed surfaces, surfaces in contact with earth or liquid, and interior exposed surfaces in humid areas shall have all plastic or stainless steel supports.
 - 4. Interior exposed surfaces in dry areas shall have all plastic, stainless steel, or plastic tipped steel supports.
 - 5. When supports bear directly on the ground and it is not practical to use steel or plastic supports, solid precast concrete blocks may be used to support only the bottom mat of reinforcement. Precast blocks must be of equal or greater strength than the concrete being placed.
- E. Reinforcing Bar Splicers:
 - 1. Develop minimum 125% of yield capacity of bars spliced in tension when tested as assembly in accordance with ASTM A370 and ASTM A615.
 - 2. Manufacturers:
 - a. Lenton Lock by Pentair.
 - b. Bar Lock by Dayton Superior Corp..
- F. Dowel Bar Splicer Systems:
 - 1. Develop minimum 125% of yield capacity of dowels when tested as assembly in accordance with ASTM A370 and ASTM A615.
 - 2. Manufacturers:
 - a. C2D Rebar Flange Coupler by Williams Form Engineering Corp.
 - b. Lenton Form Saver by Pentair.
 - c. DBR Form Saver by Dayton Superior Corp.
- G. Dowel Adhesive:
 - 1. Epoxy or acrylic adhesive.
 - 2. Manufacturers:
 - a. HIT RE 500 V3 or HIT-HY 200-R System by Hilti Corp.
 - b. Pure 110+, AC100+ Gold or PE 1000+ by Dewalt.
 - c. SET-XP Epoxy or AT-XP Acrylic Adhesive System by Simpson Strong-Tie Co., Inc.

- d. Red Head A7+, G5 or C6+ by ITW Commercial Construction.

2.02 FABRICATION

- A. Fabricate reinforcing bars to conform to the required shapes and dimensions and in accordance with ACI 318 and CRSI Manual.
- B. In case of fabricating errors, do not straighten or rebend reinforcement in a manner that will weaken or injure the material.
- C. Reinforcement with any of the following defects will not be acceptable.
 - 1. Bar lengths, depths, and/or bends exceeding the specified fabrication tolerances.
 - 2. Bends or kinks not shown on the Drawings.
 - 3. Bars with reduced cross-section due to excessive rusting or other causes.

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 INSTALLATION

- A. Clean reinforcement to remove loose rust and mill scale, earth, and other materials which reduce or destroy bond with concrete.
- B. Position, support, and secure reinforcement against displacement by formwork, construction, and concrete placing operations. Unless otherwise noted, provide clear cover as follows:
 - 1. Cast against:
 - Earth: 3 inches
 - Mud Slab: 2 inches
 - 2. Exposed to earth, weather, or water:
 - a. Slabs:
 - #5 Bars and smaller: 1 ½ inches
 - #6 through #11 Bars: 2 inches
 - b. Walls, Beams, and Columns: 2 inches
 - 3. Not exposed to earth, weather, or water:
 - a. Slabs and Walls:
 - #3 through #7 Bars: 1 inch
 - #8 through #11 bars: 1 ½ inches
 - b. Beams and Columns: 1 ½ inches

- C. Correct displacement of reinforcement prior to and during concrete placement. Maintain clear cover as noted on Drawings. Tolerances shall be in accordance with ACI 117 and ACI 318, unless noted otherwise.
- D. Support reinforcing steel in accordance with CRSI "Placing Reinforcing Bars" with maximum spacing of 4 feet.
- E. Tie reinforcing steel at intersections in accordance with CRSI "Placing Reinforcing Bars".
 - 1. Spacing for Footings, Walls, and Columns: Every third intersection, 3 feet maximum.
 - 2. Spacing for Slabs and Other Work: Every fourth intersection, 3 feet maximum.
 - 3. Tie each dowel in-place.
- F. Reinforcement shall be continuous through construction joints.
- G. Reinforcement may be sliced at construction joints provided that the entire lap is placed within only 1 pour.
- H. Unless shown otherwise, place WWF between upper third point and mid point of slab. WWF placement on subgrade and pulling up during concrete placement not allowed.
- I. Do not field bend bars, including bars partially embedded in concrete unless indicated.
- J. Tack welding of, or to, reinforcement prohibited.
- K. Placement of reinforcement shall be approved by Engineer before placing concrete.
- L. Anchor dowels into drilled holes with epoxy dowel adhesive where noted. Conform to details shown.

3.03 SPLICES

- A. Lap reinforcing at splices. Tie securely to prevent displacement of splices during placement of concrete.
- B. Dowel Bar Splicer Systems may be substituted for dowels at Contactor's option when approved by Engineer.
- C. Reinforcing Bar Splicers may be substituted for lapped splices at Contactor's option when approved by Engineer. Stagger splices.
- D. Extend WWF to within 2 inches of edges of section. Lap sheets at least 12 inches at ends and edges and wire together. Stagger laps.
- E. Welding of reinforcing bars permitted only where noted and when approved by Engineer. Perform welding in accordance with AWS D1.4.

END OF SECTION

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 – GENERAL

1.01 SUMMARY

- A. Provide cast-in-place concrete where shown on the Drawings, as specified herein, and as needed for a complete and proper installation.

1.02 REFERENCES

- A. ASTM: American Society for Testing and Materials
- B. NRMCA: National Ready Mixed Concrete Association
- C. ACI: American Concrete Institute
- D. AASHTO: American Association of State Highway and Transportation Officials

1.03 SUBMITTALS

A. Shop Drawings:

1. Verification of Mix Design:

- a. Proposed mix design for each class of concrete to be used as specified using designations indicated. Provide dry weight of cement, saturated dry weight of coarse and fine aggregate, brand name and quantities of admixtures when applicable, fly ash when applicable, gallons of water required for 1 cubic yard of concrete, and chloride ion content.
- b. Source and material certificates of cement and fine and coarse aggregate, including sieve analysis that will be used in each class of concrete.
- c. Admixture product data.
- d. Source and test reports of fly ash.
- e. Source of blast furnace slag and documented ability of supplier to consistently furnish these materials in accordance with applicable ASTM and AASHTO requirements.
- f. Test data supporting proportions of design mixes based on laboratory trial batches or past field experience in accordance with ACI 318.
- g. NRMCA certification or letter stating plant and equipment complies with NRMCA requirements.
- h. Mix design shall be approved by Engineer before concrete delivered to site.

B. Product Data:

- 1. Waterstop: Samples of material and manufacturer's literature.
- 2. Fiber Reinforcement manufacturer's literature.
- 3. Patching Mortar manufacturer's literature.

C. Test Results:

- 1. Concrete test results.
- 2. Concrete delivery tickets: With each load of concrete delivered, provide duplicate tickets, one for Contractor, one for Engineer, with following information.

- a. Serial number of ticket.
- b. Date and truck number.
- c. Name of supplier.
- d. Class of concrete.
- e. Type of cement and cement content in bags/cubic yard.
- f. Admixture brand names.
- g. Aggregate size.
- h. Time loaded.
- i. Amount of concrete in load.
- j. Gallons of water added at site and slump of concrete after addition of water.
- k. Temperature of concrete at delivery.
- l. Time unloaded.

D. Submit in accordance with Section 01 33 00.

1.04 QUALITY ASSURANCE

- A. Plant Certification: Plant or concrete supplier shall comply with requirements of NRMCA certification plan as regards material storage and handling, batching equipment, central mixer, truck mixers with counters, agitators, nonagitating units, and ticketing system.
- B. Do not commence placement of concrete until mix designs have been reviewed and approved by Engineer.
- C. Concrete Testing: Testing shall be provided by Contractor in accordance with Section 01 45 29 and this Section.
 1. Conduct tests on sample material in accordance with methods listed below:
 - a. Slump: ASTM C143.
 - b. Air-Entrainment: ASTM C231.
 - c. Compressive Strength: ASTM C31 and ASTM C39.

1.05 PROJECT / SITE CONDITIONS

A. Hot Weather:

1. Comply with ACI 305.1.
2. Concrete temperature shall not exceed 90°F.
3. At air temperatures of 80°F or above, keep concrete as cool as possible during placement and curing.
4. When concrete temperature exceeds 80°F, water reducing, set-retarding admixtures shall be used.

B. Cold Weather:

1. Comply with ACI 306.1.
2. Temperature of reinforcement, forms, fillers, and other material in contact with concrete at time of placement shall not be less than 35°F. Preheat if temperature below 35°F.
3. Maintain air and forms in contact with concrete sections having minimum dimension less than 12 inches at temperature above 50°F for at least 3 days and at temperature above 32°F for remainder of specified curing period.

4. Maintain air and forms in contact with concrete in more massive sections at temperature above 40°F for at least 3 days and at temperature above 32°F for remainder of specified curing period.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Cement:

1. Portland cement conforming to ASTM C150.
2. Type I or II except tricalcium aluminate (C₃A) content of Type I shall not exceed 8%. If this type of Type I not available, Type I with C₃A content less than 12% shall be used in combination with fly ash.
3. Type III may be substituted for Type I when approved by Engineer and additional requirements for Type I are met.
4. When aggregates determined to be deleteriously reactive, as defined by ASTM C33, alkali content of cement defined by ASTM C150 shall not exceed 0.60%.

B. Fly Ash:

1. ASTM C618, Class C or F including requirements of Table 1A.
2. Supplemental Requirements:
 - a. Loss on Ignition (maximum): 3%.
 - b. Water Requirement (maximum): 100% (as percent of control).

C. Blast Furnace Slag:

1. Blast furnace slag shall conform to the requirements of ASTM C989 Grade 100 or 120.
2. Blast furnace slag from different sources or of different grades shall not be mixed in the same construction.

D. Aggregates:

1. ASTM C33, modified as follows:
 - a. Fine aggregate: Natural sand.
 - b. Coarse aggregate: Crushed gravel, crushed stone or gravel, Size 467 (1-1/2 inch maximum), size 67 (3/4 inch maximum), Size 8 (3/8 inch maximum).
2. Potential reactivity of aggregates shall be determined in accordance with ASTM C33.

E. Admixtures:

1. Air-Entraining: ASTM C260.
2. Chemical Admixtures: ASTM C494, non-corrosive and chloride free.

F. Water: Potable.

G. Premolded Joint Filler:

1. ASTM D 1751.
2. ASTM D1752, Type I, II, or III.
3. Closed cell polyethylene.

H. Waterstop:

1. Virgin polyvinyl chloride (PVC) waterstop conforming to CRD C572, with hog rings or grommets at 12 to 18 inches on center.
2. Construction Joints: Dumbbell or serrated type, 6 inches wide by 3/8 inch thick, at center, 4 inches wide by 3/16 inch thick only where noted.
3. Expansion Joints: Arctic grade, dumbbell or serrated type, 9 inches wide by 3/8 inch thick, at center, with 3/4 inch inside diameter hollow center bulb for joints less than 2 inches wide and 1-1/2 inch inside diameter hollow center bulb for joints 2 inches wide or wider.
4. Provide prefabricated tees, crosses, and other configurations as required.
5. Gasket Type Waterstop:
 - a. Hydrotite CJ-1020-2K by Greenstreak
 - b. MC-2010MN with P-201 by Adeka Corp.
 - c. AKWASTOP or WATERSTOP-XP by CETCO
 - d. 3/4 inch SikaSwell S-2 by Sika Corp.

I. Vapor Barrier: Polyethylene film minimum 10 mills thick.

J. Floor Sealer:

1. Manufacturers:
 - a. Dress and Seal 30 by L&M Construction Materials, Inc.
 - b. Tuf-Seal J-35 by Dayton Superior.

K. Membrane Forming Curing Compound:

1. Manufacturers:
 - a. Dress and Seal 30 by L&M Construction Materials, Inc.
 - b. MasterKure CC 200 WB by BASF.
2. ASTM C309, and compatible with scheduled finishes and coatings, except permeability shall not exceed 0.39 kilogram/meter²/72 hours.

L. Finishing Grout

1. Manufacturers:
 - a. Thoroseal with Acryl 60 by Thoro.
 - b. Concrete Finisher with AKKRO-7T by Tamms Industries Co.
 - c. SikaTop Seal 107 by Sika Corp.

M. Cement Grout: Mixture of cement and fine sand in proportions used in concrete being finished.

N. Epoxy Bonding Agent:

1. Manufacturers:
 - a. Sikadur 32 Hi-Mod by Sika Corp.
 - b. Epoxite 2362 by A.C. Horn.
 - c. Sure Bond J-58 by Dayton Superior.
 - d. Epobond by L&M Construction Materials, Inc.

- e. Five Star Bonding Adhesive by Five Star Products, Inc.
 - 2. Use when joining new to existing concrete.
 - 3. Conforming to ASTM C881.
- O. Non-Epoxy Bonding Agent:
- 1. Manufacturers:
 - a. Weld-Crete by Larsen Products Corp.
 - b. Acryl 60 by Thoro.
 - c. Acrylset by Master Builders Co.
 - d. Everbond by L&M Construction Materials, Inc.
 - 2. Use when joining new to existing concrete when bonding agent cannot be placed immediately prior to placement of new concrete.
 - 3. Conforming to ASTM C1059 Type II.
- P. Epoxy Joint Filler:
- 1. Manufacturers:
 - a. Sikadur 51 or Sikadur CJR by Sika Corp.
 - b. MM80 by Metzger/McGuire.
 - c. Epoflex or Everjoint by L&M Construction Materials, Inc.
 - d. Poxy-Fil J-52 by Dayton Superior.
 - 2. Minimum Shore Hardness of 70.
- Q. Evaporation Retardant:
- 1. Manufacturers:
 - a. Econ by L&M Construction Materials, Inc.
 - b. Confilm by Master Builders Co.
 - c. Sikafilm by Sika Corp.
- R. Fiber Reinforcement:
- 1. Manufacturers:
 - a. GCP Applied Technologies (W.R. Grace & Co.)
 - b. Fibermesh Co.
 - c. Euclid Chemical Co.
 - d. BASF
 - 2. 1/2 inch to 3/4 inch fibrillated virgin polypropylene fibers.
 - 3. ASTM C1116 Type III.
- S. Patching Mortar.
- 1. Manufacturers:
 - a. Sikatop by Sika Corp.
 - b. Duratop by L&M Construction Materials, Inc.
 - c. MasterEmaco N 300 by BASF.

2. Polymer modified cementitious fast setting mortar for repair of concrete surfaces. Consisting of polymer and selected Portland cements, aggregates, accelerator, admixtures for controlling set, water reducers for workability, and corrosion inhibitor. Shall contain no chlorides, nitrates, gypsum, or lime. Shall not produce vapor barrier. Shall be thermally compatible with concrete and shall be freeze-thaw resistant.
 - a. Concrete gray.
 - b. 5000 pounds per square inch minimum compressive strength.
 - c. 400 pounds per square inch minimum bond strength.

2.02 CONCRETE MIX DESIGN

- A. Concrete Mix: Measure and combine cement, aggregate, water, and admixtures in accordance with ASTM C94 and ACI 211.1.
 1. Cement: When used in exposed concrete shall be one brand from one source. Do not mix different cements in same element of Work.
 2. Water-Cementitious Ratio (if fly ash or slag is used, water-cement plus fly ash and slag ratio): 0.42 maximum for Class A concrete, 0.50 maximum for Class B concrete.
 3. Air-Entrainment: Air-entrain concrete exposed to exterior or exposed to liquids. Interior concrete floor with polished or trowel-finished surface, limit air content to 3% max.
 4. Chemical Admixtures: Use is optional to aid concrete properties and allow for efficient placement. Manner of use and amount shall be in accordance with manufacturer's written recommendations and as approved by Engineer. Do not use admixtures that increase early shrinkage or negatively affect finishing.
 5. Fly Ash: Use is optional unless otherwise noted. Combine fly ash with cement at rate of 1 pound fly ash for each pound reduction of cement. Amount of fly ash shall not be less than 15% or more than 25% of weight of cementitious material.
 6. Blast Furnace Slag: Use is optional unless otherwise noted. Combine blast furnace slag with cement at a rate of 1 pound blast furnace slag for each pound reduction of cement. Amount of blast furnace slag shall not be greater than 50% of weight of cementitious material.
 7. Fly Ash and Blast Furnace Slag Combination: Use is optional unless otherwise noted. Combine fly ash and blast furnace slag with cement at a rate of 1 pound fly ash or blast furnace slag for each pound reduction of cement. Amount of fly ash and blast furnace slag combination shall not be greater than 50% of weight of cementitious material. Amount of fly ash shall not be greater than 25% of weight of cementitious material.
 8. Concrete fill shall be fiber reinforced.
 - a. Dosage Rate: 1-1/2 pounds per cubic yard minimum.
 - b. Use in strict accordance with manufacturer's written recommendation and ASTM C94.
 9. Use no admixtures other than specified, unless approved by Engineer.
- B. Class of Concrete:
 1. Furnish in accordance with table. Cement contents listed are minimum values and shall be increased as required to attain other specified characteristics.
 2. Slumps listed are maximum, except when high range water reducer is used. Maximum slump when high-range water reducer is used, 10 inches.
 3. Chloride ion content shall not exceed values listed in ACI 318, Table 4.4.1.
 4. Mid-range water reducer: ASTM C494, Type A required for Class A1 and A2 concrete.

Class	28-Day Compressive Strength (psi)	Coarse Aggregate (size no.)	Minimum Cementitious Material (lbs/cu yd)	Air Content (%)	Slump (in.)
A1	4500	467	517	5.5±1.5	3±1
A2	4500	67	564	6±1.5	3±1
B1	3000	467	423	5.5±1.5	3±1
B2	3000	67	446	6±1.5	3±1
B3	3000	8	470	7.5±1.5	4 max
C	2000	67	212	---	---
psi = pounds per square inch cu yd = cubic yard in. = inch max = maximum Note: Interior concrete floor with trowel-finished surface, limit air content to 3% max.					

C. Concrete Usage:

1. Class A: All locations, except where Class B and C specified.
2. Class B: Interior slabs of Administration Building, interior equipment bases (excluding chemical tank pad), fence post piers, concrete fill in tanks, and where specifically noted.
3. Class A1: Exterior unreinforced concrete pavement.
4. Class A2: Concrete curb and gutter and concrete sidewalk.
5. Class C: Mud slabs and backfill below and around structures where noted.
6. Do not use coarse aggregate Size 467 in sections less than 12 inches thick, where clear cover of reinforcement is less than 1-1/2 inches or where clear spacing between reinforcement bars is less than 3 inches.

2.03 MIXING AND DELIVERY

- A. Use ready mixed concrete conforming to ASTM C94.
- B. Deliver and complete discharge within 1-1/2 hours of commencing of mixing. Limitations may be waived by Engineer if concrete slump, after 1-1/2 hours, is sufficient so that concrete can be placed without addition of water. In hot weather, time criteria may be reduced by Engineer.
- C. Do not add water on-site unless slump and water-cement ratio, after addition of water, is below maximum allowed.
- D. Deliver concrete to site having temperature not less than 50°F or greater than 90°F.

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 FORMS

- A. Formwork design, detailing, and installation shall be Contactor's responsibility and shall conform to ACI 347.

- B. Type of forms used is Contractor's option, except as other wise indicated or shown. Plywood and other wood surfaces shall have smooth, level surfaces treated with formoil or sealer to produce clean release of concrete from forms.
 - 1. Where walls remain exposed use plywood, prefabricated metal or wood forms; do not use boards.
 - 2. Form ties shall be plastic cone snap ties. Cone shall be min 3/4 inch diameter by 1 inch deep. Ties for liquid holding structures or dry structures below grade shall have integral waterstop. Taper tie through-bolt form ties may be used as an alternate to plastic cone snap ties; conform to details shown. Do not use wire ties on exposed concrete.
 - 3. Removal of ties shall leave holes clean cut and without appreciable spalling at face of concrete.
 - 4. Provide 3/4 inch chamfer on external corners of exposed concrete walls, beams, columns, equipment bases and exposed edges of construction joints. Do not chamfer edges flush with masonry walls.
 - 5. Provide openings at base of vertical forms as access for cleaning and inspection of forms and reinforcing prior to depositing concrete.
- C. Coat plywood and wood forms with non-staining form release agent. Apply release agent before reinforcement is placed.
- D. Clean, patch, and repair form material before reuse.
- E. Formwork shall prevent leakage of mortar, shall not deflect under weight of concrete and workmen, and shall withstand fluid pressure of concrete.
- F. Conform to tolerances as specified in ACI 117.

3.03 SUBGRADE PREPARATION

- A. Subgrade and bedding shall be compacted and free of frost. If placement occurs at temperatures below freezing, provide temporary heat and protection to remove frost. Do not place concrete on frozen material.
- B. Provide mud slabs where noted, where necessary, and when required by Engineer to obtain dry and stable working platform for placement of concrete. Unless otherwise approved by Engineer, 2 inch thick mud slabs shall be provided between free-draining fill and concrete as detailed.
- C. Provide vapor barrier between subgrade and building floor slabs where noted, overlap joints minimum 6 inches.
- D. Remove standing water, ice, mud, and foreign matter before placing concrete.

3.04 PLACING CONCRETE

- A. Notify Engineer 24 hours in advance of placing operations.
- B. Place concrete, except as modified herein, in accordance with ACI 304R.
- C. Concrete will not be allowed to drop freely where reinforcing will cause segregation of mix.
 - 1. Superplasticized Concrete: 10 feet maximum drop.
 - 2. Other Concrete: 5 feet maximum drop.
- D. If pumping used, do not use aluminum piping for delivery system.

- E. When placing concrete temporarily halted or delayed, provide construction joints as shown and as specified.
- F. Place in lifts not exceeding 24 inches and compact with internal mechanical vibrator equipment.
- G. Minimum of 2 hours shall elapse after depositing concrete in columns or walls before depositing concrete in adjoining beams or slabs.
- H. If in process of pouring wall, pour is stopped unexpectedly, leave surface of joint level but rough. Roughened surface shall have amplitude of 1/4 inch minimum.
- I. Provide bonding agent between new and hardened or existing concrete where shown. Existing concrete shall be sandblast cleaned to remove all foreign materials, to expose the coarse aggregate, and result in a roughened surface with minimum amplitude of 1/8 inch.
- J. When hot and/or wind conditions will result in evaporation of 0.2 pounds per square foot per hour or more, evaporation retardant shall be used in accordance with manufacturer's written recommendations to minimize plastic shrinkage cracking.

3.05 JOINTS

- A. Unless otherwise noted, construction joints shown are optional. Joints not shown on Drawings shall be approved by Engineer. Locate to miss splices in reinforcement.
- B. Before concrete placed, construction joints shall be cleaned, laitance removed, and surface wetted. Remove standing water.
- C. Locate construction joints in floors within middle third of span. Construction joints in floors supported by walls may be located at center of wall.
- D. Construction joints in beams shall be offset minimum distance of 2 times width of intersecting beam.
- E. Locate vertical joints in walls a min of one-half wall height from corners or other intersecting walls or at mid point between corners or intersecting walls. Locate horizontal joints in walls within the middle third of wall height.
- F. Beams shall be placed monolithically as part of slab system, unless detailed otherwise.
- G. Construction joints shall have roughened surfaces. Surface shall have amplitude of 1/4 inch minimum.
- H. Make control joints in slabs on grade by construction joint or by tooled joint.
 - 1. Control joints shall be minimum 1/4 depth of slab.
 - 2. Fill construction joint and tooled joint with epoxy joint filler.
 - 3. Unless otherwise indicated, spacing of control joints shall not exceed 24 feet in each direction.
- I. Install premolded joint filler where noted in accordance with manufacturer's recommendations. Joint filler shall be compatible with sealant and suitable for intended purpose.

3.06 WATERSTOP

- A. Provide waterstop in construction joints in:
 - 1. Walls and slabs separating dry interior from earth or liquid.
 - 2. Exterior walls and slabs of liquid holding tanks.
 - 3. Slabs above occupied areas.
 - 4. Other locations shown on Drawings.
- B. Install in accordance with manufacturer's recommendations. Secure waterstop utilizing hog rings or grommets spaced maximum 12 in. on center and within 1 in. of edge. Wire tie bottom and top of waterstop to adjacent reinforcements prior to concrete placement. Secure as required to prevent deflection or misalignment during the concrete placement.
- C. Splice joints in waterstop to form continuous watertight diaphragm. Splice in accordance with manufacturer's recommendations. Spark test joints as required by Engineer.
- D. Use gasket type waterstop only where noted. Waterstop RX and MC-2010MN gasket type waterstops shall be glued and nailed to substrate.

3.07 EMBEDDED ITEMS

- A. Cast pipe and other embedded items into concrete as placement progresses. Do not provide blockouts.
- B. Following restrictions shall be adhered to, unless otherwise noted.
 - 1. No duct, conduit, pipe, or fitting placed vertically shall be larger in cross-sectional area than 4% of column into which it is placed.
 - 2. Duct, conduit, pipe, and fittings, when placed within slabs or walls
 - a. Shall not be larger than 1/3 thickness of slab or wall.
 - b. Shall be placed within the middle 1/3 thickness of slab or wall where possible.
 - c. Shall not be placed closer than 3 outside diameter clear from each other when parallel.
 - d. Shall cross each other at right angles.
 - e. Shall be secured to prevent shifting or "floating" during concrete placement.
 - f. Multiple conduits shall not cross each other at the same location.
 - g. Except for conduits that must run up a column, keep conduits a minimum of 2 to 3 feet away from columns.
 - h. Where conditions require conduit to be tied to the inside face of the reinforcing mat, the conduit shall be galvanized steel or PVC, shall not be tied directly adjacent to a parallel reinforcement bar, and shall be placed 3 outside diameter clear away from the parallel reinforcement bar.
 - 3. Reinforcing steel shall be in place before embedded items placed and reinforcing cut or removed shall be replaced with additional reinforcing as indicated.
 - 4. Do not pass sleeves through columns without Engineer's approval.
- C. Do not place ducts, conduit, and pipes in slabs on grade. Place minimum 4 inches below slab.
- D. Set items such as bolts, anchors, piping, and frames in concrete as shown.
- E. Place items constructed of dissimilar metals to avoid physical contact with reinforcing. Secure item and reinforcing to ensure they will not shift and come into contact during

concrete placement. Contact between reinforcing steel and other metal, other than bare, coated, or plated carbon steel not permitted.

3.08 REPAIR OF SURFACE DEFECTS

A. General:

1. Prior to starting repair work, obtain Engineer's approval of proposed repair techniques and materials.
2. Method of repair shall not adversely affect the appearance of the finished structure.
3. Develop repair techniques on portion of as-cast surface selected by Engineer. Surface of repair remaining exposed to view shall match color and texture of adjacent surfaces.
4. Prepare surfaces, apply and install materials, and cure as recommended by material manufacturers.

B. Tie Holes: Fill plastic cone snap tie holes with Patching Mortar. Fill taper tie through-bolt form tie holes with Non-Shrink Grout.

C. Defective Areas:

1. Remove honeycombing, stone pockets, spalls, and other defective concrete down to sound concrete. If chipping required, make edges perpendicular to surface. Do not feather edges.
2. Fill defective area with Patching Mortar.

3.09 FINISHING SLABS AND FLATWORK

A. Slab Finishes:

Description	Concrete Finish
Surfaces to Receive Grout or Topping	Float
Submerged and Buried Slabs	Float
Slabs with Floor Coverings	1 Troweling
Sealer Applied Floors and Slabs	2 Trowelings
Exterior Exposed Slabs	Float and Broom Finish
Exterior Stairs and Walks	Float and Broom Finish

B. After placement, screed concrete with straightedges, power strike-offs or vibrating screeds.

C. After screeding, bull float or darby surfaces to eliminate ridges and to fill in voids left by screeding.

D. Float:

1. Use magnesium or aluminum hand floats or power floats with slip on float shoes.
2. Float finish shall result in uniform smooth granular texture.

E. Trowel:

1. Use steel trowels.
2. Use power or hand troweling.
3. Final troweling shall be by hand and continue until concrete surface consolidated to uniform, smooth, dense surface free of trowel marks and irregularities.

- F. Broom Finish: Use fine, soft-bristled broom and broom at right angles to direction of traffic to give nonskid finish approved by Engineer.
- G. Floor Sealer:
 - 1. Apply in accordance with manufacturer's written instructions.
 - 2. Apply first coat after final troweling, surface water glaze has dissipated, and when surface is hard enough to sustain foot traffic on same day as pour.
 - 3. When floor has been water cured, apply first coat after curing has been completed. Apply within one day of floor being dry enough for application.
 - 4. Apply second coat after Work completed and ready for occupancy.
- H. For special coatings or finishes, see room finish schedule.
- I. Tolerances:
 - 1. Concrete slabs shall be within 3/16 inch of 10 foot straightedge in all directions except where slabs are dished for drains. Deviations from elevation indicated shall not exceed 3/4 inch.
 - 2. Pitch floor to floor drains minimum 1/8 inch per foot or as shown. Pitch bottom of slab or beam to match top slope to maintain thickness or depth indicated. As an alternate, bottom of slab or beam may be placed level provided that min thickness or depth is maintained.

3.10 FINISHING FORMED CONCRETE

- A. As-Formed Finish: Finish resulting directly from formwork for surfaces which will be hidden from view by earth, submergence in water, or subsequent construction.
 - 1. Repair surface defects as specified herein.
 - 2. Where joint marks or fins on submerged surfaces exceed 1/4 inch, grind smooth.
- B. Smooth Finish: Interior concrete surfaces permanently exposed to view and concrete surfaces scheduled to be coated.
 - 1. Repair surface defects as specified herein.
 - 2. Grind joint marks and fins smooth with adjacent surface. Remove stains and rinse.
 - 3. Dampen concrete and paint entire surface with Cement Grout. Work grout into surface with suitable float. When grout has set to where it will not be pulled out of holes or depressions, brush off surface with burlap or carpet.
 - 4. Prepare surface to be coated in accordance with Section 09 96 00 and coating manufacturer's recommendations.
- C. Rubbed Finish: Exterior concrete surfaces permanently exposed to view extending to 6 inch below finished grade or liquid level.
 - 1. Repair surface defects as specified herein.
 - 2. Grind joint marks and fins smooth with adjacent surface. Remove stains and rinse.
 - 3. Apply heavy coat of Finishing Grout. After first coat has set, apply second coat. When second coat has set, float to uniform texture.
 - 4. Follow manufacturer's written recommendations.
 - 5. Finish color shall be gray.

3.11 PROTECTION AND CURING

- A. Protect concrete from frost and keep moist for min curing period of 7 days after placement in accordance with ACI 308.
- B. Formed Surfaces:
 - 1. Wet cure by spraying surfaces as frequently as drying conditions may require to keep concrete surfaces moist.
 - 2. Surfaces may be cured by leaving forms in-place. For vertical surfaces, apply water to run down inside of forms, if necessary, to keep concrete moist.
 - 3. After forms are removed, wet cure for remainder of curing period or apply curing compound.
 - 4. Do not use curing compound where mortar, grout, concrete, or other coatings or adhesives will be applied.
- C. Flatwork:
 - 1. Cure using curing compound or wet cure.
 - 2. Do not use curing compound where mortar, grout, concrete, or other coatings or adhesives will be applied.
- D. Curing Compound:
 - 1. Apply curing compound at uniform rate sufficient to comply with requirements for water retention as specified and as measured in accordance with ASTM C156.
 - 2. Cover areas subjected to direct sunlight with ambient temperature expected to exceed 80°F with white pigmented compound, other surfaces may be covered with fugitive dye compound.
- E. Protect from damaging mechanical disturbances, load stresses, heavy shock, and excessive vibration.
- F. Protect finished concrete surfaces from damage caused by construction equipment, materials, and methods, and from rain or running water.
- G. Do not load self-supporting structures to overstress concrete.

3.12 REMOVAL OF FORMING AND SHORING

- A. Do not remove forming or shoring until member supported has acquired sufficient strength to safely support own weight and any imposed loads. Forming shall remain in place for at least min time recommended by ACI 347. In addition, forming for horizontal members shall remain in place minimum 7 days. In no case shall forming for horizontal members be removed before concrete has reached 70% of specified design strength.
- B. Reshore areas as required to carry additional imposed loads.

3.13 FIELD QUALITY CONTROL

- A. Obtain samples of concrete in accordance with ASTM C172. Place cylinders on-site where they can be stored under conditions similar to concrete they represent without being disturbed for first 24 hours.
- B. Make slump tests daily and when requested by Engineer, in accordance with ASTM C143. Make slump tests from same load from which strength tests are made.

- C. Make air content tests daily and when requested by Engineer, in accordance with ASTM C231. Make air content tests from same load from which strength tests are made.
- D. If measured slump or air content falls outside specified limits, make check test immediately on another portion of same sample. In event of second failure, concrete shall be considered to have failed to meet requirements of Specifications and will be rejected.
- E. Make strength test for each of the following conditions for each class of concrete
 - 1. Each day's pour.
 - 2. Each change of source.
 - 3. Each 100 cubic yards poured.
- F. Strength test for each class of concrete consists of 4 cured standard cylinders made from composite samples secured from same load of concrete in accordance with ASTM C172. Make compressive strength tests on 1 cylinder at 7 days and 2 cylinders at 28 days. Test results at 28 days shall be average strength of 2 specimens as determined in accordance with ASTM C39. Test remaining cylinder if needed.
 - 1. When temperatures are expected to fall below 45°F within 48 hours after concrete placement, make 2 additional cylinders and cure in the field under conditions similar to concrete they represent. Test 1 cylinder at 7 days and the other at 28 days.
- G. Strength of concrete considered satisfactory if following requirements met.
 - 1. Average of all sets of 3 consecutive strength tests equal or exceed specified 28-day compressive strength.
 - 2. No individual strength test falls below specified 28-day compressive strength by more than 500 pounds per square inch.
- H. If analysis of strength tests indicate above requirements are not being met, make immediate adjustments to mix design and make additional tests as required by Engineer to determine strength of concrete in-place in portion of structure represented by deficient cylinders. If tests verify Work in-place is not in conformance with Specifications, Engineer will determine if Work in-place is adequate for intended use. If Work in-place is determined to be inadequate, Contractor shall follow such remedial or replacement measures which Engineer may require. Contractor shall bear costs associated with testing, engineering analysis, remedial work, and replacement required under terms of this paragraph.

END OF SECTION

SECTION 03 35 00
POLISHED CONCRETE FINISHING

PART 1 – GENERAL

1.01 SUMMARY

- A. Provide polished concrete where shown on the Drawings, as specified herein, and as needed for a complete and proper installation.

1.02 REFERENCES

- A. ASTM: American Society for Testing and Materials
- B. NRMCA: National Ready Mixed Concrete Association
- C. ACI: American Concrete Institute
- D. AASHTO: American Association of State Highway and Transportation Officials
- E. ANSI: American National Standards Institute
- F. NFSI: National Floor Safety Institute

1.03 SYSTEM DESCRIPTION

- A. Performance Requirements: Provide polished flooring that has been designed, manufactured and installed to achieve the following:
 - 1. Abrasion Resistance: ASTM C779, Method A, high resistance, no more than 0.008 inch wear in 30 minutes.
 - 2. Reflectivity: Increase of 35% as determined by standard gloss meter.
 - 3. Waterproof Properties: Rilem Test Method 11.4, 70% or greater reduction in absorption.
 - 4. High Traction Rating: NFSI 101-A, ANSI B-101.1 2009 non-slip properties.
- B. Design Requirements:
 - 1. Hardened Concrete Properties:
 - a. Minimum Concrete Compressive Strength: 3500 psi.
 - b. Normal Weight Concrete: No lightweight aggregate.
 - c. Non-air entrained.
 - d. Placement Properties:
 - 1.) Concrete slump of 4-1/2 inches to 5 inches.
 - 2.) Flatness Requirements:
 - a. Overall FF 50.
 - b. Local FF 40.
 - e. Hard steel troweled (3 passes) concrete. No burnishing marks. Finish to ACI 302 IR, Class 5 floor.
 - f. Curing Options: Membrane forming curing compounds (ASTM 309, Type 1, Class B, all resin dissipating cure).

1.04 SUBMITTALS

- A. Shop Drawings:

1. Plan layout including dimensions and floor grinding schedule.
 - a. Proposed mix design for each class of concrete to be used as specified using designations indicated. Provide dry weight of cement, saturated dry weight of coarse and fine aggregate, brand name and quantities of admixtures when applicable, fly ash when applicable, gallons of water required for 1 cubic yard of concrete, and chloride ion content.
 - b. Source and material certificates of cement and fine and coarse aggregate, including sieve analysis that will be used in each class of concrete.
 - c. Admixture product data.
 - d. Source and test reports of fly ash.
 - e. Source of blast furnace slag and documented ability of supplier to consistently furnish these materials in accordance with applicable ASTM and AASHTO requirements.
 - f. Test data supporting proportions of design mixes based on laboratory trial batches or past field experience in accordance with ACI 318.
 - g. NRMCA certification or letter stating plant and equipment complies with NRMCA requirements.
 - h. Mix design shall be approved by Engineer before concrete delivered to site.

B. Product Data:

1. Curing Compound, Floor Hardener, Floor Sealer, Densifier and Evaporation Retardant: Proposed rate of coverage and manufacturer's literature.
2. Preparation and concrete grinding procedures.
3. Provide Safety Data Sheets (SDS) for each product specified.

C. Test Results:

1. Certified test reports showing compliance with specified performance characteristics and physical properties as indicated in Performance Requirements..
2. Certificates:
 - a. Letter of certification from the National Floor Safety Institute confirming the system has been tested and passed phase Two Level of certification when tested by Method 101-A, ANSI B=101.1 2009 non-slip properties.
 - b. Contractor's certificate signed by manufacturer declaring Contractor as an approved installer of polished systems.

D. Operation and Maintenance Data:

1. Submit manufacturer's instructions on maintenance renewal of applied treatments.
2. Procedures and product specifications for joint filling, crack repair and surface repair.

E. Submit in accordance with Section 01 33 00.

1.05 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer trained and holding a current certificate as a FGS PermaShine installer.
2. Current certification from the CPAA stating that the technicians are trained craftsmen.
3. Installer with a minimum of 5 years of experience in performing work of this section who has specialized in installation of work similar to that required for this project.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Concrete finishing components and materials shall be from single manufacturer.
- B. Manufacturer Qualifications:
 - 1. Manufacturer capable of providing field service representation during construction and approving application method.
 - 2. Manufacturer shall have a minimum 5 years of experience in manufacturing components similar or exceeding components of this project.
- C. Regulatory Requirements: Comply with NFSI Test Method 101-A Phase Two Level High Traction Material.
- D. Mock-Ups:
 - 1. Mock-Up Size: 100 sf sample panel at jobsite at location as directed under conditions similar to those which will exist during actual placement.
 - 2. Mock-up will be used to judge workmanship concrete substrate preparation, operation of equipment, material application and shine.
 - 3. When accepted, mock-up will demonstrate minimum standard of quality required. Approved mock-up may remain as part of finished work.
 - 4. Mock-up will demonstrate required level of cut:
Level 3 – Medium Aggregate: Exposing more of the overall girth of the course aggregate within the concrete. Level of cut shall be within 1/8 inch of the surface.
 - 5. Sheen – Level B: High gloss as determined by a gloss reading of 60-70.

2.02 DELIVERY STORAGE AND HANDLING

- A. Deliver materials in manufacturer's original packaging with identification labels and seals intact.
- B. Store materials protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.

2.03 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and entilation) within limits recommended by manufacturer.
- B. Do not install products under environmental conditions outside manufacturer's recommended limits.

2.04 SEQUENCING

- A. Comply with manufacturer's written recommendations for sequencing construction operations.

2.05 WARRANTY

- A. **Manufacturer's Warranty:** Submit for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and does not limit other rights Owner may have under Contract Documents.

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.
- B. **Verify Concrete Slab Performance Requirements:**
 - 1. Verify slab is cured to 28 day duration and 3500 psi strength.
 - 2. Verify concrete surfaces have received a hard steel trowel finish (3 passes) during placement.
 - 3. Verify overall floor flatness is a minimum of FF 40.

3.02 PREPARATION

- A. Ensure surfaces are clean and free of dirt and other foreign matter harmful to performance of concrete finishing materials.
- B. Examine surface to determine soundness of concrete for polishing.

3.03 INSTALLATION

- A. **Floor surface polishing and treatment:**
 - 1. Provide polished concrete floor treatment in entirety of slab indicated by Drawings. Provide consistent finish in all contiguous areas.
 - 2. Apply floor finish prior to installation of fixtures and accessories.
 - 3. Diamond polish floor surfaces with power disc machine recommended by floor finish manufacturer. Sequence with course to fine grit.
 - 4. Verify optimum starting grit with Engineer in order to achieve the specified aggregate exposure.
 - a. Comply with manufacturer's recommended polishing grits to for each sequence to achieve desired finish level. Following the initial passes of metal bond diamonds, the installer shall drop back a minimum of one grit level when transitioning to resin bond diamonds. The separation in grit designation shall be a minimum of 50 for the transitioning step. The install shall refine each abrasive grit to its fullest potential before moving on to the next level. Floor shall be thoroughly scrubbed between each grit pass to remove all loose material. Level of sheen shall match approved mock-up.
 - b. Expose aggregate in concrete surface only as determined by approved mock-up.
 - c. All concrete surfaces shall be uniform in appearance.
 - 5. **Hardener and Densifier Application:**
 - a. First coat of FGS Hardener Plus at 250 sf/gal following the 400 grit level.
 - b. Second coat of FGS Hardener Plus at 350 sf/gal prior to the final polishing pass.
 - c. Follow manufacturer's recommendations for drying time between successive coats.
 - 6. Remove defects and re-polish defective areas.
 - 7. Finish edges of floor finish adjoining other materials in a clean and sharp manner.

3.04 ADJUSTMENTS

- A. Re-polish area not meeting specified gloss levels.
- B. Fill joints flush to surface prior to the start of polishing operations.

3.05 FINAL CLEANING

- A. Upon completion, remove surplus and excess materials, rubbish and equipment.

3.06 PROTECTION AND CURING

- A. Protect finished polished floor from damage during construction in accordance with manufacturer's recommendations.
- B. Protect from damaging mechanical disturbances, load stresses, heavy shock, and excessive vibration.
- C. Protect finished concrete surfaces from damage caused by construction equipment, materials, and methods, and from rain or running water.
- D. Do not load self-supporting structures to overstress concrete.

END OF SECTION

SECTION 03 40 00
PRECAST CONCRETE

PART 1 – GENERAL

1.01 SUMMARY

- A. Provide precast prestressed concrete roof members where shown on the Drawings, as specified herein, and as needed for a complete and proper installation.

1.02 REFERENCES

- A. ACI: American Concrete Institute
- B. PCI: Precast Concrete Institute
- C. ASCE: American Society of Civil Engineers
- D. AWS: American Welding Society

1.03 SYSTEM DESCRIPTION

- A. Precast manufacturer shall be responsible for structural design of individual precast prestressed components and connections between components.
- B. Design, reinforce, and prestress units as required by ACI 318, PCI Design Handbook, local building code, and as specified herein.
- C. Design and provide members capable of supporting superimposed loads shown on Drawings.
- D. Provide 1-1/2 hour UL fire resistance rated units unless otherwise noted.
- E. Roof plank shall be hollow core Machine Cast (Dry Cast) units.
- F. Conform to the shapes indicated.

1.04 SUBMITTALS

- A. Shop Drawings:
 - 1. Content:
 - a. Dimensions.
 - b. Design loads.
 - c. Design camber.
 - d. Fabrication details.
 - e. Details of inserts, anchors, connections, accessories, joints, and openings.
 - f. Chamfer and radius of corners.
 - g. Reinforcement and tendons.
 - h. Welds.
 - i. Finishes.
 - j. Lifting positions and devices.

2. Erection drawings including piece numbers and table referencing piece numbers to standard unit designations.
 3. Stamped by Structural Engineer registered in State of Illinois.
- B. Product Data:
1. Catalog or table information for standard precast units.
- C. Miscellaneous Submittals:
1. Evidence of certification or experience qualifications, when requested by Engineer.
- D. Submit in accordance with Section 01 33 00.
- 1.05 QUALITY ASSURANCE
- A. Conduct testing in accordance with PCI MNL-116.
- B. Shop Inspection:
1. Shop inspection may be required by Owner at Owner's expense. Contractor shall give min 7 days notice to Engineer prior to starting fabrication and shipment of completed components so inspection may be provided.
 2. Shop inspection intended as means of facilitating Work and avoiding errors, but will in no way relieve Contractor from responsibility for furnishing proper materials and workmanship required by these Specifications.
- 1.06 DELIVERY, STORAGE, AND HANDLING
- A. Follow manufacturer's written instructions for handling and storage.
- B. Store units at the job site in a manner to prevent cracking, distortion, warping, staining, and other physical damage, and in a manner to keep markings visible.
- C. Lift and support the units only at designated lifting points or supporting points as shown on the approved Shop Drawings.
- 1.07 IEPA LOAN REQUIRED DOCUMENTATION – AMERICAN IRON & STEEL
- A. Pursuant to the IEPA loan being used to finance the project, the Contractor and his/her suppliers shall comply with Section 436 of federal H.R. 3547, which are requirements regarding the use of American iron and steel products. These requirements apply to and are binding to the manufacturer of the products specified in the Section.
- B. The manufacturer shall provide with the shop drawing submittal one (1) signed and dated original of the fully completed Certification Letter (a sample copy of which is provided on page A-00 30-80-3 of this manual). Said form shall demonstrate compliance with Section 436 of federal H.R. 3547.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Firms specializing in providing precast prestressed concrete products and services normally associated with industry for at least 3 yrs.

- B. Manufacturers meeting requirements of PCI MNL-116.
- C. Manufacturers may be required to submit written evidence showing experience, qualifications, and adequacy of plant, facilities, and ability to perform Work.

2.02 MATERIALS

- A. Portland Cement: ASTM C150, Type I, II, or III.
 - 1. Admixtures:Chemical: ASTM C494, non-corrosive and chloride free.
- B. Aggregates:
 - 1. ASTM C33.
 - 2. Natural materials.
 - 3. Maximum 3/4 inch.
- C. Water: Potable.
- D. Reinforcing Steel:
 - 1. Deformed Steel Bars: ASTM A615, Grade 60.
 - 2. Welded Wire Fabric: ASTM A185.
 - 3. Fabricated Steel Bar Mats: ASTM A184.
- E. Fiber Reinforcement:
 - 1. Manufacturers:
 - a. W.R. Grace & Co.
 - b. Fibermesh Co.
 - c. Euclid Chemical Co.
 - 2. 1/2 inch to 3/4 inch fibrillated virgin polypropylene fibers.
 - 3. ASTM C1116 Type III.
- F. Tendons: Uncoated, stress-relieved strand, ASTM A416, Grade 250K or 270K. Low relaxation strand conforming to Supplement 1 may be used.
- G. Anchors and Inserts:
 - 1. 316 stainless steel where noted.
 - 2. 304 stainless steel bolts.
 - 3. Types as indicated on the Drawings or as approved by Engineer.
- H. Cement Grout: One part Portland cement and 3 parts sand.
- I. Bearing Pads:
 - 1. Hollow Core Plank: 1/8 inch thick tempered hardboard or high-density plastic.
- J. Welded Studs: AWS D1.1.
- K. Joint Sealants and Accessories: Conform to requirements of Section 07 92 00.

2.03 MIX DESIGN

- A. Mix design shall be in accordance with manufacturer's recommendations.
- B. Concrete Properties:
 - 1. 28-Day Compressive Strength: Minimum 5000 pounds per square inch for hollow core plank.

2.04 FABRICATION

- A. Formwork:
 - 1. Construct forms to maintain units within specified tolerances with radius or chamfer corners.
 - 2. Locate lifting devices to not harm appearance of unit in finished position.
 - 3. Form treatments or curing compounds shall not contain ingredients which might stain concrete or reduce bond with subsequent coatings, finishes, etc.
- B. Reinforcement:
 - 1. Pretension tendons in accordance with PCI MNL-116.
 - 2. Provide reinforcement necessary to resist applied loads, handling and erection.
- C. Locate lifting devices to not harm appearance of unit in finished position.
- D. Accurately and rigidly position embedded items during concrete placement. Avoid contact of dissimilar metals.
- E. Batch, mix, and handle concrete in accordance with ACI and PCI recommendations.
- F. Cure units in accordance with PCI MNL-116.
- G. Detensioning:
 - 1. Detension units after concrete has reached release strength in accordance with design.
 - 2. If heat cured, perform detensioning while unit is still warm.
 - 3. Detension tendons in gradual sequence to prevent shock and unbalanced loads.
- H. Finishes:
 - 1. Unexposed Areas: As cast.
 - 2. Interior Exposed Faces of Roof Plank (Dry Cast Units):
 - a. Cast against concrete or steel casting beds maintained in accordance with industry practice.
 - b. Surface holes, chips, and spalls shall not exceed 1/4 inch.
 - c. Casting bed offsets and finish shall not exceed 1/8 inch.
 - 3. Field coated / stained as specified in section 09 96 00.
- I. Fabrication tolerances shall conform to requirements of PCI MNL-116.
 - 1. Edges of units shall be true and parallel and not vary from a straight line more than 1/8 inch at any point.
 - 2. Edges shall be parallel within maximum variation of 1/8 inch at any point.
 - 3. Faces shall not vary from flat plane more than 1/8 inch at any point.

4. Maximum warpage prior to installation shall not exceed that which can be corrected during installation.

2.05 ANCHORS, HOLES, AND FRAMING

- A. Provide pipes, sleeves, inserts, weld plates, anchor plates, anchor bolts, bolts, concrete anchors, and other embedded items shown and as required. Place dissimilar metals to avoid physical contact between them.
- B. Furnish inserts, plates, fastening devices, and anchors to be set in supporting structure.
- C. Provide anchor straps, plates, angles, bolts, and other items as required to connect individual members to each other and supporting structure.
- D. Holes shall be formed during manufacture of units, or field cut or cored. Location shall be coordinated with manufacturer. Do not cut tendons without manufacturer's consent. Over cutting will not be allowed. Edges of holes shall be neat and square, spalled edges will not be allowed.
- E. Large Openings:
 1. Design and provide steel headers.
 2. Reinforce units adjacent to units with large openings to support additional dead and live load caused by opening.
- F. At holes and along cut edges of hollow core units, exposed cores shall be grouted solid within 6 inches of hole or cut edge.

2.06 SOURCE QUALITY CONTROL

- A. Comply with applicable requirements of PCI MNL-116.
 1. Make one compression test and absorption test for each day's production of each type of member.
 2. Test cylinders and absorption specimens shall be cast from the same materials and by the same methods as the precast units, and shall be cured in the same manner as the precast units.
 3. Compression test shall conform to ASTM C39.
- B. Failure of any member to come within tolerances specified herein shall be cause for rejection.

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 INSTALLATION

- A. Erect units in accordance with manufacturer's written instructions.
- B. Do not bear units on cast-in-place concrete or masonry construction until support has reached 80% of design strength.

- C. Provide bearing pads set on level and uniform bearing surfaces.
- D. Do not place warped, cracked, or broken units.
- E. Ends of units may be saw cut if required for proper clearance. Do not break units with hammer to produce proper clearance.
- F. Set units straight, level, plumb, and square.
- G. Provide temporary supports and bracing as required to maintain position, stability, and alignment until units are permanently connected.
- H. Perform welding in accordance with AWS D1.1 and AWS D1.4.
- I. Remove lifting devices and grout flush with adjacent surface.
- J. Repair damaged surfaces to match adjacent surfaces.
- K. Connect and anchor units to each other and other structural elements as shown and in accordance with approved shop drawings.
- L. Anchor hollow core units to supporting members as shown. When approved by Engineer, anchors may be drilled and grouted into supporting structure.
- M. Erection Tolerances:
 - 1. Roof Plank:
 - a. Alignment between units and along other structural elements: Maximum 1/8 inch per 10 feet, vertical and horizontal.
 - b. Elevation between adjacent roof members: Maximum difference 3/4 inch at any point.
 - c. Gaps between adjacent roof units: Maximum 1/4 inch.

3.03 GROUTING, POINTING, AND CAULKING

- A. Roof Units: Grout joints between hollow core floor and roof units from top of unit, and finish on underside before hardening as follows:
 - 1. Where units to be exposed or painted as finished ceiling: Rake joints 1/2 inch deep and fill with sealant, finish smooth.
 - 2. Unexposed areas and areas with suspended ceilings: Rough formed or rough broomed.
 - 3. Trowel top of grout joints on roofs smooth to prevent unevenness interfering with placing of, or causing damage to, insulation or roofing. Slope due to differential elevations shall not exceed 1:12.

3.04 CLEANING

- A. Clean exposed surfaces with water, rinse thoroughly.

END OF SECTION

SECTION 03 62 00
NON SHRINK GROUTING

PART 1 – GENERAL

1.01 SUMMARY

- A. Cement based grout for setting equipment base plates.

1.02 REFERENCES

- A. ASTM: American Society for Testing and Materials

1.03 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's literature.
- B. Submit in accordance with Section 01 33 00.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Manufacturers:
 - 1. Five Star NBEC by Five Star Products, Inc.
 - 2. SET Grout by BASF.
 - 3. Duragrout by L&M Construction Chemicals, Inc.
 - 4. SikaGrout 212 by Sika Corp.
- B. Grout:
 - 1. Preblended, cement based, nonmetallic, nongas forming, nonshrink and shall not bleed.
 - 2. Comply with ASTM C1107 and CRD C621, Grade B.
 - 3. Moderate fluidity.
 - 4. 5000 pounds per square inch minimum compressive strength.
- C. Water: Potable.

PART 3 – EXECUTION

3.01 PREPARATION

- A. Clean grout contact surfaces of oil, grease, scale, and other foreign matter.
- B. Chip away unsound concrete leaving surface rough but level.
- C. Clean base plates, rails, anchors, bolts, etc. in contact with grout of oil, grease, dirt, and coatings.

3.02 MIXING AND PLACING

- A. Mix and place in accordance with manufacturer's written instructions.
- B. Provide forming materials where necessary to retain grout until hardened.
- C. Work grout from one side. Avoid trapping air under base plate.
- D. Do not load grout until it has reached a minimum of 3000 pounds per square inch compressive strength.

3.03 CURING

- A. Cure as recommended by grout manufacturer.

END OF SECTION

DIVISION 4

MASONRY

SECTION 04 21 13
BRICK MASONRY

PART 1 – GENERAL

1.01 SUMMARY

- A. Provide clay brick masonry where shown on the Drawings, as specified herein, and as needed for a complete and proper installation.

1.02 REFERENCES

- A. ASTM: American Society for Testing and Materials
- B. ACI: American Concrete Institute

1.03 SUBMITTALS

A. Shop Drawings:

- 1. Source, material certificates, and proportions by weight of cement, fine aggregate, and admixtures for mortar.

B. Product Data:

- 1. Brick cleaner manufacturer's literature.
- 2. Flashing manufacturer's literature.
- 3. Weephole manufacturer's literature.

C. Samples:

- 1. Brick.
- 2. Flashing.
- 3. Mortar catcher.

D. Miscellaneous Submittals:

- 1. Material certification for brick units. Test data shall not be more than 5 years old.

E. AIS Certification.

F. Submit in accordance with Section 01 33 00.

1.04 QUALITY ASSURANCE

A. Sample Panel:

- 1. 6 feet long by 4 feet high panel showing:
 - a. Color range.
 - b. Texture range.
 - c. Bonding.
 - d. Soldier coursing using accent brick.
 - e. Mortar color.

- f. Tooled joints.
 - g. Quality of workmanship.
2. Do not start Work until Engineer has accepted sample panel.
 3. Use panel as standard of comparison. Failure of masonry work to meet or exceed quality of work depicted by sample panel shall be cause for rejection.
 4. Do not destroy or move panel until Work completed and accepted by Owner.
 5. When approved by Engineer, sample panel may be incorporated into finished work.

1.05 IEPA LOAN REQUIRED DOCUMENTATION – AMERICAN IRON & STEEL

- A. Pursuant to the IEPA loan being used to finance the project, the Contractor and his/her suppliers shall comply with Section 436 of federal H.R. 3547, which are requirements regarding the use of American iron and steel products. These requirements apply to and are binding to the manufacturer of the products specified in the Section.
- B. The manufacturer shall provide with the shop drawing submittal one (1) signed and dated original of the fully completed Certification Letter (a sample copy of which is provided on page A-00 30-80-3 of this manual). Said form shall demonstrate compliance with Section 436 of federal H.R. 3547.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units above ground on level platforms which allow air circulation under the stacked units.
- B. Cover and protect against wetting prior to use.

1.07 PROJECT / SITE CONDITIONS

A. Cold Weather Protection:

1. Temperature of masonry units shall not be less than 32°F when laid.
2. When air temperature falls below 40°F or when temperature of masonry units is below 40°F:
 - a. Remove visible ice on masonry units before unit is laid.
 - b. Heat mortar sand or mixing water to produce mortar temperature between 40°F and 120°F.
 - c. When air temperature is between 25°F and 40°F, completely cover masonry by covering with weather resistant membrane for 24 hours after construction.
 - d. When air temperature is between 20°F and 25°F, use heat sources, install wind breaks when wind velocity exceeds 15 miles per hour, and completely cover masonry with insulating blankets for 24 hours after construction.
 - e. When air temperature is below 20°F, provide enclosure and use heat source to maintain temperature within enclosure above 32°F for 24 hours after construction.

B. Hot Weather Protection:

1. When air temperature exceeds 100°F, or 90°F with wind velocity greater than 8 miles per hour:
 - a. Do not spread mortar more than 4 feet ahead of masonry.
 - b. Set units within 1 minute of spreading mortar.

PART 2 – PRODUCTS

2.01 MORTAR AND GROUT

A. Materials:

1. Portland Cement: ASTM C150, Type I.
2. Masonry Cement: ASTM C91, Type S.
3. Lime: Hydrated lime, ASTM C207, Type S.
4. Sand: ASTM C144, acceptable in color, 10% passing No. 100 sieve.
5. Water: Potable.
6. Coloring Pigments: Commercial iron oxide, manganese dioxide, or chromium oxide of color selected by Owner to match existing buildings.
7. Do not use antifreeze compounds.
8. Do not use water repellent admixture.

B. Proportions: ASTM C270, property specification Type S (1800 pounds per square inch).

2.02 BRICK MASONRY UNITS

A. Brick:

1. Modular size units (7 5/8 x 2 1/4 x 3 5/8) conforming to ASTM C216, Grade SW, Type FBX.
2. Provide special shapes where indicated on Drawings, and as required for complete and proper installation.
3. Buildings 120 (Process Control Building) and Building 125 (Chemical Building): Color and texture to match existing brick.
4. Building 900 (Administration Building).
 - a. Field Brick Color: Urban Grey (WK12-3010) Stone Rolled Texture by Glen-Gery Corporation.
 - b. Accent Brick Color (Soldier Coursing): Stone Grey (K12-3009) by Glen-Gery Corporation.

2.03 WEEPHOLE MATERIAL

A. Manufacturer:

1. William Goodco Brick Vent by William Products, Inc.

B. Offset "T" shape brick vent with vertical leg, slotted to allow air passage while preventing water passage and top flap designed to keep mortar out. Vent shall be designed for full height of brick.

2.04 MORTAR CATCHER

A. Manufacturers:

1. Mortar Trap by Hohmann & Barnard, Inc.
2. MortarNet by Mortar Net Solutions.

B. Mesh material placed in the wall cavity to prevent mortar droppings from blocking weep holes.

2.05 FLASHING

- A. Rubberized asphalt sheet flashing with metal drip edge.
- B. Sheet Flashing:
 - 1. Perm-A-Barrier as manufactured by W. R. Grace & Co.
 - 2. Dur-O-Barrier as manufactured by Dur-O-wall.
 - 3. A self-sealing, self-healing, fully adhered composite flexible, self-adhesive, cold applied sheet consisting of a minimum of 32 mils of rubberized asphalt bonded to an 8 mil high density cross laminated polyethylene film.
- C. Metal drip edge shall be 26 gauge 304 stainless steel sheet. Drip edge shall be minimum 2 ½ inches wide with 5/8 inch 135 degree drip and minimum 1/4 inch hem along outside edge.
- D. Accessories: Primer, conditioner, adhesive, and mastic compatible with the sheet flashing as recommended by the sheet flashing manufacturer.

2.06 BRICK CLEANER

- A. Manufacturers:
 - 1. Sure Klean.
- B. As recommended by brick manufacturer.

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 BRICK MASONRY UNITS

- A. General:
 - 1. Use only brick that are clean and free of dust and other foreign matter.
 - 2. Use masonry saws to cut and fit masonry units.
 - 3. Set units plumb, true to line, with level courses accurately spaced, and with square angles and corners.
 - 4. Clean the top surface of foundation free from dirt and debris prior to start of installing first course.
 - 5. Where brick are moved or shifted, remove and lay again on fresh mortar.
- B. Wetting:
 - 1. Brick which have an initial rate of absorption (suction) greater than 30 grams per 30 square inch per minute, as measured in accordance with ASTM C67, shall be wetted prior to laying except when air temperature falls below 40°F or when temperature of units is below 40°F.
 - 2. Use wetting method which will assure each unit is nearly saturated but surface dry when laid.
- C. Unless otherwise shown on the Drawings, provide running bond with vertical joints located at center of masonry units in the alternate course below.

- D. Do not use chipped or broken units. If such units are discovered in the finished wall, Engineer may require their removal and replacement with new units at no additional cost to the Owner.
- E. Laying up:
 - 1. Place units in mortar with full bed and head joints.
 - 2. Where brick laid against concrete masonry units, provide horizontal joint reinforcement in accordance with Section 04 22 00.
- F. Tooling:
 - 1. Tool joints to a dense, smooth surface.
 - 2. Unless otherwise shown on the Drawings, provide joints of "concave" pattern throughout.
 - 3. Brush with soft brush to remove projecting mortar.
- G. Provide control joints where shown. Conform to details shown.
- H. Flashing:
 - 1. Clean surface of masonry smooth and free from projections which might puncture or otherwise damage flashing.
 - 2. Install in accordance with manufacturer's recommendations to provide continuous flashing system.
 - 3. Provide end dam at each end of flashing to funnel flow out of wall.
 - 4. Turn up sheet flashing a minimum of 8 inches and fully adhere to substrate.
 - 5. Fully adhere sheet flashing to top of metal drip edge and cut off sheet flashing 1/2 inch back from exterior face.
 - 6. In cold or wet weather when flashing will not fully adhere to substrate, provide termination bar mechanically anchored to substrate at top of flashing to secure flashing in place.
- I. Provide weepholes by omission of 1 inch of mortar head joints or provide vents at base of flashings. Space not over 32 inches on center with a minimum of 1 weep hole between openings. Keep weepholes and area above flashings free of mortar.
- J. Build into masonry rough frames, metal frames, lintels, anchors, anchor bolts, inserts, sleeves, brackets, etc.
- K. Install insulation into cavities of exterior walls. Conform to requirements of Section 07 21 00.
- L. Tolerances: Conform to requirements of ACI 530.1.

3.03 PROTECTION

- A. Protect masonry from damage.
- B. Cover freshly laid masonry and walls not being worked on to prevent rapid drying and to exclude rain and snow.

3.04 CLEANING

- A. Clean as units are set and daily.
- B. Remove surplus mortar and leave surface clean and finished.

- C. Upon completion, visually inspect Work and point, or cut out and repoint all holes and defective joints.
- D. Thoroughly clean all brick surfaces to be left exposed in finished work. Use brick cleaner in accordance with manufacturer's recommendations. Acid shall not be used.

END OF SECTION

SECTION 04 22 00
CONCRETE UNIT MASONRY

PART 1 – GENERAL

1.01 SUMMARY

- A. Provide concrete unit masonry where shown on the Drawings, as specified herein, and as needed for a complete and proper installation.

1.02 REFERENCES

- A. ASTM: American Society for Testing and Materials
- B. ACI: American Concrete Institute

1.03 SUBMITTALS

A. Shop Drawings:

- 1. Source, material certificates, and proportions by weight of cement, fine and coarse aggregates, and admixtures for mortar and masonry grout.
- 2. Bar reinforcement shop drawings.

B. Product Data:

- 1. Wall reinforcing and anchors manufacturer's literature.
- 2. Decorative masonry unit manufacturer's literature.
- 3. Weephole manufacturer's literature.
- 4. Flashing and air barrier manufacturer's literature.

C. Miscellaneous Submittals:

- 1. Material certification for masonry units. Test data shall not be more than 3 year old.

D. AIS Certification.

E. Submit in accordance with Section 01 33 00.

1.04 IEPA LOAN REQUIRED DOCUMENTATION – AMERICAN IRON & STEEL

- A. Pursuant to the IEPA loan being used to finance the project, the Contractor and his/her suppliers shall comply with Section 436 of federal H.R. 3547, which are requirements regarding the use of American iron and steel products. These requirements apply to and are binding to the manufacturer of the products specified in the Section.

- B. The manufacturer shall provide with the shop drawing submittal one (1) signed and dated original of the fully completed Certification Letter (a sample copy of which is provided on page A-00 30-80-3 of this manual). Said form shall demonstrate compliance with Section 436 of federal H.R. 3547.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units above ground on level platforms which allow air circulation under the stacked units.

- B. Cover and protect against wetting prior to use.
- C. Deliver decorative units packaged in manner to prevent damage.

1.06 PROJECT / SITE CONDITIONS

A. Cold Weather Protection:

1. Temperature of masonry units shall not be less than 32°F when laid.
2. When air temperature falls below 40°F or when temperature of masonry units is below 40°F:
 - a. Remove visible ice on masonry units before unit is laid.
 - b. Heat mortar sand or mixing water to produce mortar temperature between 40°F and 120°F.
 - c. When air temperature is between 25°F and 40°F, completely cover masonry by covering with weather resistant membrane for 24 hours after construction.
 - d. When air temperature is between 20°F and 25°F, use heat sources, install wind breaks when wind velocity exceeds 15 miles per hour, and completely cover masonry with insulating blankets for 24 hours after construction.
 - e. When air temperature is below 20°F, provide enclosure and use heat source to maintain temperature within enclosure above 32°F for 24 hours after construction.

B. Hot Weather Protection:

1. When air temperature exceeds 100°F, or 90°F with wind velocity greater than 8 miles per hour:
 - a. Do not spread mortar more than 4 feet ahead of masonry.
 - b. Set units within 1 minute of spreading mortar.

PART 2 – PRODUCTS

2.01 MORTAR AND GROUT

A. Materials:

1. Portland Cement: ASTM C150, Type I.
2. Masonry Cement: ASTM C91, Type S.
3. Lime: Hydrated lime, ASTM C207, Type S.
4. Aggregates:
 - a. Mortar: ASTM C144, acceptable in color, 10% passing No. 100 sieve.
 - b. Masonry Grout: ASTM C404.
5. Water Repellant Admixture:
 - a. Dry-Block by W.R. Grace & Co.
6. Water: Potable.
7. Coloring Pigments: Commercial iron oxide, manganese dioxide, or chromium oxide of color selected by Owner.
8. Do not use antifreeze compounds.

B. Proportions:

1. Mortar: ASTM C270, property specification Type S (1800 pounds per square inch).
2. Masonry Grout: ASTM C476 (2500 pounds per square inch minimum).
3. Use water repellant admixture in mortar for units exposed to earth or weather in accordance with manufacturer's written recommendations. Do not use water repellant admixture for brick masonry.

2.02 CONCRETE MASONRY UNITS

A. Hollow Normal Weight Concrete Block: ASTM C90.

B. Solid Block: ASTM C90, normal weight.

C. Decorative Concrete Masonry Units (Glazed Face):

1. Manufacturers:

- a. Spectra - Glaze II by a licensed Spectra Group manufacturer.
- b. Astra - Glaze-SW by Anchor Concrete Products.

2. Hollow light weight concrete block with glazed finish on exposed surfaces.

3. Glazed Facing Requirements: Conform to requirements of ASTM C744.

4. Color of glazing shall be as selected by Engineer from manufacturer's standard color series.

D. Provide fire rated units where noted.

E. Provide special block for corners, control joints, jambs, sills, lintels, bond beams, etc. Joints at outside corners are not acceptable.

F. Provide bull nose edges where shown and at all interior exposed vertical corners, including door and window openings.

2.03 REINFORCEMENT AND ANCHORS

A. Horizontal Joint Reinforcement:

1. Truss, Ladur, Ladur Tri-Rod, CRT, Dur-o-Tab, adjustable CRT, adjustable Dur-o-Tab by Dur-O-Wall, Inc.
2. 2 or 3 longitudinal 9 gauge galvanized rods welded to 9 gauge cross rods at 16 inches on center, conforming to ASTM A82.
3. Provide special manufactured corner and wall intersection pieces.
4. Hot dipped galvanize coated: ASTM A153, Class B2.

B. Reinforcing Bars: Conform to requirements of Section 03 20 00.

2.04 WEEPHOLE MATERIAL

A. Vertical Cell Vent: 3/8 in. W x 2-1/2 in. H x 3-3/8 in. L; gray polypropylene, multi-cell construction.

2.05 MORTAR CATCHER

A. Manufacturers:

1. Mortar Trap by Hohmann & Barnard, Inc.

2. MortarNet by Mortar Net Solutions.
- B. Mesh material placed in the wall cavity to prevent mortar droppings from blocking weep holes.

2.06 FLASHING AND AIR BARRIER

- A. Rubberized asphalt sheet flashing with metal drip edge.
- B. Sheet Flashing and Air Barrier:
 1. Perm-A-Barrier as manufactured by W. R. Grace & Co.
 2. Dur-O-Barrier as manufactured by Dur-O-wall.
 3. A self-sealing, self-healing, fully adhered composite flexible, self-adhesive, cold applied sheet consisting of a minimum of 32 mils of rubberized asphalt bonded to an 8 mil high density cross laminated polyethylene film.
- C. Metal drip edge shall be 24 gauge, G-90 galvanized commercial quality prefinished steel sheet, coated with a high performance fluoropolymer coating (Kynar 500). Color as selected by Owner. Drip edge shall be minimum 2½ inches wide with 5/8 inch 135 degree drip and minimum 1/4 inch hem along outside edge.
- D. Accessories: Primer, conditioner, adhesive, and mastic compatible with the sheet flashing as recommended by the sheet flashing manufacturer.

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 CONCRETE MASONRY UNITS

- A. General:
 1. Use normal weight block for interior partitions or backing for exterior walls.
 2. Use normal weight block with water repellant admixture where exposed to earth or weather.
 3. Lay only dry masonry units.
 4. Use masonry saws to cut and fit masonry units.
 5. Set units plumb, true to line, and with level courses accurately spaced.
 6. Clean the top surface of foundation free from dirt and debris prior to start of installing first course.
 7. Accurately fit the units to plumbing, ducts, openings, and other interfaces, neatly patching all holes.
 8. Keep the walls continually clean, preventing grout and mortar stains. If grout does run over, clean immediately.
- B. Unless otherwise shown on the Drawings, provide running bond with vertical joints located at center of masonry units in the alternate course below.
- C. Do not use chipped or broken units. If such units are discovered in the finished wall, Engineer may require their removal and replacement with new units at no additional cost to the Owner.

D. Laying up:

1. Place units in mortar with full bed and head joints where cells are to be filled with mortar or masonry grout. Other masonry shall have face-shell bedding.
2. Align vertical cells of hollow units to maintain a clear and unobstructed system of flues.
3. Reinforce walls with continuous horizontal joint reinforcement spaced at 16 inches on center. Reinforce parapets with continuous horizontal joint reinforcement spaced at 8 inches on center. Lap reinforcement minimum of 8 inches, and stagger laps minimum of 32 inches.
4. Bond intersections of walls with horizontal joint reinforcement, conform to details shown.
5. Tie / reinforce cavity walls with horizontal joint reinforcement.

E. Bar Reinforcement:

1. Provide reinforcement as shown on the Drawings.
2. Provide required metal accessories to ensure adequate alignment of steel during grout filling operations.
3. Unless otherwise shown, provide continuous bond beam around top of buildings at roof bearing elevation. Reinforce with 2 No. 5 bars.

F. Tooling:

1. Tool joints to a dense, smooth surface.
2. Unless otherwise shown on the Drawings, provide joints of "concave" pattern throughout.
3. Brush with soft brush to remove projecting mortar.
4. Cut mortar flush with surface on concealed surfaces.

G. Provide control joints where shown. Conform to details shown.

H. Provide reinforced masonry lintels over openings where noted and where steel lintels not provided. Form lintels by using bond beam units to match wall texture. Lintels shall bear on masonry minimum 8 inches beyond each side of opening. Openings 4 feet and less in width, that do not have a lintel scheduled, shall have 8 inch high reinforced masonry lintels reinforced with 2 No. 5 bars or double steel angle lintels. For cavity walls, provide additional steel angle, L6x6x5/16, bolted to the masonry lintel with 1/2" diameter concrete anchors at 16" spacing. Steel lintels shall conform to requirements of Section 05 50 00.

I. Flashing and Air Barrier:

1. Clean surface of masonry smooth and free from projections which might puncture or otherwise damage flashing.
2. Install in accordance with manufacturer's recommendations to provide continuous flashing and air barrier system.
3. Provide end dam at each end of flashing to funnel flow out of wall.
4. Turn up sheet flashing a minimum of 8 inches and fully adhere to substrate.
5. Fully adhere sheet flashing to top of metal drip edge and cut off sheet flashing 1/2 inch back from exterior face.
6. In cold or wet weather when flashing will not fully adhere to substrate, provide termination bar mechanically anchored to substrate at top of flashing to secure flashing in place.

J. Provide weephole vents cord at base of flashings. Space not over 32 inches on center with a minimum of 1 weephole between openings. Keep weepholes and area above flashings free of mortar.

- K. Build into masonry rough frames, metal frames, lintels, anchors, anchor bolts, inserts, sleeves, brackets, bearing plates, etc.
- L. Install insulation into cavities of exterior walls. Conform to requirements of Section 07 21 00.
- M. Tolerances: Conform to requirements of ACI 530.1.

3.03 GROUTING

- A. Perform grouting in strict accordance with the provisions of ACI 530.1.
 - 1. Spaces to be grouted shall be free of mortar droppings, debris, and loose aggregate.
 - 2. Provide cleanouts at the bottom of each cell containing vertical reinforcement when pour height exceeds 4 feet.
 - 3. Solidly fill vertical cells containing reinforcement with masonry grout.
 - 4. Fill cores under lintels with masonry grout.
 - 5. Consolidate grout at time of pour by puddling with a mechanical vibrator, filling all cells of the masonry, and then reconsolidating later by puddling before the plasticity is lost.

3.04 PROTECTION

- A. Protect masonry from damage.
- B. Cover freshly laid masonry and walls not being worked on to prevent rapid drying and to exclude rain and snow.
- C. Brace walls until roof or floor system in-place.
- D. Do not apply superimposed loads until completed masonry reaches design strength.

3.05 CLEANING

- A. Clean as units are set, daily, and upon completion. Acid shall not be used.
- B. Remove surplus mortar and leave surface clean and finished.

END OF SECTION

SECTION 04 41 00
STONE MASONRY

PART 1 – GENERAL

1.01 SUMMARY

- A. Cut Indiana limestone sills, coping, and limestone veneer as shown on Drawings.

1.02 REFERENCES

- A. ASTM: American Society for Testing and Materials

1.03 SUBMITTALS

A. Shop Drawings:

1. Cutting and setting drawings showing sizes, dimensions, sections, and profiles of stonework units, arrangement and provisions for jointing, anchoring and fastening, supports, and other necessary details.
 - a. Show location of inserts to be built into concrete or masonry.
 - b. Show large-scale details of decorative surfaces and inscriptions.

B. Product Data:

1. Specifications and other data for each type of accessory required.
2. Instructions for handling, storage, installation, and protection of stone.

C. Samples:

1. 2 samples not less than 12-inches by 12-inches, in size of each different color, grade, and finish of stonework required. Include full range of exposed color and texture to be expected in completed Work.

D. Sample Panel:

1. 6 feet long by 4 feet high panel showing each type of stone unit, including:
 - a. Color range.
 - b. Texture range.
 - c. Bonding.
 - d. Mortar color.
 - e. Tooled joints.
 - f. Typical reinforcement.
 - g. Quality of workmanship.
2. Do not start Work until Engineer has accepted sample panel.
3. Use panel as standard of comparison. Failure of masonry work to meet or exceed quality of work depicted by sample panel shall be cause for rejection.
4. Do not destroy or move panel until Work completed and accepted by Owner.
5. When approved by Engineer, sample panel may be incorporated into finished work.

E. Submit in accordance with Section 01 33 00.

1.04 QUALITY ASSURANCE

A. Source Quality Control:

1. Provide stone complying with the recommendations of the Indiana Limestone Institute.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect stone during storage and construction against moisture, soiling, staining, and physical damage.
- B. Handle stone to prevent chipping, breakage, soiling or other damage. Do not use pinch or wrecking bars without protecting edges of stone with wood or other rigid materials. Lift with wide belt type slings where possible; do not use wire rope or ropes containing tar or other substances which might cause staining. If required, use wood rollers and provide cushion at end of wood slides.
- C. Store stone on wood skids or pallets, covered with nonstaining, waterproof membrane. Place and stack skids and stones to distribute weight evenly and to prevent breakage or cracking of stones. Protect stored stone from weather with waterproof, nonstaining covers or enclosures, but allow air to circulate around stones.
- D. Protect mortar materials and stonework accessories from weather, moisture, and contamination with earth and other foreign materials.

1.06 PROJECT / SITE CONDITIONS

A. Cold Weather Protection:

1. Conform to requirements of Section 04 22 00.

B. Hot Weather Protection:

1. Conform to requirements of Section 04 22 00.

PART 2 – PRODUCTS

2.01 LIMESTONE

- A. A. Furnish Indiana (oolitic) limestone complying with ASTM C568, Category II (medium density), and as follows.
1. Minimum Compressive Strength: 4,000 psi (ASTM C170) and maximum absorption of 7.5% (ASTM C97).
 2. Buff color range.
 3. Select grade (fine to average grained stone of closely matched color).
 4. Smooth finish (machine-planed with tool marks removed by hand) at copings and window sills.
 5. Rusticated finish at limestone veneer.

2.02 MORTAR

A. Cement:

1. Portland Cement: White ASTM C150, except complying with staining requirements of ASTM C91 for not more than 0.03% water soluble alkali. Furnish Type I, except Type III may be used for setting stonework in cold weather.
2. Masonry Cement: ASTM C91, nonstaining.

B. Hydrated Lime: ASTM C207, Type S.

C. Sand: ASTM C144, except graded with 100% passing No. 16 sieve.

1. For white or colored pointing mortar, furnish natural white sand or ground white stone meeting specified requirements.

D. Water: Potable.

E. Mortar: Nonstaining, cement/lime mortar, complying with ASTM C270, Type N proportion specification, using specified materials. Color as selected by Architect.

2.03 STONWORK ACCESSORIES

A. Expansion Anchors: 316 stainless steel, type and size shown or, if not shown, as required to support loading involved.

B. Anchor Bolts, Nuts, and Washers: 316 stainless steel.

C. Stone Anchors: 316 stainless steel, type and size indicated or, if not indicated, as required to securely anchor and fasten stonework in-place.

D. Setting Buttons: Lead or plastic buttons of thickness required for joint size indicated, and of size required to maintain uniform joint width.

2.04 FABRICATION

A. General: Fabricate as shown and detailed on Shop Drawings and in compliance with recommendations of applicable stone association. Provide holes and sinkages cut or drilled for anchors, fasteners, supports, and lifting devices, as shown and necessary to secure stonework in-place. Cut and backcheck as required for proper fit and clearance. Shape beds to fit supports.

B. Cut accurately to shape and dimensions shown on Shop Drawings, maintaining fabrication tolerances of applicable stone associations.

1. Dress joints (bed and vertical) straight and at 90-degree angle to face, unless otherwise indicated.
2. Provide quirk-mitered corners, unless otherwise shown.
3. Joint Width: Cut to provide joint widths as indicated or, if not indicated, cut to allow for uniform 3/8 inch wide joints.

PART 3 – EXECUTION

3.01 PREPARATION

A. Advise installers of other Work about specific requirements relating to placement of inserts and flashing reglets to be used by stone mason for anchoring and supporting and flashing of

stonework. Furnish installers of other work with drawings or templates showing location of inserts for stone anchors and supports.

- B. Clean stone before setting by thoroughly scrubbing with fiber brushes followed by thorough drenching with clear water. Use only mild cleaning compounds containing no caustic or harsh fillers or abrasives. If not thoroughly wet at time of setting, drench or sponge stone. Do not wet expansion or control joint surfaces.

3.02 INSTALLATION

- A. Execute stonework by skilled mechanics and employ skilled stone fitters at site to do necessary field cutting as stone is set.
- B. Where stonework will contact ferrous metal surfaces concealed in back-up construction (anchors, supports, structural framing, and similar surfaces), apply heavy coat of bituminous paint on metal surfaces prior to setting of stone. Do not extend coating onto portions of ferrous metal exposed in finished Work. Do not apply coating to stainless or nonferrous metals.
- C. Provide expansion joints where shown. Do not fill with mortar. Install continuous strips of preformed joint filler to allow for installation of backer rod and sealant, as specified in Section 07 92 00.
- D. Set stone in accordance with Drawings and Shop Drawings. Provide anchors, supports, fasteners, and other attachments shown or necessary to secure stonework in-place. Shim and adjust accessories for proper setting of stone. Completely fill holes, slots, and other sinkages for anchors, dowels, fasteners, and supports with mortar during setting of stones.
- E. Set limestone veneer in random broken coursed ashlar pattern.
- F. Allowable Tolerances:
 - 1. Variation from Plumb: For lines and surfaces of columns, walls and arises, do not exceed 1/4 inch in 10 feet, 3/8 inch in story height or 20 feet maximum, nor 1/2 inch in 40 feet or more. For external corners, expansion joints, and other conspicuous lines, do not exceed 1/4 inch in any story or 20 feet maximum, nor 1/2 inch in 40 feet or more.
 - 2. Variation from Level: For grades shown for exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines, do not exceed 1/4 inch in any bay or 20 feet maximum, nor 3/4 inch in 40 feet or more.
 - 3. Variation of Linear Building Line: For position shown in plan and related portion of columns, walls, and partitions, do not exceed 1/2 inch in any bay or 20 feet maximum, nor 3/4 inch in 40 feet or more.
 - 4. Variation in Cross-sectional Dimensions: For columns and thickness of walls from dimensions shown, do not exceed -1/4 inch nor +1/2 inch.
- G. Walls: Erect walls plumb and true with joints uniform in width and accurately aligned. Set in full bed of mortar, unless otherwise indicated. Provide setting buttons as required to prevent extrusion of mortar. Do not set units above until mortar in courses below is set sufficiently to maintain alignment and prevent extrusion.
- H. Cavity Construction: Where open space between back of stone units and back-up or framing is shown, keep cavity open; do not fill with mortar or grout.
 - 1. Back-paint stone wall units with nonstaining, asphalt emulsion dampproofing or cement base masonry dampproofing compound. Wherever possible, apply compound to back of stone units and joints after setting.

2. Back-purge stone wall units with nonstaining cement mortar not more than 1/2 inch thick. Add specified stearate to mortar mix in amount equal to not more than 3% of cement weight.

I. Joints

1. Butter vertical joints full width before setting and set units in full bed of mortar, unless otherwise indicated.
2. Rake out joints before mortar is set to allow for sealant pointing as shown. See Section 07 92 00 for backer rod and sealant.
3. Head joints in coping shall be left open and sealed. See Section 07 92 00 for backer rod and sealant.
4. Tool slightly concave.

3.03 FIELD QUALITY CONTROL

- A. Remove and replace stone units which are broken, chipped, stained or otherwise damaged. Remove and replace units which do not match adjoining stonework. Provide new matching units, install as specified, and point-up joints to eliminate evidence of replacement. Repoint defective and unsatisfactory joints as required to provide neat, uniform appearance.

3.04 CLEANING

- A. Clean stonework not less than 6 days after completion of Work. Use clean water and stiff-bristle brushes. Do not use wire brushes, acid type cleaning agents or other cleaning compounds with caustic or harsh fillers.

3.05 PROTECTION

- A. Provide final protection and maintain conditions in manner acceptable to fabricator and installer which ensures stonework being without damage, discolorations or deterioration during subsequent construction and until Substantial Completion.

END OF SECTION

DIVISION 5

METALS

SECTION 05 12 00
STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide structural steel as shown on the Drawings, specified herein, and needed for a complete and proper installation.
- B. Related Work.
 - 1. Section 05 50 00: Metal Fabrications.

1.02 REFERENCES

- A. AWS: American Welding Society
- B. ASTM: American Society for Testing and Materials
- C. AISC: American Institute of Steel Construction
- D. IBC: International Building Code

1.03 SUBMITTALS

- A. Shop Drawings.
 - 1. Complete details and schedules for fabrication and shop assembly of members.
 - 2. Details of cuts, connections, camber, holes, and other pertinent data.
 - 3. Indicate welds by AWS symbols, and show size, type, and length of weld.
 - 4. Provide setting drawings, templates, and directions for installing anchor bolts and other required anchors.
 - 5. Identify details by reference to sheet and detail number of the Drawings.
- B. Product Data.
 - 1. Producers' or manufacturers' specifications and installation recommendations for the following products, including laboratory test reports and other data required to prove compliance with the specified requirements.
 - a. High strength bolts, including nuts and washers.
 - b. Primer.

1.04 QUALITY ASSURANCE

- A. Qualify welding processes and welding operators in accordance with AWS Standard Qualification Procedures.
- B. Perform welding with electric arc process and in accordance with AWS Code for Arc and Gas Welding in Building Construction.
- C. In addition to complying with pertinent codes and regulations, comply with:

1. AISC Specifications for Design, Fabrication, and Erection of Structural Steel for Buildings.
 2. AISC Code of Standard Practice.
 3. AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts.
- D. Provide special inspections in accordance with the IBC.
- 1.05 DELIVERY, STORAGE, AND HANDLING
- A. Deliver materials to the job site properly marked to identify the location for which they are intended.
 - B. Use markings corresponding to markings shown on the approved Shop Drawings.
 - C. Store in a manner to maintain identification and to prevent damage.
- 1.06 IEPA LOAN REQUIRED DOCUMENTATION – AMERICAN IRON & STEEL
- A. Pursuant to the IEPA loan being used to finance the project, the Contractor and his/her suppliers shall comply with Section 436 of federal H.R. 3547, which are requirements regarding the use of American iron and steel products. These requirements apply to and are binding to the manufacturer of the products specified in the Section.
 - B. The manufacturer shall provide with the shop drawing submittal one (1) signed and dated original of the fully completed Certification Letter (a sample copy of which is provided on page A-00 30-80-3 of this manual). Said form shall demonstrate compliance with Section 436 of federal H.R. 3547.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Structural steel shapes: ASTM A992.
- B. Plates and bars: ASTM A36 or A992.
- C. Steel pipe: ASTM A53, type E or S, grade B.
- D. Steel tube: ASTM A501.
- E. Anchor bolts: ASTM A307.
- F. High strength bolts: ASTM A325 heavy hex bolts, nuts, and hardened washers.
- G. Machine bolts: ASTM A307
- H. Coatings as specified in Section 09 96 00.
- I. Welding electrodes: AWS A5.1 or A5.5 E70XX electrodes.

2.02 FABRICATION

- A. Shop fabrication and assembly.
 1. Fabricate items of structural steel in accordance with AISC specifications, and as indicated on the approved Shop Drawings.

2. Properly mark and match-mark materials for field assembly and for identification as to location for which intended.
3. Where finishing is required, complete the assembly, including welding of units, before start of finishing operations.
4. Provide finish surfaces of members exposed in the final structure free from markings, burrs, and other defects.

B. Connections.

1. Unless otherwise shown, use connections or single plate framing connections capable of supporting min of 50% of total uniform load capacity of member.
2. Unless otherwise approved by the Engineer, shop connections shall be welded and field connection shall be bolted.
3. Provide bolts and welds of types and sizes required. Connections shall consist of min two 3/4 inch diameter high strength bolts or welds developing min of 10,000 pounds capacity.
4. Welded construction: Comply with AWS Code for procedures, appearance, and quality of welds, and methods used in correcting welded work.
5. Assemble and weld built-up sections by methods which will produce true alignment of axes without warp.

C. Holes for other work.

1. Provide holes required for securing other work to structural steel framing, and for passage of other work through steel framing members, as shown on the approved Shop Drawings.
2. Provide threaded nuts welded to framing, and other specialty items as required, to receive other work.
3. Cut, drill, or punch holes perpendicular to metal surfaces.
4. Do not flame cut holes or enlarge holes by burning.
5. Drill holes in column base plates and bearing plates for anchor bolts.

2.03 SHOP PAINTING

- A. Conform to the requirements of Section 09 96 00.
- B. Shop prime structural steel work, except those members or portions of members to be embedded in concrete or mortar.
 1. Shop prime embedded steel which is partially exposed on the exposed portions, and the initial 2 inches of embedded areas only.
- C. Do not shop prime surfaces which are to be welded or high-strength bolted with friction type connections.
- D. Apply two coats of primer to surfaces which are inaccessible after assembly or erection. Change color of the second coat to distinguish it from the first.

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 ERECTION

- A. Comply with AISC specifications and Code of Standard Practice, except as may be modified herein.
- B. Anchor bolts.
 - 1. Provide anchor bolts and other connectors required for securing structural steel to foundations and other in-place work.
 - 2. Provide templates and other devices necessary for presetting bolts and anchors to accurate locations.
- C. Column base plates and bearing plates: Shop weld to columns and members attached to concrete.
- D. Splicing.
 - 1. Splice members only where indicated.
 - 2. For splices not indicated, obtain Engineers approval.
- E. Gas cutting.
 - 1. Do not use gas cutting torches for correcting fabricating errors in the structural framing.
 - 2. Cutting will be permitted only in secondary members as acceptable to Engineer.
 - 3. When gas cutting is permitted, finish the gas cut section to a sheared appearance acceptable to Engineer.
- F. Temporary shoring and bracing.
 - 1. Provide temporary shoring and bracing members with connections of sufficient strength to bear imposed loads.
 - 2. Provide temporary guy lines to achieve proper alignments of the structure as erection proceeds.
 - 3. Remove temporary connections and members when permanent members are in place and the final connections have been made.
- G. Setting column base plates and bearing plates.
 - 1. Clean concrete bearing surfaces free from bond-reducing materials, and then roughen to improve bond to the surface.
 - 2. Clean the bottom surface of base and bearing plates.
 - 3. Set loose and attached base plates and bearing plates for structural members on wedges or other adjusting devices.
 - 4. Tighten anchor bolts after the supported members have been positioned and plumbed.
 - 5. Do not remove wedges or shims but, if protruding, cut off flush with the edge of the base or bearing plate prior to packing with grout.
 - 6. Pack grout solidly between bearing surfaces and bases or plates to assure that no voids remain.
 - 7. Finish exposed surfaces, protect installed materials, and allow to cure in strict compliance with the manufacturers' recommendations.
- H. Field assembly.
 - 1. Set structural frames accurately to the lines and elevations indicated.
 - 2. Align and adjust members forming part of a complete frame or structure before fastening permanently.

3. Clean the bearing surface, and other surfaces which will be in permanent contact, before assembly.
4. Adjust as required to compensate for discrepancies in elevation and alignment.
5. Level and plumb individual members of the structure within specified AISC tolerances.
6. Comply with AISC specifications for bearing, adequacy of temporary connections, alignment, and the removal of paint on surfaces adjacent to welds.

3.03 INSPECTION AND TESTING

- A. Owner shall have the right to have Engineer, or Owner selected testing laboratory, inspect the shop fabrication and field erection of the work specified herein and make tests as appropriate.
 1. Contractor shall provide test specimens as required by the Engineer or the Owner's selected testing laboratory.
 2. The costs associated with this inspection and testing will be paid for by the Owner.
 3. If, after inspection and testing, the work of this Section is found to be defective and to require reinspection and retesting, cost of such reinspection and retesting will be paid by the Owner and backcharged to the Contactor.
- B. Provide access to Engineer or the testing laboratory to places where structural steel work is being fabricated or produced and to the field so that required testing and inspecting may be accomplished.
- C. Inspection and testing may include inspection of high strength bolted connections, visual inspection and nondestructive testing of welded connections, and performing such additional tests and inspections of work as are required by Engineer.
- D. Correct deficiencies in structural steel work which inspections and tests indicate to be not in compliance with the specified requirements.

3.04 FIELD PAINTING

- A. Conform to the requirements of Section 09 96 00.

END OF SECTION

SECTION 05 21 00
STEEL JOIST FRAMING

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide steel joist system, complete with accessories, where shown on the Drawings, as specified herein, and as needed for a complete and proper installation.

1.02 REFERENCES

- A. SJI: Steel Joist Institute
- B. ASTM: American Society for Testing and Materials

1.03 SUBMITTALS

- A. Shop Drawings.
 - 1. Shop Drawings showing sizes, spacing, and location of joists, connections, bridging, reinforcing, anchoring, cambers, loads, and other pertinent data.
- B. Product Data.
 - 1. Manufacturer's catalog data.
 - 2. Manufacturer's recommended installation procedures.
- C. Submit in accordance with Section 01 33 00.

1.04 IEPA LOAN REQUIRED DOCUMENTATION – AMERICAN IRON & STEEL

- A. Pursuant to the IEPA loan being used to finance the project, the Contractor and his/her suppliers shall comply with Section 436 of federal H.R. 3547, which are requirements regarding the use of American iron and steel products. These requirements apply to and are binding to the manufacturer of the products specified in the Section.
- B. The manufacturer shall provide with the shop drawing submittal one (1) signed and dated original of the fully completed Certification Letter (a sample copy of which is provided on page A-00 30-80-3 of this manual). Said form shall demonstrate compliance with Section 436 of federal H.R. 3547.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Provide steel joists and accessories system in dimensions and arrangements shown on the Drawings.
- B. Joists and accessories shall conform to SJI standards.
- C. Threaded Fasteners: Comply with ASTM A307.

2.02 FABRICATION

- A. Fabricate the steel joists system in strict accordance with the approved Shop Drawings, the requirements of governmental agencies having jurisdiction, and in accordance with SJI standards.
 - 1. Verify dimensions prior to fabrication.
 - 2. Provide top and bottom joist chord extensions where indicated on the Drawings or otherwise required.
 - 3. Provide holes in chord members where required for securing other work to steel joists; however, deduct area of holes from the area of chord when calculating strength of member.
 - 4. Camber joists to accommodate dead load deflection.
- B. Provide bridging of type noted and as required by SJI standards. Provide bridging anchors for ends of bridging lines terminating at walls or beams.
- C. Provide end anchorages including bearing plates, to secure joists to adjacent construction, complying with SDI Specifications, unless otherwise indicated.
- D. Provide header units to support tail joists at openings in floor or roof system not framed with steel shapes.
- E. Shop-prime the joist system in accordance with Section 09 96 00 using one coat of 10-99 Tnemec Primer, or equal, to a dry film thickness between 2.0 and 3.5 mils.

2.03 OTHER MATERIALS

- A. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the approval of the Engineer.

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 INSTALLATION

- 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.
- B. Anchors:
 - 1. Provide anchor bolts, bearing plates, and other devices to be built into concrete and masonry construction.
 - 2. Provide unfinished threaded fasteners for anchor bolts, unless otherwise indicated.
- C. Install the work of this Section in strict accordance with the original design, the approved Shop Drawings, pertinent requirements of governmental agencies having jurisdiction, SJI standards, and the manufacturer's recommended installation procedures, anchoring all components firmly into position.
- D. Do not start placement of steel joists until supporting work is in place and secured.

1. Place joists on supporting work, adjust, and align in accurate locations and spacing before permanent fastening.
2. Provide temporary bridging, connections, and anchors to assure lateral stability during construction.
3. Where open web joist lengths are 40 feet and longer, provide a center row of bolted bridging to assure lateral stability before slackening of hoisting lines.

E. Bridging:

1. Install bridging simultaneously with joist erection, before construction loads are applied.
2. Anchor ends of bridging lines at top and bottom chords where terminating at walls or beams.

F. Fastening joists:

1. Field weld joists to supporting steel framework in accordance with SJI Specifications for type of joists used.
2. Coordinate welding sequence and procedure with placing of joists.

G. Touch-up painting:

1. After joist installation, paint field bolt heads and nuts, and welded areas, abraded, or rusty surfaces on joists and steel supporting members.
2. Wire brush surfaces and clean with solvent before painting.
3. Use same type of paint as used for shop painting.

END OF SECTION

SECTION 05 30 00
METAL DECKING

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide metal decking where shown on the Drawings, as specified herein, and as needed for a complete and proper installation.

1.02 REFERENCES

- A. AISI: American Iron and Steel Institute
- B. ANSI: American National Standards Institute
- C. AWS: American Welding Society
- D. SDI: Steel Deck Institute

1.03 SUBMITTALS

- A. Shop Drawings.
 - 1. Shop Drawings showing layout of decking, with details of materials, gages, accessories, openings, finishes, welds, and other pertinent conditions.
- B. Product Data.
 - 1. Manufacturer's product data.
 - 2. Manufacturer's recommended installation procedures.
- C. Submit in accordance with Section 01 33 00.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Member of the Steel Deck Institute.
- B. Codes and Standards: Comply with applicable provisions of the following specifications:
 - 1. AISI.
 - 2. ANSI/AWS D1.3 Structural Welding Code/Sheet Steel.
 - 3. SDI.
- C. Each welder shall have satisfactorily passed AWS qualification tests for welding processes involved, and if applicable, shall have undergone recertification.
- D. When the materials of this Section are used as part of an assembly indicated on the Drawings in which fire-resistive construction ratings are required, demonstrate approval by Underwriters' Laboratories, Inc. and the governmental agencies having jurisdiction.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage and handling.

- B. If ground storage is needed, store deck bundles off the ground, with one end elevated to provide drainage. Protect bundles against condensation with a ventilated waterproof covering. Stack bundles so there is no danger of tipping, sliding, rolling, shifting or material damage. Check bundles periodically for tightness, and retighten as necessary so wind cannot loosen sheets.
- C. Place deck bundles on the building frame near a main supporting beam, at a column or wall. Do not place bundles on unbolted frames or on unattached or unbridged joists. Ensure that the structural frame is properly braced to receive the bundles.

1.06 IEPA LOAN REQUIRED DOCUMENTATION – AMERICAN IRON & STEEL

- A. Pursuant to the IEPA loan being used to finance the project, the Contractor and his/her suppliers shall comply with Section 436 of federal H.R. 3547, which are requirements regarding the use of American iron and steel products. These requirements apply to and are binding to the manufacturer of the products specified in the Section.
- B. The manufacturer shall provide with the shop drawing submittal one (1) signed and dated original of the fully completed Certification Letter (a sample copy of which is provided on page A-00 30-80-3 of this manual). Said form shall demonstrate compliance with Section 436 of federal H.R. 3547.

PART 2 - PRODUCTS

2.01 METAL DECK UNITS

- A. Design the units in accordance with AISC Specification for Design of Cold-Formed Steel Structural Members, with appropriate steel fiber stress limitations and appropriate maximum live load deflection limitations.
- B. Steel Roof Deck: Provide the following deck type with depth, design thickness, and design configuration in accordance with the requirements of the SDI.
 - 1. Wide rib (Type B).
 - 2. Depth: 1.5 in.
 - 3. Design thickness: 22 gage.
 - 4. Depth and gage: As indicated unless noted otherwise on the drawings.
- C. Sheet Steel for Galvanized Roof Deck and Accessories: ASTM A653 Structural Quality, Grade 33 or higher. Galvanizing: ASTM A924 with a minimum coating class of G60 as defined in ASTM A653.
- D. Sheet steel for prime-painted roof deck and accessories shall conform to ASTM A611 with minimum yield strength of 33 kilopounds per square inch. Steel deck shall have a coat of manufacturer's standard shop primer paint.

2.02 ACCESSORIES

- A. Provide accessories specifically designed to be used with the metal deck units supplied to the Work, and as normal to the uses shown on the Drawings.
- B. Furnish ridge and valley plates, flat plates at change of deck direction, and sump pans, as shown on plans to provide a finished surface for the application of roof insulation and roof covering.

- C. Provide other materials, not specifically described but required for a complete and proper installation.

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 PREPARATION

- A. Place deck in accordance with approved placement plans.
- B. Locate deck bundles to prevent overloading of support members.

3.03 INSTALLATION

- A. Do not use deck units as a working platform or storage area until units are permanently attached in position.
- B. Do not impose construction loads that exceed load carrying capacity of deck.
- C. Install deck panels and accessories according to SDI specifications and recommendations, SDI Manual of Construction with Steel Deck, and in accordance with the placement plans and requirements of this Section.
- D. Place deck panels on structural supports and adjust to final position with ends lapped minimum of 3 inches over structural supports with a minimum end bearing of 1.5 inches. Attach the deck panels firmly to the supports immediately after placement in order to form a safe working platform.
- E. Cut and neatly fit deck and accessories at skew conditions, around openings, and at other work projecting through or adjacent to the decking. Install accessory items in accordance with the manufacturer's recommended installation procedures.
- F. Do not cut unscheduled openings through the deck without the approval of Engineer; reinforce openings as shown.

3.04 ATTACHMENT

- A. Anchor deck units to steel supporting members by arc spot puddle welds or approved mechanical fasteners.
 - 1. Arc spot puddle welds shall be 5/8 inch minimum visible diameter at 12 inch maximum intervals, or with the attachment pattern shown on placement drawings.
 - 2. Mechanical fasteners, either powder actuated, pneumatically driven, or self-drilling screws may be used in lieu of welding, provided product data has been submitted and approved.
- B. Side lap attachment: Fasten side laps of deck units with spans greater than 5 feet at mid span or maximum 36 inch intervals, whichever distance is smaller, or as shown on design drawings using one of the following methods:
 - 1. #10 self-drilling screws.

2. Arc spot puddle welds 5/8 inch minimum visible diameter or 1 inch long arc seam or fillet weld.
- C. Perimeter Edge Attachment: Fasten perimeter edges of deck units at maximum 36 inch intervals or as shown on design drawings using one of the following methods:
1. Arc spot puddle welds 5/8 inch minimum visible diameter or 1 inch long arc seam or fillet weld.
 2. Mechanical fasteners, either powder actuated, pneumatically driven or self-drilling screws may be used in lieu of welding, provided product data has been submitted and approved.
- D. Anchor accessories to supporting members by arc spot welds or self-drilling screws at 12 inch maximum intervals or as shown on design drawings.

3.05 TOUCHUP

- A. Upon completion of installation, and before placement of roof insulation and roof covering, visually inspect each item installed under this Section and locate surfaces where finish was damaged.
1. Inspect the deck for tears, dents, or other damage that may prevent the deck from action as a structural roof base.
 2. Repair tears, dents, or other damage.
 3. Touchup galvanized surfaces with zinc-rich primer or other galvanize repair paint approved by the Engineer.
 4. Touchup other damaged surfaces as required to return the surfaces to condition commensurate with the services required.

END OF SECTION

SECTION 05 40 00
COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide metal studs and accessories as indicated on the Drawings, as specified herein, and as needed for a complete and proper installation.

1.02 SUBMITTALS

- A. Product data:
 - 1. Manufacturer's literature and other data needed to prove compliance with the specified requirements.
 - 2. Manufacturer's recommended installation procedures.
- B. Submit in accordance with the requirements of Section 01 33 00.

1.03 IEPA LOAN REQUIRED DOCUMENTATION – AMERICAN IRON & STEEL

- A. Pursuant to the IEPA loan being used to finance the project, the Contractor and his/her suppliers shall comply with Section 436 of federal H.R. 3547, which are requirements regarding the use of American iron and steel products. These requirements apply to and are binding to the manufacturer of the products specified in the Section.
- B. The manufacturer shall provide with the shop drawing submittal one (1) signed and dated original of the fully completed Certification Letter (a sample copy of which is provided on page A-00 30-80-3 of this manual). Said form shall demonstrate compliance with Section 436 of federal H.R. 3547.

PART 2 - PRODUCTS

2.01 METAL STUDS AND ACCESSORIES

- A. Meet or exceed minimum requirements of Fed Spec QQ-S-698 and Fed Spec QQ-S-775d, class d, for the item and use intended.
- B. Metal studs:
 - 1. At interior metal stud partitions, unless otherwise shown on the Drawings, provide standard punched steel studs of the gages shown on the Drawings, either hot-dip galvanized or factory pre-painted.
 - 2. Use only one type throughout the Work, unless otherwise shown on the Drawings or specifically approved.
 - 3. At exterior metal stud walls, unless otherwise shown on the Drawings, provide 14 gage standard punched steel "C" studs, either hot-dip galvanized or factory pre-painted.
- C. Accessories: Provide all accessories including, but not necessarily limited to, tracks, clips, anchors, fastening devices, sound attenuation pencil rods and resilient clips, and other accessories required for a complete and proper installation, and as recommended by the manufacturer of the steel studs used.

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 INSTALLATION

- A. Accurately layout partition and wall lines from the dimensions shown on the Drawings.
- B. Install metal studs and accessories in strict accordance with the manufacturer's recommendations, anchoring all components firmly into position.
- C. Align partition and wall assemblies to a tolerance of one in 200 horizontally and one in 500 vertically.
- D. Coordination:
 - 1. Space the studs as required for compliance with pertinent regulations, to give proper support for the covering material, and as indicated on the Drawings.
 - 2. Coordinate and provide required backing and other support for items to be mounted on the finished covering.
 - 3. Coordinate requirements for pipes and other items designed to be housed within the partition and wall systems.

END OF SECTION

SECTION 05 50 00
METAL FABRICATIONS

PART 1 – GENERAL

1.01 SUMMARY

- A. Provide miscellaneous metal work shown on the Drawings, as specified herein, and as needed for a complete and proper installation.
- B. Section Includes:
 - 1. Concrete anchors.
 - 2. Stairs.
 - 3. Ladders
 - 4. Grating support angles and framing.
 - 5. Weirs.
 - 6. Lintels.
 - 7. Metal frames.
 - 8. Miscellaneous items.

1.02 DEFINITIONS

- A. Submerged: At or below level 1 foot 6 inches above maximum water level in water holding structures.

1.03 REFERENCES

- A. AISC: American Institute of Steel Construction
- B. AA: Aluminum Association
- C. AWS: American Welding Society
- D. ASTM: American Society for Testing and Materials
- E. AISI: American Iron and Steel Institute
- F. OSHA: Occupational Safety and Health Administration

1.04 SUBMITTALS

- A. Shop Drawings:
 - 1. Indicate materials, sizes, connections, anchors, and finishes.
- B. Product Data:
 - 1. Manufacturer's catalog sheets on premanufactured items.
- C. Submit in accordance with Section 01 33 00.

1.05 QUALITY ASSURANCE

- A. Perform shop and/or field welding required in connection with the work of this Section by certified welders in strict accordance with pertinent recommendations of AWS.
- B. Conform to AISC and AA standards.

1.06 IEPA LOAN REQUIRED DOCUMENTATION – AMERICAN IRON & STEEL

- A. Pursuant to the IEPA loan being used to finance the project, the Contractor and his/her suppliers shall comply with Section 436 of federal H.R. 3547, which are requirements regarding the use of American iron and steel products. These requirements apply to and are binding to the manufacturer of the products specified in the Section.
- B. The manufacturer shall provide with the shop drawing submittal one (1) signed and dated original of the fully completed Certification Letter (a sample copy of which is provided on page A-00 30-80-3 of this manual). Said form shall demonstrate compliance with Section 436 of federal H.R. 3547.

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, and roughness.
- B. Comply with following standards, as pertinent.
 - 1. Structural Steel Shapes:
 - a. W Shapes: ASTM A992, 50 ksi.
 - b. M Shapes: ASTM A36.
 - c. S, C and MC Shapes: ASTM A36.
 - d. L Shapes: ASTM A36.
 - e. HP Shapes: ASTM A572 Grade 50.
 - f. HSS Square and Rectangular Shapes: ASTM A500, Grade B, 46 ksi.
 - g. HSS Round Shapes: ASTM A500, Grade B, 42 ksi.
 - h. Pipe Shapes: ASTM A53, Grade B, 35 ksi.
 - i. Plates and Bars: ASTM A36.
 - 2. Stainless Steel:
 - a. Exterior and submerged uses: AISI, Type 316.
 - b. Interior uses: AISI, Type 304 or Type 316.
 - 3. Aluminum shapes and plates: Alloy 6061-T6 or 6063-T6.
 - 4. Floor Plate: Checkered surface aluminum plate.
 - 5. Connection Bolts:
 - a. For steel members: ASTM A325.
 - b. For wood members: ASTM A307, galvanized.
 - c. For aluminum and galvanized steel members: Stainless steel.
 - 6. Cast-in-place Anchor Bolts:
 - a. 1/2 inch minimum diameter.

- b. Nonsubmerged: ASTM A307, galvanized.
 - c. Submerged: Stainless steel.
- 7. Malleable Iron: ASTM A47.
 - 8. Cast Iron: ASTM A48, Class 35B.
 - 9. Ductile Iron: ASTM A536, Grade 65-45-12.
 - 10. Cast Aluminum: ASTM B26.

2.02 CONCRETE ANCHORS

A. Wedge Anchors:

1. Manufacturers:

- a. Power-Stud+ SD1, SD2, SD4 or SD6 by Dewalt.
- b. Kwik Bolt 3 or Kwik Bolt TZ by Hilti Corp.
- c. Ankr-Tite CCAT Wedge Anchor by Wej-it Fastening Systems.
- d. Strong-Bolt 2 by Simpson Strong-Tie Co., Inc.
- e. Red Head Trubolt + by ITW Commercial Construction

2. Usage: In concrete.

- a. 316 stainless steel unless noted otherwise.
- b. Do not use when submerged or subjected to dynamic loads.

B. Expansion Anchors:

1. Manufacturers:

- a. Power-Bolt+ by Dewalt.
- b. HSL-3 by Hilti Corp.

2. Usage: In concrete.

- a. 316 stainless steel unless noted otherwise.
- b. Do not use when submerged, in overhead applications, or subjected to dynamic loads.

C. Sleeve Anchors:

1. Manufacturers:

- a. Lok-Bolt AS by Dewalt.
- b. HLC by Hilti Corp.
- c. Sleeve-Tite Sleeve Anchors by Wej-it Fastening Systems.
- d. Sleeve-All by Simpson Strong-Tie Co., Inc.
- e. Red Head Dynabolt by ITW Commercial Construction

2. Usage: In masonry.

- a. 316 stainless steel.

D. Adhesive Anchors (Concrete):

1. Manufacturers:

- a. HIT RE 500-V3 or HIT-HY 200-R Adhesive Anchor by Hilti Corp.
- b. Pure 110+, AC100+ Gold or PE 1000+ by Dewalt.
- c. SET-XP or AT-XP Adhesive System by Simpson Strong-Tie Co., Inc.
- d. Red Head A7+, G5 or C6+ by ITW Commercial Construction.

2. Adhesive with 316 stainless steel stud assembly.
3. Usage:

- a. In concrete, submerged.
- b. Do not use in overhead applications.

E. Adhesive Anchors (Masonry):

1. Manufacturers:

- a. HIT-HY 70 Adhesive Anchor by Hilti Corp.
- b. AC100+ Gold by Dewalt.
- c. SET-XP Adhesive System by Simpson Strong-Tie Co., Inc.
- d. Red Head Epcon A7+ Adhesive by ITW Commercial Construction

2. Adhesive with 316 stainless steel stud assembly.
3. Usage:

- a. In masonry.
- b. Grout masonry cores at anchor locations unless noted otherwise or approved by Engineer.
- c. Provide screen tube inserts for hollow masonry units or multi-wythe masonry.
- d. Do not locate anchors in vertical mortar joints.

F. Screw Anchors:

1. Manufacturers:

- a. Wedge-Bolt or Screw-Bolt+ by Dewalt.
- b. Kwik-Con II+ or Kwik HUS by Hilti Corp.
- c. Titen or Titen HD by Simpson Strong-Tie Co., Inc.
- d. Red Head Tapcon or Large Diameter Tapcon (LDT) by ITW Commercial Construction

2. Zinc plated carbon steel or stainless steel concrete/masonry screw with hex head.
3. Usage:

- a. In concrete, where noted or approved by Engineer.
- b. In masonry, where noted or approved by Engineer.

G. Rod Hanger Anchors:

1. Manufacturers:

- a. Vertigo+ by Powers Fasteners.
- b. KH-EZ I by Hilti Corp.
- c. Titen HD by Simpson Strong-Tie Co., Inc.
- d. Snake+ by Powers Fasteners.

2. Usage: In concrete.

- a. Zinc plated carbon steel or stainless steel unless noted otherwise.
- b. Overhead applications in interior locations for attachment of light duty pipe and equipment supports.
- c. Do not use in corrosive or humid areas, tanks, when submerged, or subjected to dynamic loads.

2.03 FINISHES

- A. Primer: Conform to requirements of Section 09 96 00.
- B. Galvanizing Repair Paint: High zinc-dust content paint complying with MIL-P-21035.

2.04 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. Provide clips, lugs, brackets, straps, plates, bolts, nuts, washers, and similar items, as required for fabrication and erection.
- C. Fabricate with accurate angles and surfaces which are true to the required lines and levels, with projecting corners clipped, grinding exposed welds smooth and flush, forming exposed connections with hairline joints, and using concealed fasteners wherever possible.
- D. Weld shop connections and bolt or weld field connections.
- E. Use AISC standard 2-angle web connections or single plate framing connections capable of supporting min of 50% of total uniform load capacity of member.
- F. Connections shall consist of minimum two 3/4 inch diameter bolts or welds developing minimum of 10,000 pounds capacity.
- G. Prior to shop painting or priming, properly clean metal surfaces as required for the applied finish and for the proposed use of the item. Conform to Section 09 96 00.
 1. Do not coat ferrous metal surfaces embedded in concrete.
 2. Coating of cast iron or ductile iron floor access hatches and pressure relief valves not required.
 3. 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.
 4. Coat aluminum surfaces in contact with concrete in accordance with AA and Section 09 96 00. Under no circumstances shall aluminum contact dissimilar metal.
- H. Galvanizing:
 1. Galvanize after fabrication.
 2. Galvanize by hot-dip process conforming to ASTM A123 and AHDGA specifications.

2.05 STAIRS

- A. Construct stairs and platforms of aluminum channel stringers and framing members to support uniform live load of 100 pounds per square foot or a moving concentrated load of 1000 pounds, whichever produces the greatest stress.
- B. Close exposed ends of stringers with plates, continuously welded to main member.

C. Provide grating treads and landing platforms. Conform to Section 05 53 00.

2.06 LADDERS

A. Ladders shall conform to OSHA and local building code safety requirements.

B. Construct from aluminum, 6063-T5 or 6060-T6 alloy, mill finish

1. Stringers: 1-1/2 inch diameter schedule 40 pipe (nominal 2 inch outside diameter.), minimum clear spacing 18 inches.
2. Rungs: 2 inch serrated C-channel.
3. Other materials shall be minimum ¼ inch thick.
4. Weld rungs to stringers.
5. Fabricate brackets for fastening ladders to wall, weld to ladder.

C. Retractable Safety Post:

1. Provide safety post extension at top of ladder where noted. Device shall be aluminum. It shall be designed with telescoping tubular section that locks automatically when extended. Movement shall be controlled by stainless steel spring mechanism. Device shall be secured to ladder rungs.
 - a. Ladder UP by Bilco.
 - b. Ladder Safety Post by Nystrom.

2.07 GRATING SUPPORT ANGLES AND FRAMING

A. Provide aluminum support angles embedded in concrete, unless noted otherwise. Angles shall be 1/4 inch thick, inside depth shall equal depth of grating, inside length shall equal depth of grating, but not less than 1-1/4 inch. Provide 1 inch by 1/4 inch by 8 inches long strap anchors or 3/8 inch diameter by 6 inches long headed anchor studs welded to back of angles at 18 inches on center.

B. Provide aluminum angles, channels, and beams as noted bolted to concrete or masonry with concrete anchors as noted.

2.08 WEIRS

A. Straightedge and 90-Degree V-Notch Weir Plates:

1. 3/8 inch stainless steel plates and angles.
2. Stainless steel bolts, nuts, washers, and concrete anchors.
3. Provide in lengths to suit tank, but not to exceed 12 feet.
4. Grind top edges smooth.
5. Conform to details shown.

2.09 LINTELS

A. Provide stainless steel lintels over openings in masonry walls as noted and wherever reinforced masonry or concrete lintels are not provided. Prep all stainless steel to be coated with an abrasive blast creating a minimum angular surface profile of 1.5 mils. Coat all exposed surfaces of stainless steel lintels and stainless steel OH door jamb plates per System 32 in specification 09 96 00.

- B. Fabricate lintels from structural steel shapes as detailed, selected for straightness of section, with minimum of 8 inches bearing each side of opening.
- C. Openings 4 feet and less in width without lintel scheduled, shall have double steel angle lintels or reinforced masonry lintels. Total width of horizontal legs shall be 1 inch less than nominal thickness of wall. Weld angles together. Masonry lintels shall conform to requirements of Section 04 22 00.

2.10 METAL FRAMES

- A. Provide door, hatch, grille, louver, and other frames fabricated from structural shapes or plates.
- B. Select sections for trueness of web and flange. Straighten members so finished frames are uniform, square, and true throughout length and depth of assembled units.
- C. Miter or cope and join members with continuous welds.
- D. Provide temporary spreader bars to prevent springing frames out of shape prior to and during erection.

2.11 MISCELLANEOUS ITEMS

- A. Fabricate miscellaneous framing, supports, and items of structural shapes, plates, bars, and tubing of sizes and arrangements indicated and as required.

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 INSTALLATION

A. General:

1. Set work accurately into position, plumb, level, true, and free from rack.
2. Tolerance: 1/8 inch in 10 feet.
3. Anchor firmly into position.
4. Where field welding is required, comply with AWS recommended procedures for appearance and quality of weld and for methods to be used in correcting welding work.
5. Grind exposed welds smooth, and touchup shop prime coats.
6. 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.
7. Perform cutting, drilling, and fitting as required for proper installation. Drill field holes for bolts, do not burn holes.
8. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint the exposed areas with same material used for shop priming.

B. Concrete Anchors:

1. Do not install until concrete or masonry has reached its design strength.
2. Do not install closer than 6 bolt dia to edge of concrete or masonry, or closer than 12 bolt diameter to another anchor unless otherwise shown.

3. Minimum embedment shall be 8 bolt diameter.
4. Install in accordance with manufacturer's recommendations.

3.03 WEIRS

- A. Install weirs and supports in accordance with approved Shop Drawings.
- B. Install to elevation indicated. Maintain top edges level and straight, with not more than 1/8 inch variation from level throughout entire length.
- C. After installation complete, test weirs under normal operating conditions in presence of Engineer. Repair leaks and other imperfections found during testing.

3.04 ADJUSTING AND CLEANING

- A. Clean exposed surfaces, removing dirt, dust, and other foreign matter.
- B. Prepare surfaces for finished painting as specified in Section 09 96 00.
- C. Field Repair of Damaged Galvanized Coatings:
 1. Repair surfaces damaged during shipping, erection, or construction operations.
 2. Use zinc rich paint.
 3. Prepare surfaces and apply in accordance with ASTM A780, Annex A2.

END OF SECTION

SECTION 05 52 00
METAL RAILING

PART 1 – GENERAL

1.01 SUMMARY

- A. Provide aluminum handrail and railing as shown on the Drawings, as specified herein, and as needed for a complete and proper installation.

1.02 REFERENCES

- A. OSHA: Occupational Safety and Health Administration

1.03 SUBMITTALS

- A. Shop Drawings:
 - 1. Indicate materials, sizes, connections, anchors, and finishes.
- B. Product Data:
 - 1. Manufacturer's catalog sheets.
- C. Submit in accordance with Section 01 33 00.

1.04 QUALITY ASSURANCE

- A. Handrail and railing shall meet requirements of OSHA and local building code.
- B. Provide end products of one manufacturer to achieve standardization of appearance.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle components in manner preventing damage to finished surfaces.
- B. Pack units in individual plastic shrink-wrap to protect finish, do not remove until after installation.
- C. Store in clean, dry condition away from uncured concrete and masonry. Cover with waterproof sheeting.

1.06 IEPA LOAN REQUIRED DOCUMENTATION – AMERICAN IRON & STEEL

- A. Pursuant to the IEPA loan being used to finance the project, the Contractor and his/her suppliers shall comply with Section 436 of federal H.R. 3547, which are requirements regarding the use of American iron and steel products. These requirements apply to and are binding to the manufacturer of the products specified in the Section.
- B. The manufacturer shall provide with the shop drawing submittal one (1) signed and dated original of the fully completed Certification Letter (a sample copy of which is provided on page A-00 30-80-3 of this manual). Said form shall demonstrate compliance with Section 436 of federal H.R. 3547.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Golden Railing, Inc.
- B. BMC-Rail by Breuer Metal Craftsman, Inc.
- C. ConnectoRail by Julius Blum Co., Inc.
- D. Wesrail by Moultrie Manufacturing Co.
- E. Series 500 by Superior Aluminum Products, Inc.
- F. Or equal.

2.02 MATERIALS

- A. Rails, Posts, and Formed Elbows: 1-1/2 inch diameter schedule 40 aluminum pipe (1.90 inch outside diameter, 0.145 inch wall thickness) alloy 6063-T6.
- B. Fittings:
 - 1. Riveted type fabricated from material similar to rails and posts.
 - 2. Connections shall be continuous type to permit sliding of hands.
 - 3. Fittings for open railing extensions shall be welded construction and welded to posts to comply with OSHA loading requirements. Welds shall be ground smooth and finished to match adjacent finish.
 - 4. Base plates and side mounted flanges shall be aluminum or stainless steel.
- C. Chain gates shall be 3/16 inch stainless steel link chain with stainless steel clasp capable of withstanding 250 pounds load.
- D. Toe plate shall be 1/4 inch by 4 inches flat aluminum plate, alloy 6063-T6.
- E. Mechanical fasteners shall be stainless steel.

2.03 FINISHES

- A. Clear satin anodized finish:
 - 1. Extruded Components: 0.7 mil.
 - 2. Cast Components: 0.4 mil.
- B. Light brushed finish on pipe and fittings before anodizing.

2.04 FABRICATION

- A. Use materials of size, thickness, and type required to produce required strength and durability.
- B. Fabricate with accurate angles and surfaces which are true to the required lines and levels, grinding welds smooth and flush, forming exposed connections with hairline joints, and using concealed fasteners wherever possible.
- C. Form connections and changes in direction by using prefabricated fittings or radius bends.

- D. Form elbow bends and wall returns to uniform radius, free from buckles and twists, with smooth finished surfaces.
- E. Remove burrs from exposed cut edges.
- F. Close pipe ends using prefabricated fittings.
- G. Fabricate joints of exterior units to exclude water or provide weep holes where water may accumulate.
- H. Provide base flange or side mounted base plate.
- I. Provide slip-fit sleeves for interior removable railings.
- J. Coat surfaces to be in contact with concrete with bituminous paint.

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 INSTALLATION

- A. Assemble and install in accordance with manufacturer's written instructions.
- B. Set posts plumb and align in each direction to within 1/8 inch in 10 feet maximum post spacing 5 feet on center.
- C. Set rails horizontal or parallel to slope of surface or rake of steps to within 1/8 inch in 10 feet.
- D. Provide expansion joints in rails and toe plate at 30 feet maximum on center. Locate within 12 inches of post.
- E. Support handrail on brackets having 2 inch clearance between handrail and wall spaced not more than 5 feet on center and within 12 inches of each end of rail. Return handrail ends to within 1/2 inch of wall.
- F. Provide toe plate except on stairs, where concrete curb provided and on top of walls that project above grade where foot traffic is not feasible.
- G. Bolt to top of concrete or stair stringers. Bolt to side of platform framing.

3.03 CLEANING

- A. Clean as recommended by railing manufacturer. Do not use acid, steel wool, or harsh abrasive.
- B. If stains remain after cleaning, remove finish and restore in accordance with manufacturer's recommendations.

END OF SECTION

SECTION 05 53 00
BAR GRATING

PART 1 – GENERAL

1.01 SUMMARY

- A. Provide metal bar grating as shown on the Drawings, as specified herein, and as needed for a complete and proper installation.

1.02 REFERENCES

- A. NAAMM: National Association of Architectural Metal Manufacturers

1.03 SUBMITTALS

- A. Shop Drawings:
 - 1. Type, layout, dimensions, fasteners, welds, and locations.
- B. Product Data:
 - 1. Manufacturer's literature.
- C. AIS Certification.
- D. Submit in accordance with Section 01 33 00.

1.04 QUALITY ASSURANCE

- A. Grating shall be end product of one manufacturer to achieve standardization of appearance.
- B. Conform to Metal Bar Grating Manual and NAAMM requirements.

1.05 IEPA LOAN REQUIRED DOCUMENTATION – AMERICAN IRON & STEEL

- A. Pursuant to the IEPA loan being used to finance the project, the Contractor and his/her suppliers shall comply with Section 436 of federal H.R. 3547, which are requirements regarding the use of American iron and steel products. These requirements apply to and are binding to the manufacturer of the products specified in the Section.
- B. The manufacturer shall provide with the shop drawing submittal one (1) signed and dated original of the fully completed Certification Letter (a sample copy of which is provided on page A-00 30-80-3 of this manual). Said form shall demonstrate compliance with Section 436 of federal H.R. 3547.

PART 2 – PRODUCTS

2.01 GENERAL

- A. Provide shop-fabricated grating and accessories such as frames, support angles, fasteners, and treads.
- B. Grating and treads shall be serrated aluminum.

- C. Treads and exposed edges of grating platforms shall have corrugated or cast aluminum abrasive nosing.
- D. Provide fastening devices to firmly anchor grating and treads to supports. Sections designated as removable shall not be attached to supports.
 - 1. Minimum of 4 per panel.
 - 2. Shall allow for repeated removal.
 - 3. Saddle clip type.
 - 4. "G" clip type.
 - 5. Clamp type.
 - 6. Minimum 1/4 inch bolts or self tapping screws.
 - 7. 316 stainless steel.
- E. Provide trim banding or load carrying banding on edges and cutouts welded to grating.
 - 1. Bearing bars not resting on supports shall have load carrying banding sized to span opening.
 - 2. Minimum banding thickness shall match bearing bar thickness.
 - 3. Banding shall be flush with top of grating.
 - 4. Banding depth shall be 1/4 inch less than bearing bar depth at supports.
- F. Cross bars shall not extend more than 1/8 inch past bearing bars at panel edges.
- G. Panels shall bear on supports a minimum length equal to bearing bar depth.
- H. Minimum width of panels shall be 16 inches except for locations requiring a single piece.
- I. Maximum width of panels shall be 48 inches.
- J. Grating supports shall conform to requirements of Section 05 50 00.

2.02 ALUMINUM GRATING

A. Manufacturers:

- 1. IKG/Borden, Type BS.
- 2. Ohio Grating, Type 19-SG-4.
- 3. Barnett Bates, Type 19-AP-4.
- 4. Klemp Grating, Type KRP-19-4.

B. Materials:

- 1. Pressure locked serrated grating (expanded tube or swagged type).
- 2. Alloy 6061-T6 or 6063-T6.
- 3. Bearing bars shall be spaced at 1-3/16 inch on center.
- 4. Cross bars shall be spaced at 4 inch on center.
- 5. Size bearing bars as follows:

Maximum Clear Span (ft - in.)	Bearing Bar Size (depth below serrations) (in.)
3 - 8	1-1/4 x 1/8
4 - 3	1-1/4 x 3/16
4 - 5	1-1/2 x 1/8
5 - 1	1-1/2 x 3/16
5 - 11	1-3/4 x 3/16
6 - 2	2 x 3/16
6 - 11	2-1/4 x 3/16
7 - 9	2-1/2 x 3/16
in. = inch ft = feet	

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 INSTALLATION

- A. Install in accordance with manufacturer's written instructions.
- B. Clearances:
1. 1/4 inch maximum from metal sections.
 2. 1/2 inch maximum from concrete or masonry walls.
 3. 1/4 inch maximum between sections.

END OF SECTION

DIVISION 6

WOOD, PLASTICS, AND COMPOSITES

SECTION 06 10 00
ROUGH CARPENTRY

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Wood framing.
2. Plywood sheathing.
3. Gypsum board sheathing.

1.02 DEFINITIONS

- A. Rough Carpentry: Carpentry work not specified as part of other sections and generally not exposed, except as otherwise indicated.

1.03 REFERENCES

- A. ALSC: American Lumber Standard Committee
- B. WCLIB: West Coast Lumber Inspection Bureau
- C. WWPA: Western Wood Products Association
- D. SPIB: Southern Pine Inspection Bureau
- E. NLGA: National Lumber Grades Authority
- F. RIS: Remote Installation Services
- G. APA: American Planning Association
- H. ASTM: American Society for Testing and Materials
- I. AWWPA: American Wood Protection Association
- J. NFPA: National Fire Protection Association

1.04 QUALITY ASSURANCE

- A. Lumber Standards: Comply with PS 20 and applicable grading rules of inspection agencies certified by ALSC Board of Review.
- B. Grade Stamps: Factory-mark each piece of lumber with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying grading agency, grade, species, and moisture content at time of surfacing, and mill.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Keep materials under cover and dry. Protect against exposure to weather and contact with damp or wet surfaces.

PART 2 - PRODUCTS

2.01 LUMBER, GENERAL

- A. Nominal sizes indicated except as shown by detail dimensions.
- B. Provide dressed lumber, S4S, unless otherwise indicated.
- C. Provide seasoned lumber with 19% maximum moisture content at time of dressing and shipment, unless otherwise indicated.

2.02 DIMENSION LUMBER

- A. For light framing, provide "stud" or "standard" grade lumber for stud framing and "standard" grade for other light framing, any species.
- B. For structural light framing (2 to 4 inches thick, 2 to 4 inches wide), provide following grade and species.
 - 1. Select structural, No. 1 grade.
 - 2. Same species as indicated for structural framing grade below.
- C. For structural framing (2 to 4 inches thick, 5 inches. and wider), provide following grade and species.
 - 1. Select structural, No. 1 grade:
 - 2. Species:
 - a. Douglas Fir or Douglas Fir Larch graded respectively under WCLIB or WWPA.
 - b. Hem-Fir graded under WWPA.
 - c. Southern Pine graded under SPIB.
 - d. Spruce-Pine-Fir graded under NLGA.
 - e. Redwood graded under RIS.

2.03 MISCELLANEOUS LUMBER

- A. Provide Standard Grade wood for support or attachment of other Work including cant strips, bucks, nailers, blocking, furring, grounds, stripping, and similar members. Provide lumber of sizes indicated, worked into shapes shown.

2.04 PLYWOOD SHEATHING

- A. General:
 - 1. Comply with PS 1.
 - 2. Factory-mark each panel with APA trademark evidencing compliance with grade requirements.
- B. Wall Sheathing: APA rated sheathing.
 - 1. Exposure durability classification: Exposure 1
 - 2. Span rating: As required to suit stud spacing indicated.
- C. Roof Sheathing: APA rated sheathing.
 - 1. Exposure durability classification: Exposure 1.

2. Span rating: As required to suit rafter spacing indicated.

D. Plywood Backing Panels:

1. For mounting electrical or telephone equipment, provide fire-retardant treated plywood panels with trade designation, APA C-D plugged interior with exterior glue in thickness indicated.

2.05 GYPSUM SHEATHING

A. Provide gypsum sheathing board complying with FS SS-L-300, Type II; Class 2 and grade (core) indicated below; and with ASTM C79.

1. Regular Wallboard: Grade R.
2. Style: Square edges and ends.
3. Thickness: 5/8 inch

B. Size: 4 feet-0 inches. by 8 feet-0 inches or 4 feet 0 inches by 12 feet-0 inches.

C. Metal Trim:

1. Form from zinc-coated steel not lighter than 26 gauge, complying with Fed Spec QQ-S-775, Type I, Class D or E.
2. Casing Beads:
 - a. Provide channel-shapes with exposed wing, and with concealed wing not less than 7/8-in. wide.
 - b. Exposed wing may be covered with paper cemented to metal, but shall be suitable for joint treatment.
3. Corner Beads: Provide angle shapes with wings not less than 7/8-in. wide and perforated for nailing and joint treatment, or with combination metal and paper wings bonded together, not less than 1-1/4-inches wide and suitable for joint treatment.
4. Edge beads for use at perimeter of ceilings:
 - a. Provide angle shapes with wings not less than 3/4-inches wide.
 - b. Provide concealed wing perforated for nailing, and exposed wing edge folded flat.
 - c. Exposed wing may be factory finished in white color.

D. Jointing System:

1. Provide jointing system, including reinforcing tape and compound, designed as system to be used together and as recommended for this use by manufacturer of gypsum wallboard.

E. Fastening Devices:

1. For fastening gypsum wallboard in place on metal studs and metal channels, use flat-head screws, shouldered, specially designed for use with power-driven tools, with self-tapping threads and self-drilling points.
2. For fastening gypsum wallboard in place on wood, use type W bugle-head screws, or use annular ring type nails complying with ASTM C514.

2.06 MISCELLANEOUS MATERIALS

A. Fasteners and Anchorages:

1. Provide size, type, material, and finish indicated and recommended by applicable standards, complying with applicable Federal Specifications for nails, staples, screws, bolts, nuts, washers, and anchoring devices.
2. Provide metal hangers and framing anchors of size and type recommended by manufacturer for each use, including recommended nails.
3. Where rough carpentry work exposed to weather, in-ground contact or area of high relative humidity, provide fasteners and anchorages with hot-dip zinc coating (ASTM A153).

B. Building Paper:

1. ASTM D226, Type I; asphalt saturated felt, nonperforated, 15-pound type.

C. Air Infiltration Barrier:

1. Manufacturers:
 - a. Tyvek, Textile Fibers Department by DuPont Company.
 - b. Or equal.

D. Sill Sealer Gaskets:

1. Glass fiber resilient insulation fabricated in strip form for use as sill sealer; 1 inch nominal thickness compressible to 1/32 inch.
2. Select from manufacturer's standard widths to suit width of sill members indicated.

2.07 WOOD TREATMENT BY PRESSURE PROCESS

A. Preservative Treatment:

1. Where lumber or plywood indicated "treated," or specified herein to be treated, comply with applicable requirements of AWPA C1, C2, and C9. Mark each treated item with AWPA quality mark requirements.
2. Preservative: CA-B (Copper Azole Type B).
3. Pressure-treat above ground items to minimum retention of 0.25. After treatment, kiln-dry lumber and plywood to maximum moisture content, respectively, of 19% and 15%. Treat indicated items and following.
 - a. Wood cants, nailers, curbs, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
 - b. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
 - c. Wood framing members less than 18 inches above grade.
 - d. Wood floor plates installed over concrete slabs directly in contact with earth.
4. Complete fabrication of treated items prior to treatment, where possible. If cut after treatment, coat cut surfaces with heavy brush coat of same chemical used for treatment to comply with AWPA M4. Inspect each piece of lumber or plywood after drying and discard damaged or defective pieces.

B. Fire-Retardant Treatment:

1. Where fire-retardant treated wood indicated, pressure impregnate lumber and plywood with fire-retardant chemicals to comply with AWPA C20 and C27, respectively, for treatment type indicated below; identify lumber with appropriate classification marking of UL, U.S. Testing, Timber Products Inspection or other testing and inspecting agency acceptable to authorities having jurisdiction.
2. Interior Type A: Interior applications.
3. Exterior Type: Exterior, exposed applications.
4. Inspect each piece of treated lumber or plywood after drying and discard damaged or defective pieces.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Discard units of material with defects which might impair quality of Work and units too small to use in fabricating Work with minimum joints or optimum joint arrangement.
- B. Set to required levels and lines, with members plumb and true to line and cut and fitted.
- C. Securely attach carpentry work to substrate by anchoring and fastening as shown and required by recognized standards.
 1. Countersink nail heads on exposed carpentry work and fill holes.
 2. Use common wire nails, except as otherwise indicated. Use finishing nails for finish work. Select fasteners of size that will not penetrate members where opposite side will be exposed to view or receive finish materials. Make tight connections between members. Install fasteners without splitting of wood; predrill as required.

3.02 NAILERS, BLOCKING, AND SLEEPERS

- A. Provide where shown and required for screening or attachment of other Work. Form to shapes shown and cut as required for true line and level of Work to be attached. Coordinate location with other Work involved.
- B. Attach to substrates as required to support applied loading. Countersink bolts and nuts flush with surfaces, unless otherwise indicated. Build into masonry during installation of masonry work. Where possible, anchor to formwork before concrete placement.

3.03 WOOD FRAMING

- A. Provide framing members of sizes, on spacings, and frame openings shown, or if not shown, comply with recommendations of NFPA "Manual for House Framing." Do not splice structural members between supports.
- B. Anchor and nail as shown to comply with NFPA "Recommended Nailing Schedule" in "Manual for House Framing" and "National Design Specification for Wood Construction."
- C. Firestop concealed spaces of wood framed walls and partitions at each floor level and ceiling line of top story. Where firestops not automatically provided by framing system used, use closely fitted wood blocks of nominal 2 inch thick lumber of same width as framing members.
- D. Provide special framing as required for eaves, overhangs, dormers, and similar conditions, if any.

3.04 STUD FRAMING

- A. General:

1. Provide single bottom plate and double top plates using 2-inch thick members with widths equaling that of studs, except single top plate may be used for nonload-bearing partitions.
2. Nail or anchor plates to supporting construction.
3. Exterior walls: 2-inch by 4-inch wood studs spaced 16 inches on center.

4. Interior partitions and walls: 2-inch by 4-inch wood studs spaced 16 inches on center.
5. Construct corners and intersections with not less than 3 studs. Provide miscellaneous blocking and framing as required for support of facing materials, fixtures, specialty items, and trim.

6. Provide continuous horizontal blocking row at mid-height of single-story partitions over 8-foot high and midpoint of multi-story partitions, using 2-inch thick members of same width as wall or partitions.

B. Openings:

1. Frame openings with multiple studs and headers. Provide nailed header members of thickness equal to width of studs. Set headers on edge and support on jamb studs.
2. For nonbearing partitions, provide double jamb studs and headers not less than 4 inches deep for openings 3 feet and less in width, and not less than 6 inches deep for wider openings.
3. For load-bearing partitions, provide double jamb studs for openings 6 feet and less in width, and triple-jamb studs for wider openings. Provide headers of depth shown, or if not shown, as recommended by NFPA "Manual for House Framing."

3.05 PLYWOOD SHEATHING

A. Comply with applicable recommendations contained in APA.

B. Fastening Methods: Fasten panels as indicated below.

1. Sheathing: Nail to framing.
2. Plywood Backing Panels: Nail to supports.

3.06 GYPSUM SHEATHING

A. General:

1. At internal and external corners, conceal cut edges of boards by overlapping covered edges of abutting boards.
2. Install gypsum wallboard to ceilings with long dimension of wallboard at right angles to supporting members.
3. Install gypsum wallboard to studs at right angles to framing members.

B. Attaching:

1. Space specified screws or nails 8 inches on center at ceilings and 12 inches on center at walls.
2. Attach double layers in accordance with pertinent code and manufacturer's recommendations.

C. Joint and Fastener Treatment:

1. Apply compound over fastener heads.

2. Provide reinforcing tape joints and embed tape in compound.
3. Sandpaper between coats as required.

D. Corner Treatment:

1. Internal corners: Treat as specified for joints, except fold reinforcing tape lengthwise through middle and fit neatly into corner.
2. External corners:
 - a. Install specified corner bead, fitting neatly over corner and securing with same type fasteners used for installing wallboard.
 - b. Space fasteners approximately 150 millimeters (6 inches) on center, and drive through wallboard into framing or furring member.
 - c. After corner bead has been secured into position, treat corner with joint compound and reinforcing tape as specified for joints, feathering joint compound out from 8 inches to 10 inches on each side of corner.

E. Finishes:

1. Plenum areas above ceilings, in attics, in areas where assembly is concealed.
 - a. Leave surfaces free of excess joint compound.
 - b. Tool marks and ridges are acceptable.
2. Areas which are to receive paints as final decoration:
 - a. Apply 3 separate coats of joint compound over all joints, angles, fastener heads, and accessories.
 - b. Leave surfaces smooth and free of tool marks and ridges.
3. Where noted on Drawings:
 - a. Apply thin skim coat of joint compound over entire surface.
 - b. Leave surfaces smooth and free of tool marks.

3.07 AIR INFILTRATION BARRIER

- A. Cover wall sheathing with air infiltration barrier to comply with manufacturer's written instructions.

END OF SECTION

SECTION 06 20 00
FINISH CARPENTRY

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Interior standing and running trim for field-finish.
2. Shelving and clothes rods.

1.02 DEFINITIONS

A. Inspection agencies, and abbreviations used to reference them, include following:

1. NELMA - Northeastern Lumber Manufacturers Association.
2. NHLA - National Hardwood Lumber Association.
3. NLGA - National Lumber Grades Authority.
4. RIS - Redwood Inspection Service.
5. SCMA - Southern Cypress Manufacturers Association.
6. SPIB - Southern Pine Inspection Bureau.
7. WCLIB - West Coast Lumber Inspection Bureau.
8. WWPA - Western Wood Products Association.

1.03 SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Include construction details, material descriptions, dimensions of individual components and profiles, textures, and colors.

1. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.

B. Samples for Initial Selection: Color charts consisting of actual materials in small sections for paneling for each type of material indicated.

C. Miscellaneous

1. Research/Evaluation Reports: Showing that fire-retardant-treated wood complies with building code in effect for Project.

D. Product Certificates: For each type of product, signed by product manufacturer.

G. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates or WI-certified compliance certificates.

H. Qualification Data: For fabricator.

I. Submit in accordance with Section 01 33 00.

1.04 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Where fire-retardant materials are indicated, provide materials with specified fire-test-response characteristics as determined by testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency on surfaces of materials that will be concealed from view after installation.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect materials against weather and contact with damp or wet surfaces. Stack lumber, plywood, and other panels. Provide for air circulation within and around stacks and under temporary coverings.
- B. Deliver interior finish carpentry only when environmental conditions meet requirements specified for installation areas. If finish carpentry must be stored in other than installation areas, store only where environmental conditions meet requirements specified for installation areas.

1.06 PROJECT/SITE CONDITIONS

- A. Environmental Limitations: Do not deliver or install interior finish carpentry until building is enclosed and weatherproof, wet work in space is completed and nominally dry, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during remainder of construction period.

PART 2 PRODUCTS

2.01 MATERIALS, GENERAL

- A. Lumber: DOC PS 20 and applicable grading rules of inspection agencies certified by American Lumber Standards' Committee Board of Review.
 - 1. Factory mark each piece of lumber with grade stamp of inspection agency indicating grade, species, moisture content at time of surfacing, and mill.
 - 2. For exposed lumber, mark grade stamp on end or back of each piece, or omit grade stamp and provide certificates of grade compliance issued by inspection agency.
- B. Wood Products: Comply with following:
 - 1. Recycled Content of Medium-Density Fiberboard and Particleboard: Provide products with average recycled content so post-consumer recycled content plus one-half of pre-consumer recycled content is not less than 20%.
 - 2. Hardboard: AHA A135.4.
 - 3. Medium-Density Fiberboard: ANSI A208.2, Grade MD, made with binder containing no urea formaldehyde.
 - 4. Particleboard: Straw-based particle board complying with requirements in ANSI A208.1, Grade M-2, except for density.
 - 5. Softwood Plywood: DOC PS.1

2.02 INTERIOR STANDING AND RUNNING TRIM AND INTERIOR BOARD CEILING

- A. Hardwood Lumber Trim for Transparent Finish (Stain or Clear Finish): Clear, kiln-dried, red oak finished lumber (S4S), selected for compatible grain and color.
- B. Moldings: Made to patterns included in WMMPA WM 7. Wood moldings made from kiln-dried stock and graded under WMMPA WM 4.
 - 1. Moldings for Transparent Finish (Stain or Clear Finish): N-grade red oak.

- a. Provide material selected for compatible grain and color.

2.03 SHELVING AND CLOTHES RODS

- A. Shelving: 3/4 in. (19 mm) particleboard shelving with solid-wood front edge or boards of same species and grade indicated above for interior lumber trim for opaque finish.
 - 1. Shelf Cleats: 3/4 by 5-1/2 in. (19 by 140 mm) boards with holes to receive clothes rods, of same species and grade indicated above for interior lumber trim for opaque finish.
 - 2. Shelf Brackets: Prime-painted formed steel with provision to support clothes rod where rod is indicated.
- B. Clothes Rods: 1-1/2 in. (38 mm) dia, aluminum tubes.
 - 1. Rod Flanges: Metal or plastic.

2.04 MISCELLANEOUS MATERIALS

- A. Fasteners for Interior Finish Carpentry: Nails, screws, and other anchoring devices of type, size, material, and finish required for application indicated to provide secure attachment, concealed where possible.
 - 1. Where finish carpentry materials are exposed in areas of high humidity, provide fasteners and anchorages with hot-dip galvanized coating complying with ASTM A153/A153M.
- B. Adhesives, General: Do not use adhesives that contain urea formaldehyde.
- C. VOC Limits for Installation Adhesives and Glues: Use installation adhesives that comply with the following limits for VOC content when calculated according to 40-CFR 59, Subpart D (EPA Method 24):
 - 1. Wood Glues: 30 g/L.
 - 2. Contact Adhesive: 250 g/L.
- D. Adhesive for Bonding Plastic Laminate: Contact cement.
 - 1. Adhesive for Bonding Edges: Adhesive specified above for faces.

2.05 FABRICATION

- A. Wood Moisture Content: Comply with requirements of specified inspection agencies and with manufacturer's written recommendations for moisture content of finish carpentry at relative humidity conditions existing during time of fabrication and in installation areas.
- B. Back out or kerf backs of the following members, except members with ends exposed in finished work:
 - 1. Interior standing and running trim, except shoe and crown molds.
 - 2. Wood board paneling
- C. Ease edges of lumber less than 1 in. (25 mm) in nominal thickness to 1/16 in. (1.5 mm) radius and edges of lumber 1 in. (25 mm) or more in nominal thickness to 1/8 in. (3 mm) radius.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean substrates of projections and substances detrimental to application.
- B. Before installing finish carpentry, condition materials to average prevailing humidity in installation areas for minimum of 24 hrs, unless longer conditioning is recommended by manufacturer.

3.03 INSTALLATION, GENERAL

- A. Do not use materials that are unsound, warped, improperly treated or finished, inadequately seasoned, or too small to fabricate with proper jointing arrangements.
 - 1. Do not use manufactured units with defective surfaces, sizes, or patterns.
- B. Install finish carpentry level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.
 - 1. Scribe and cut finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
 - 2. Countersink fasteners, fill surface flush, and sand where face fastening is unavoidable.
 - 3. Install to tolerance of 1/8 in. in 96 in. (3 mm in 2438 mm) for level and plumb. Install adjoining finish carpentry with 1/32 in. (0.8 mm) maximum offset for flush installation and 1/16 in. (1.5 mm) maximum offset for reveal installation.
 - 4. Coordinate finish carpentry with materials and systems in or adjacent to it. Provide cutouts for mechanical and electrical items that penetrate finish carpentry.

3.04 STANDING AND RUNNING TRIM INSTALLATION

- A. Install with minimum number of joints practical, using full-length pieces from maximum lengths of lumber available. Do not use pieces less than 24 in. (610 mm) long, except where necessary. Stagger joints in adjacent and related standing and running trim. Cope at returns and miter at corners to produce tight-fitting joints with full-surface contact throughout length of joint. Use scarf joints for end-to-end joints. Plane backs of casings to provide uniform thickness across joints, where necessary for alignment.
 - 1. Match color and grain pattern across joints.
 - 2. Install trim after gypsum board joint finishing operations are completed.
 - 3. Drill pilot holes in hardwood before fastening to prevent splitting. Fasten to prevent movement or warping. Countersink fastener heads on exposed carpentry work and fill holes.

3.05 ADJUSTING

- A. Replace finish carpentry that is damaged or does not comply with requirements. Finish carpentry may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing. Adjust joinery for uniform appearance.

3.06 CLEANING

- A. Clean finish carpentry on exposed and semiexposed surfaces. Touch up factory-applied finishes to restore damaged or soiled areas.

END OF SECTION

SECTION 06 40 20
INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Plastic-laminate cabinets.
2. Solid surface countertops, backsplashes, and window stools.

1.02 DEFINITIONS

A. Interior architectural woodwork includes wood furring, blocking, shims, and hanging strips for installing woodwork items unless concealed within other construction before woodwork installation.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated, including cabinet hardware and accessories and finishing materials and processes.
- B. Product Data: For panel products high-pressure decorative laminate adhesive for bonding plastic laminate, cabinet hardware and accessories, and finishing materials and processes.
- C. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.

1. Show details half size.
2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
3. Show locations and sizes of cutouts and holes for plumbing fixtures and other items installed in architectural woodwork.
4. Apply WI-certified compliance label to first page of Shop Drawings.

D. Samples for Initial Selection:

1. Plastic laminates.
2. Solid surface materials.
3. Wood materials.

E. Samples for Verification:

1. Plastic laminates, 8 by 10 inches (200 by 250 mm), for each type, color, pattern, and surface finish, with 1 sample applied to core material and specified edge material applied to 1 edge.
2. Solid surface materials, 8 x 10 inches (200 by 250 mm), for each type, color, and surface finish.
3. Exposed cabinet hardware and accessories, one unit for each type and finish.
4. Colors to be selected by Owner.

F. Product Certificates: For each type of product, signed by product manufacturer.

G. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates or WI-certified compliance certificates.

H. Qualification Data: For fabricator.

1.04 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance. Shop is a certified participant in AWI's Quality Certification Program or licensee of WI's Certified Compliance Program.

B. Installer Qualifications: Fabricator of products.

C. Quality Standard: CONTRACTOR option to comply with AWI's "Architectural Woodwork Quality Standards" for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.

1. Provide AWI Quality Certification Program certificates indicating that woodwork, including installation, complies with requirements of grades specified.

D. Quality Standard: In lieu of AWI, CONTRACTOR can comply with WI's "Manual of Millwork" for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.

1. Provide WI-certified compliance certificates indicating that woodwork, including installation, complies with requirements of grades specified.

2. The Contract Documents contain selections chosen from options in the quality standard and additional requirements beyond those of the quality standard. Comply with such selections and requirements in addition to the quality standard.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

1.06 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F (16 and 32 deg C) and relative humidity between 25 and 55 percent during the remainder of the construction period.

C. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed, and indicate measurements on Shop Drawings.

2. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating woodwork without field measurements. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.07 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.
- B. Hardware Coordination: Distribute copies of approved hardware schedule specified in Division 08 Section "Door Hardware (Scheduled by Describing Products)" to fabricator of architectural woodwork; coordinate Shop Drawings and fabrication with hardware requirements.

PART 2 - PRODUCTS

2.01 WOODWORK FABRICATORS

- A. Available Fabricators: Subject to compliance with requirements, fabricators offering interior architectural woodwork that may be incorporated into the Work include, but are not limited to, the following:
- B. Fabricators: Subject to compliance with requirements, provide interior architectural woodwork by one of the following:

2.02 MATERIALS

- A. General: Provide materials that comply with requirements of AWI's or WI's quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.
- B. Wood Products: Comply with the following:
 1. Recycled Content of Medium-Density Fiberboard and Particleboard: Provide products with an average recycled content so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 20%.
 2. Hardboard: AHA A135.4.
 3. Medium-Density Fiberboard: ANSI A208.2, Grade MD, made with binder containing no urea formaldehyde.
 4. Particleboard: Straw-based particleboard complying with requirements in ANSI A208.1, Grade M-2, except for density.
 5. Softwood Plywood: DOC PS 1.
- C. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or, if not indicated, as required by woodwork quality standard.
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering high-pressure decorative laminates that may be incorporated into the Work include, but are not limited to, the following:
 2. Manufacturer: Subject to compliance with requirements, provide high-pressure decorative laminates by one of the following:
 - a. Abet Laminati, Inc.

- b. Arborite; Division of ITW Canada, Inc.
 - c. Formica Corporation.
 - d. Lamin-Art, Inc.
 - e. Nevamar Company, LLC; Decorative Products Div.
 - f. Panolam Industries International Incorporated.
 - g. Westinghouse Electric Corp.; Specialty Products Div.
 - h. Wilsonart International; Div. of Premark International, Inc.
- D. Solid Surface Products: Acrylic resins, fire-retardant mineral fillers, and proprietary coloring agents through the body color for full thickness of sheet material.
 Manufacturer: Subject to compliance with requirements, provide solid surface laminates by one of the following:
- 1. DuPont Corian
 - 2. Wilsonart International; Div. of Premark International, Inc.
 - 3. Avonite Surfaces

2.03 CABINET HARDWARE AND ACCESSORIES

- A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets, except for items specified in Division 08 Section "Door Hardware (Scheduled by Describing Products)."
- B. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 135 degrees of opening.
- C. Back-Mounted Pulls: BHMA A156.9, B02011.
- D. Wire Pulls: Back mounted, solid metal, 4 inches (100 mm) long, 5/16 inch (8 mm) in diameter.
- E. Catches: Magnetic catches, BHMA A156.9, B03141.
- F. Adjustable Shelf Standards and Supports: BHMA A156.9, B04102; with shelf brackets, B04112.
- G. Shelf Rests: BHMA A156.9, B04013; metal.
- H. Drawer Slides: BHMA A156.9, B05091.
 - 1. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Side mounted; full-extension type; zinc-plated steel ball-bearing slides.
- I. Door Locks: BHMA A156.11, E07121.
- J. Drawer Locks: BHMA A156.11, E07041.
- K. Grommets for Cable Passage through Countertops: 2-inch (51-mm) OD, black, molded-plastic grommets and matching plastic caps with slot for wire passage.
- L. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.

- M. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

2.04 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.
- B. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber, kiln dried to less than 15 percent moisture content.
- C. Anchors: Select material, type, size, and finish required for 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 sleeves for drilled-in-place anchors.
- D. Adhesives, General: Do not use adhesives that contain urea formaldehyde.
- E. VOC Limits for Installation Adhesives and Glues: Use installation adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - 1. Wood Glues: 30 g/L.
 - 2. Contact Adhesive: 250 g/L.
- F. Adhesive for Bonding Plastic Laminate: Contact cement.
 - 1. Adhesive for Bonding Edges: Adhesive specified above for faces.

2.05 FABRICATION, GENERAL

- A. Interior Woodwork Grade: Unless otherwise indicated, provide Premium-grade interior woodwork complying with referenced quality standard.
- B. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.
- C. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.
- D. 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 3/4 Inch (19 mm) Thick or Less: 1/16 inch (1.5 mm).
 - 2. Edges of Rails and Similar Members More Than 3/4 Inch (19 mm) Thick: 1/8 inch (3 mm).
 - 3. Corners of Cabinets and Edges of Solid-Wood (Lumber) Members and Rails: 1/16 inch (1.5 mm).
- E. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

1. Notify Architect seven days in advance of the dates and times woodwork fabrication will be complete.
 2. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements indicated on Shop Drawings before disassembling for shipment.
- F. Shop-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. Sand edges of cutouts to remove splinters and burrs.
1. Seal edges of openings in countertops with a coat of varnish.
- G. Install glass to comply with applicable requirements in Division 08 Section "Glazing" and in GANA's "Glazing Manual." For glass in wood frames, secure glass with removable stops.

2.06 PLASTIC-LAMINATE CABINETS

- A. Grade: Premium.
- B. AWI Type of Cabinet Construction: Reveal overlay.
- C. Laminate Cladding for Exposed Surfaces: High-pressure decorative laminate complying with the following requirements:
1. Horizontal Surfaces Other Than Tops: Grade HGS.
 2. Postformed Surfaces: Grade HGP.
 3. Vertical Surfaces: Grade VGS.
 4. Edges: Grade VGS.
- D. Materials for Semiexposed Surfaces:
1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, Grade VGS.
 - a. Edges of Plastic-Laminate Shelves: PVC edge banding, 0.12 inch (3 mm) thick, matching laminate in color, pattern, and finish.
 - b. For semiexposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, Grade VGS.
 2. Drawer Sides and Backs: Solid-hardwood lumber.
 3. Drawer Bottoms: Hardwood plywood.
- E. Concealed Backs of Panels with Exposed Plastic Laminate Surfaces: High-pressure decorative laminate, Grade BKL.
- F. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
1. As indicated by laminate manufacturer's designations.
 2. Match Architect's sample.
 3. As selected by Architect from laminate manufacturer's full range of available colors:

- G. Provide dust panels of 1/4-inch (6.4-mm) plywood or tempered hardboard above compartments and drawers, unless located directly under tops.

2.07 SOLID SURFACE COUNTERTOPS, BACKSPLASHES AND WINDOW STOOLS

- A. Composition: Acrylic resins, fire-retardant mineral fillers, and proprietary coloring agents through the body color for full thickness of sheet material.
- B. Material Thickness: 1 inch nominal.
- C. Accessory Materials:
 - 1. Joint Adhesive: Methacrylate-based adhesive for chemically bonding solid surfacing seams.
 - 2. Construction Adhesive: Countertop manufacturer's recommended silicone-based construction adhesive for backsplashes, endsplashes and other applications according to manufacturer's published fabrication instructions.

2.08 SHOP FINISHING

- A. Grade: Provide finishes of same grades as items to be finished.
- B. General: Finish architectural woodwork at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.
- C. General: Shop finish transparent-finished interior architectural woodwork at fabrication shop as specified in this Section. Refer to Division 09 painting Sections for finishing opaque-finished architectural woodwork.
- D. General: Drawings indicate items that are required to be shop finished. Finish such items at fabrication shop as specified in this Section. Refer to Division 09 painting Sections for finishing architectural woodwork not indicated to be shop finished.
- E. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural woodwork, as applicable to each unit of work.
 - 1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to back of paneling and to end-grain surfaces. Concealed surfaces of plastic-laminate-clad woodwork do not require backpriming when surfaced with plastic laminate, backing paper, or thermoset decorative panels.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Before installation, condition woodwork to average prevailing humidity conditions in installation areas.
- B. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

3.02 INSTALLATION

- A. Grade: Install woodwork to comply with requirements for the same grade specified in Part 2 for fabrication of type of woodwork involved.
- B. Assemble woodwork and complete fabrication at Project site to comply with requirements for fabrication in Part 2, to extent that it was not completed in the shop.
- C. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm).
- D. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- E. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.
- F. Cabinets: Install without distortion so 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 installation of hardware and accessory items as indicated.
 - 1. Install cabinets with no more than 1/8 inch in 96-inch (3 mm in 2400-mm) sag, bow, or other variation from a straight line.
 - 2. Maintain veneer sequence matching of cabinets with transparent finish.
 - 3. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches (400 mm) o.c.
- G. Countertops:
 - 1. Align adjacent solid-surfacing-material countertops and form seams to comply with manufacturer's written recommendations using adhesive in color to match countertop. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
 - 2. Install countertops with no more than 1/8 inch in 96-inch (3 mm in 2400-mm) sag, bow, or other variation from a straight line.
 - 3. Chalk space between backsplash and wall with sealant specified in Division 07 Section "Joint Sealants."
- H. Field Jointing: Where practicable, make in same manner as factory jointing using dowels, splines, adhesives, and fasteners recommended by manufacturer. Locate field joints as shown on accepted Shop Drawings, factory prepared so there is no jobsite processing of top and edge surfaces.
- I. Fastenings:
 - 1. For solid surface tops, secure to cabinets with epoxy cement applied at each corner and along perimeter edges of not more than 48 in. oc.
- J. Workmanship: Abut top and edge surfaces in one true plane with internal supports placed to prevent any deflection. Provide flush hairline joints in top units using clamping devices. At stone-type material joints, use manufacturer's recommended adhesives and holding devices to provide joint widths not more than 1/16 in. wide at any location, completely filled, and flush with abutting edges.

1. Where necessary to penetrate tops with fasteners, countersink heads approximately 1/8 in. and plug hole flush with material equal in chemical resistance, color, hardness, and texture to top surface.
 2. After installation, carefully dress joints smooth, remove any surface scratches, clean, and polish entire surface.
 3. Provide holes and cutouts as required for electrical service fixtures.
 4. Provide scribe mouldings for closures at junctures of top, curb, and splash with walls as recommended by manufacturer for materials involved. Use chemical resistant, permanently elastic sealing compound where recommended by manufacturer.
- K. Touch up finishing work specified in this Section after installation of woodwork. Fill nail holes with matching filler where exposed.

3.03 ADJUSTING AND CLEANING

- A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
- B. Clean, lubricate, and adjust hardware.
- C. Clean woodwork on exposed and semi-exposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION

SECTION 06 40 30
WOOD CASEWORK

PART 1 – GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Reception desk and cabinets.
 2. Solid surface countertops.

1.02 QUALITY ASSURANCE

- A. Retain services of equipment manufacturer's experienced personnel to install furniture and equipment.
- B. Use of manufacturer's name and model or catalog number for purpose of establishing standard of quality and general configuration.

1.03 SUBMITTALS

- B. Product Data:
1. Results of chemical resistance of tops.
- C. Samples: Provide samples only when manufacturer of cabinets for this Project is not manufacturer listed.
1. One sample of each casework item in specified construction and finish:
 - a. One typical base cabinet, containing not less than one door, one drawer, and one adjustable shelf.
 - b. Countertop sample. Sample to be 12 in. by 12 in. with backsplash.
 2. Assemble and ship samples in crate with removable front and side for examination. CONTRACTOR shall notify ENGINEER of shipment and make delivery as requested.
 3. Samples will be retained by ENGINEER until completion of installation of casework. Samples submitted will be used for comparison purposes with actual casework delivered and installed at site. Casework installed in building not conforming to samples submitted in construction, gauges and finish, will be rejected and shall be removed and replaced with equipment conforming to samples submitted. Upon final completion and acceptance of work, CONTRACTOR shall remove samples submitted upon written notification from ENGINEER.
- D. Submit in accordance with Section 01 33 00.

PART 2 – PRODUCTS

2.03 RECEPTION DESK

- A. Reception Desk: As shown on drawings.
- B. Exposed Materials: Do not use exposed faces of lighter-than-average color joined with exposed faces of darker-than-average color. Do not use two adjacent faces, which are noticeably dissimilar in grain, figure, and natural character markings.
 - 1. Solid Lumber: Clear, dry, sound, selected for compatible grain and color, no defects, of following species:
 - a. Northern Select Hard Maple Plain-sliced, A-Grade.
 - b. Color: White Maple.
 - 2. Plywood Face Veneer: Same species as exposed solid lumber, clear, selected for grain and color compatible with exposed solid lumber, no defects. Provide solid crossbandings without voids. Edgeband exposed edges with solid wood of same species as face veneer.
- C. Semi-Exposed Materials:
 - 1. Solid Lumber: Dry, sound, selected to eliminate appearance defects. Any species of hardwood or softwood of similar color and grain to exposed portions.
 - 2. Plywood: Hardwood, PS51, Good Grade (1), or softwood PS1, Group 1, A-A, INT, of species to match color and grain of exposed members.
- D. Concealed Members:
 - 1. Solid Lumber or Plywood: Any species, with no defects affecting strength or utility.
 - 2. Particleboard: ANSI A208.1, minimum 40 lb/cu ft density, Grade 1-M-2 or better.
 - 3. Hardboard: ANSI A135.4, Class 1, tempered.
- E. Clear Wood Finish:
 - 1. General: Provide complete factory finish to comply with chemical and physical resistance requirements. After installation, touch-up or refinish damaged portions equal to original factory finish.
 - 2. Preparation: Sand exposed and semi-exposed components, using machine and hand methods. Machine marks, cross sanding, tool marks or other surface blemishes are not acceptable.
 - 3. Exposed Portions: Carefully sand finishes after each surface treatment. Apply finishes as follows:
 - a. Sealer coat, if required.
 - b. Stain, to match color selected, if required.
 - c. Mineral filler, for open grained wood, if required.
 - d. Multiple coats of highly chemical resistant finish, heat dried and sanded between each coat to produce smooth, satin luster free of imperfections.
 - 4. Semi-Exposed Portions: Apply sealer coat, colored to match exposed portions, and follow with heavy application of clear, water repellent finish coat to provide smooth, washable surface.
 - 5. Concealed Portions: One heavy coat of water repellent finish.
- F. Hardware:

1. Hinges: 2-1/2 in., 5 knuckle, stainless steel, screw attachment. Welded hinges are not acceptable.
2. Friction Catches: Nylon roller type, adjustable, with strike.
3. Elbow Catch: Spring type with strike.
4. Shelf Clips: Plastic twin-pin.
5. Pulls: Stainless steel wire.

G. Cabinet Design:

1. RADIUS OVERLAY: Flush overlay profile design with 1/2 in. full front radius on edges and 1/8 in. reveals between door to door, door to drawer, drawer to drawer; 1/16 in. vertical reveal between doors/drawers and cabinet ends.
2. Standard Grain Pattern:
 - a. End panels - vertical.
 - b. Shelving - grain shall run width (left to right) of shelf.
 - c. Bottoms and tops of all units - grain shall run width (left to right) of unit.
 - d. Aprons and table frames – horizontal.
 - e. Kneespace panels – vertical.
3. Grain Pattern on Cabinet Fronts:
 - a. VERTICAL MATCHED GRAIN: Continuous vertical grain match on door and drawer fronts of individual cabinets.

2.04 CASEWORK FABRICATION

A. Base Units:

1. Cabinet Ends: 3/4 in. thick plywood (for both exposed and concealed ends) with 3mm hardwood banding on front edges. Bore interior faces, as appropriate, for security panels, rails, and four rows of shelf support holes:
 - a. No levelers required. Wood shimming approved.
2. Top Rails:
 - a. Front and Back:
 - 1) Horizontal Front Top Rail: 1 in. x 3 in. exposed solid hardwood or edge banded 9-ply minimum veneer core plywood. Attach to cabinet ends with glued 8mm dowel joinery and screws.
 - 2) Vertical Back Top Rail: 3/4 in. x 3-3/4 in. solid hardwood or 7-ply minimum veneer core plywood. Attach to cabinet ends with glued 8mm dowel joinery and screws.
3. Intermediate Rails:
 - a. None Required.
4. Toe Space Rail: 3-3/4 in. x 3/4 in. hardwood or 7-ply minimum veneer core plywood, mounted between end panels with glued 8 mm dowel joinery and metal fasteners, forming 4 in. high x 2-1/2 in. deep toe space, closed to cupboard bottom.
5. Bottoms: 3/4 in. thick plywood, set flush and joined to cabinet end panels with glued 8mm dowels and metal fasteners. Front edge to be banded with 3mm hardwood

- banding. Suspended unit bottoms to be 1 in. thick. Removable bottoms are not acceptable.
4. Backs:
 - a. Cupboard Units: One-piece 3/16 in. thick hardboard, rabbetted into rear top rail for easy removal from inside of cabinet.
 - b. Drawer Units:
 - 1) Open back on units less than 36 in., full backs in units 36 in. and over.
 - c. Sink Units: Half height, one-piece 3/16 in. thick hardboard, rabbetted into rear rail for easy removal from inside of cabinet.
 5. Vertical Dividers in Combination Cabinets: 1-1/2 in. thick 13-ply minimum veneer core plywood panel (frames not permitted) glued and screwed in place, top and bottom with 3 mm hardwood banding on front edge.
 6. Security Panels:
 - a. None required.
 7. Shelves:
 - a. 1 in. thick, 9-ply minimum veneer core plywood; 3 mm hardwood banded on front edge, adjustable on 32 mm centers.
 - b. Depth:
 - 1) Full depth shelf, 17-3/4 in. deep.
 8. Drawer Construction:
 - a. Box: Four sided drawer box with back, front and sides of 12 mm (1/2 in. nominal) 9-ply birch plywood with chemical resistant finish and finished top edges. Three sided drawer box attached to outer drawer front is not acceptable. Sides shall be joined by:
 - 1) Multiple dovetail all four corners.
 - b. Bottom: Nominal 1/4 in., inset into all four sides of drawer box and sealed with hot melt glue process around entire drawer bottom perimeter. Staples are not acceptable. Material to be:
 - 1) White PVC clad MDF board. (Dovetail only)
 - c. Divider Grooves: None.
 9. Door and Removable Drawer Front Construction:
 - a. 3-ply, 3/4 in. thick particleboard core with 3/4 in. x 3/4 in. hardwood framed all four sides and 1/2 in. full radius on all four edges. (Radiused overlay only)
 11. Fillers, Kneespace Panels, Scribes, etc.: Shall be of same species and grade as adjacent exposed surfaces, either 3/4 in. thick 7-ply minimum veneer core plywood or lumber as required, with same stain and finish.
 12. Pullboards: 1 in. thick plywood with balanced laminated faces. Front to be constructed same as drawer front with reveals and grain as specified for cabinet face exterior. Suspension to be 3/4 extension, open roller, 75 lb dynamic load, with hold open feature and epoxy coated. (Where shown on drawings.)

B. Hardware:

1. Drawer Suspension, Except on Files:
 - a. Full extension, ball bearing roller, 100 lb dynamic load, epoxy coated Accuride 3832 series or equal.
2. File Drawer Suspension: Full extension with overtravel, ball bearing roller, 150 lb dynamic load, zinc plated Accuride 4034 series or equal. File drawers to have built in hanging system.
3. Drawer and Hinged Door Pull:
 - a. 4 in. Wire:
 - 1) Stainless steel.
4. All pulls are mounted horizontally on drawers and vertically on doors.
5. Hinges: Notch for proper fit:
 - a. 5 knuckle, institutional style, hospital tipped, provide two hinges for doors up to 48 in. high; three hinges for doors over 48 in. high.
 - 1) Stainless steel.
 - b. Three hinges for doors 36 in. – 63 in. and four hinges for doors over 63 in. up to 78-3/4 in.
6. Unit Shelf Supports:
 - a. Plastic, twin pin seismic retaining clip.
7. Door Catches:
 - a. Adjustable, spring actuated nylon roller.
8. Tall cabinet door catches on two door units when locks are required: Heavy-duty spring bolts located at top and bottom of door without lock. Bolts are attached to one another by means that will conform to ADA requirements.

C. Countertops:

- A. Composition: Acrylic resins, fire-retardant mineral fillers, and proprietary coloring agents through the body color for full thickness of sheet material.
- B. Material Thickness: 1 inch nominal.
- C. Accessory Materials:
 1. Joint Adhesive: Methacrylate-based adhesive for chemically bonding solid surfacing seams.
 2. Construction Adhesive: Countertop manufacturer's recommended silicone-based construction adhesive for backsplashes, endsplashes and other applications according to manufacturer's published fabrication instructions.

PART 3 – EXECUTION

3.01 CASEWORK INSTALLATION

- A. Install plumb, level, true, and straight with no distortions. Shim as required using concealed shims. Where laboratory casework abuts other finished work, scribe and apply filler strips for accurate fit with fasteners concealed where practicable.
- B. Base Cabinets: Set cabinets straight, plumb, and level. Adjust subtops within 1/16 in. of single plane. Fasten each individual cabinet to floor at toe space, with fasteners spaced 24 in. oc. Bolt continuous cabinets together. Secure individual cabinets with not less than two fasteners into floor where they do not adjoin other cabinets.
 - 1. Where required, assemble units into one integral unit with joints flush, tight, and uniform. Align similar adjoining doors and drawers to tolerance of 1/8 in.
- C. Adjust casework and hardware so that doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

3.02 INSTALLATION OF TOPS

- A. Field Jointing: Where practicable, make in same manner as factory jointing using dowels, splines, adhesives, and fasteners recommended by manufacturer. Locate field joints as shown on accepted Shop Drawings, factory prepared so there is no jobsite processing of top and edge surfaces.
- B. Fastenings:
 - 1. For solid surface tops, secure to cabinets with epoxy cement applied at each corner and along perimeter edges of not more than 48 in. oc.
- C. Workmanship: Abut top and edge surfaces in one true plane with internal supports placed to prevent any deflection. Provide flush hairline joints in top units using clamping devices. At stone-type material joints, use manufacturer's recommended adhesives and holding devices to provide joint widths not more than 1/16 in. wide at any location, completely filled, and flush with abutting edges.
 - 1. Where necessary to penetrate tops with fasteners, countersink heads approximately 1/8 in. and plug hole flush with material equal in chemical resistance, color, hardness, and texture to top surface.
 - 2. After installation, carefully dress joints smooth, remove any surface scratches, clean, and polish entire surface.
 - 3. Provide holes and cutouts as required for electrical service fixtures.
 - 4. Provide scribe mouldings for closures at junctures of top, curb, and splash with walls as recommended by manufacturer for materials involved. Use chemical resistant, permanently elastic sealing compound where recommended by manufacturer.
 - 5. Chalk space between backsplash and wall with sealant specified in Division 07 Section "Joint Sealants."

3.03 ADJUSTING

- A. Repair or remove and replace defective work upon completion of installation.

3.04 CLEANING

- A. Clean shop-finished surfaces, touch-up as required, and remove or refinish damaged or soiled areas.

3.05 PROTECTION

- A. Advise CONTRACTOR of procedures and precautions for protection of materials and installed laboratory furniture from damage by work of other trades.

END OF SECTION

SECTION 06 55 00
FIBERGLASS REINFORCED GRATING

PART 1 – GENERAL

1.01 SUMMARY

- A. Provide fiberglass grating as shown on the Drawings, as specified herein, and as needed for a complete and proper installation.
- B. Section Includes:
 - 1. Design, fabrication, and erection of fiberglass grating and support framing.

1.02 REFERENCES

- A. ASTM: American Society for Testing and Materials
- B. OSHA : Occupational Safety and Health Administration

1.03 SYSTEM DESCRIPTION

- A. Design Requirements:
 - 1. Design Loads:
 - a. 100 pounds per square foot uniform live load.
 - b. 400 pounds moving concentrated live load.
 - 2. 1/4 inch maximum deflection under 100 pounds per square foot uniform live load for grating.
 - 3. L/240 maximum deflection for support members.

1.04 SUBMITTALS

- A. Shop Drawings:
 - 1. Type, layout, dimensions, design loads, fasteners, and locations.
 - 2. Stamped by Structural Engineer registered in State of Illinois.
- B. Product Data:
 - 1. Manufacturer's literature.
- C. AIS Certification.
- D. Submit in accordance with Section 01 33 00.

1.05 QUALITY ASSURANCE

- A. Grating shall be end product of one manufacturer to achieve standardization of appearance.

1.06 IEPA LOAN REQUIRED DOCUMENTATION – AMERICAN IRON & STEEL

- A. Pursuant to the IEPA loan being used to finance the project, the Contractor and his/her suppliers shall comply with Section 436 of federal H.R. 3547, which are requirements

regarding the use of American iron and steel products. These requirements apply to and are binding to the manufacturer of the products specified in the Section.

- B. The manufacturer shall provide with the shop drawing submittal one (1) signed and dated original of the fully completed Certification Letter (a sample copy of which is provided on page A-00 30-80-3 of this manual). Said form shall demonstrate compliance with Section 436 of federal H.R. 3547.

PART 2 – PRODUCTS

2.01 GENERAL

- A. Provide shop-fabricated grating and accessories such as frames, support angles, and fasteners.
- B. Seal cut edges with compatible resin.
- C. Provide fastening devices to firmly anchor grating and treads to supports. Sections designated as removable shall not be attached to supports.
 - 1. Minimum of 4 per panel, maximum 4 feet on center.
 - 2. Shall allow for repeated removal.
 - 3. Minimum 1/4 inch bolts or self tapping screws.
 - 4. 316 stainless steel or fiberglass.
- D. Provide additional supports at openings in grating panels.
- E. Panels shall bear on supports a minimum of 1-1/2 inches.
- F. Minimum width of panels shall be 16 inches except for locations requiring a single piece.
- G. Maximum width of panels shall be 60 inches.
- H. Concrete anchors shall conform to requirements of Section 05 50 00.

2.02 GRATING

- A. Manufacturers:
 - 1. Fibergrate Safe-T-Span.
 - 2. DURADECK.
 - 3. Corgrate SI.
 - 4. Or equal.
- B. Materials:
 - 1. Premium vinyl ester/ UV inhibited resin with continuous glass filament reinforcement.
 - 2. Resin rich exterior surfaces free of air bubbles and dry glass.
 - 3. Self extinguishing in accordance with ASTM D635.
 - 4. Flame spread of 25 or less in accordance with ASTM E84.
- C. Provide surface with skid resistant grit finish.
- D. Pultruded I-bar grating with bearing bars at 1-1/2 inches on center and cross bars at maximum 12 inches on center.

2.03 GRATING SUPPORT ANGLES

- A. Fiberglass angles especially fabricated to be cast into the concrete to provide a suitable bearing ledge to support the grating.
- B. Support angles shall be supplied by the grating manufacturer.
- C. The angle materials shall meet the criteria established for Structural Shapes as described herein.

2.04 STRUCTURAL SHAPES

A. Manufacturers:

- 1. Dynaform by Fibergrate.
- 2. Pultex Series by Creative Pultrusions, Inc.
- 3. Extren Series by Strongwell.
- 4. Or equal.

B. Materials:

- 1. Pultruded fiberglass angles, channels, and other structural shapes.
- 2. Reinforcement shall consist of combination fiberglass roving, continuous strand, and veil material.
- 3. Premium vinyl ester UV inhibited resin with surface veil on all faces.
- 4. Resin rich exterior surfaces free of air bubbles and dry glass.
- 5. Self extinguishing in accordance with ASTM D635.
- 6. Flame spread of 25 or less in accordance with ASTM E84.

2.05 ACCESSORIES

- A. Bolts, rivets, and other connectors shall be 316 SST.
- B. Concrete anchors shall be stainless steel conforming to requirements of Section 05 50 00.

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 INSTALLATION

- A. Install in accordance with manufacturer's written instructions.
- B. Clearances:
 - 1. 1/4 inch maximum from metal sections.
 - 2. 1/2 inch maximum from concrete or masonry walls.
 - 3. 1/4 inch maximum between sections.
- C. Seal cut edges with compatible resin.

END OF SECTION

DIVISION 7

THERMAL MOISTURE PROTECTION

SECTION 07 21 00
THERMAL INSULATION

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Board insulation at perimeter concrete foundation walls.
2. Board insulation in masonry cavity walls.
3. Batt insulation.
4. Acoustic batt insulation.

1.02 REFERENCES

- A. ASTM: American Society for Testing and Materials

1.03 PERFORMANCE REQUIREMENTS

- A. Materials of this section shall provide continuity of thermal barrier at building enclosure elements.

1.04 SUBMITTALS

- A. Product Data: Provide data on product characteristics, performance criteria, and limitations.
- B. Manufacturer's installation instructions.
- C. Submit in accordance with section 01 33 00.

1.05 ENVIRONMENTAL CONDITIONS

- A. Do not install insulation adhesives when temperatures or weather conditions are detrimental to successful installation.

PART 2 - PRODUCTS

2.01 EXTRUDED POLYSTYRENE BOARD (PERMETER FOUNDATION INSULATION)

- A. Rigid, closed-cell, extruded, polystyrene insulation with integral high density skins.
- B. Minimum thermal resistance "R" per inch: 5.0.
- C. Minimum compressive strength:
1. 25 pounds per square inch for perimeter wall and cavity wall insulation.
- D. Maximum water absorption by volume in accordance with ASTM C272: 0.1%.
- E. Manufacturer's recommended adhesive for insulation application.
- F. Minimum thickness: 2 inches unless otherwise noted. Reduce thickness of cavity wall insulation at concrete beams and columns to 1 ½ inches.

G. Acceptable Manufacturers:

1. Dow.
2. Owens Corning.
3. Tenneco.
4. Pactiv.

2.02 BATT INSULATION

A. Preformed glass fiber batts conforming to the following:

1. Minimum thermal resistance: R-30.
2. Batt roll size: As required for stud and joist spacing.
3. Facing: Unfaced.

A. Vapor Barrier: ASTM D4397, 6 mil thick polyethylene with maximum permeance rating of 0.13 perm.

2.03 ACOUSTIC BATT INSULATION

A. Preformed acoustic glass fiber batt insulation conforming to the following:

1. Sound transmission classification (STC): STC 40.
2. Batt roll size: As required for stud and joist spacing.
3. Facing: Unfaced.

2.04 POLYISOCYANURATE INSULATION (WALL INSULATION)

A. Rigid, closed-cell, foil faced polyisocyanurate insulation.

B. Minimum thermal resistance "R" per inch: 7.0.

C. Minimum compressive strength: 20 pounds per square inch.

D. Maximum flame spread and smoke developed indices of 25 and 130, respectively, per 1 inch thickness.

E. ASTM Standard C1289, Type I, Class 1 or 2.

F. Acceptable Manufacturers:

1. Apache Products Company.
2. Celotex Corporation.
3. John Mansville Corporation.

PART 3 - EXECUTION

3.01 INSTALLATION / EXTRUDED POLYSTYRENE AND POLYISOCYANURATE BOARD

A. Extruded polystyrene insulation to be installed where shown on the drawings, in accordance with manufacturer's instructions.

B. Place boards in method to maximize contact bedding. Stagger side and end joints with edges butted tightly.

C. Cut and fit boards tightly around penetrations and other openings as required.

- D. Perimeter insulation shall be set in adhesive applied to foundation wall in accordance with manufacturer's recommendations.
- E. Cavity wall insulation shall be set in adhesive applied to exterior face of interior wythe in accordance with manufacturer's recommendations. Fit courses of insulation between wall ties between wythes.
- F. Where thickness exceeds 2 inches, install first layer of insulation as specified herein. Stagger side and end joints of finish layer.

3.02 INSTALLATION / BATT

- A. Verify that the substrate and adjacent materials are dry and ready to receive the insulation.
- B. Install in accordance with manufacturer's recommendations.
- C. Install without gaps or voids.
- D. Trim insulation neatly to fit spaces.
- E. Fit insulation tight in spaces and tight to exterior side of mechanical or electrical services with the plane of the insulation.
- F. Cover the insulated areas with vapor barrier to extremities of areas to be protected. Secure in place. Lap joints a minimum of 2 feet. Seal joints and penetrations with seam tap. Repair tears or punctures in vapor barrier before concealment by other work.

END OF SECTION

SECTION 07 21 19
FOAMED-IN-PLACE INSULATION

PART – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Foamed-In-Place Insulation for exterior and interior concrete masonry walls as noted on Drawings.

1.02 REFERENCES

- A. ASTM: American Society for Testing and Materials

1.03 SUBMITTALS

- A. Product data, technical information, and installation instructions.
- B. Certified test reports showing compliance with specified performance values.
- C. Submit in accordance with Section 01 33 00.

1.04 QUALITY ASSURANCE

- A. Provide insulation produced by a single manufacturer.
- B. Engage an experienced installer who has been trained and licensed by the product manufacturer and which has not less than three years experience in the installation of the product used.
- C. Provide insulation materials which meet fire performance characteristics listed.
1. Fire Resistance Ratings: ASTM E-119
 2. Surface Burning Characteristics: ASTM E-84
 3. Combustion Characteristics: ASTM E-136

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Core-Fill 500 by Tailored Chemical Products.
- B. Tripolymer Foam Insulation by C.P. Chemical Co., Inc.
- C. Thermco Foam Insulation by Thermal Corp. of America.

2.02 INSULATING MATERIALS

- A. Provide insulating materials which comply with requirements indicated, referenced standards, and other characteristics.

- B. Two component thermal insulation produced by combining a plastic resin and catalyst foaming agent which, when properly rationed and mixed, together with compressed air produce a cold-setting rigid foam insulation in the hollow cores of hollow unit masonry walls.
 - 1. Minimum 2 hour fire resistance rating when tested as a wall system.
 - 2. Maximum flame spread, smoke developed, and fuel contributed of 15, 75 and 0 respectively.
 - 3. Minimum "R" Value: 4.9 inches. at 32°F; ASTM C-177.
 - 4. Minimum Sound Transmission Class ("STS") Rating: 50.
 - 5. Dry Density: 0.7 to 1.3 per cubic feet.
 - 6. Minimum Compressive Strength: 30 pounds per square inch.
 - 7. Maximum Shrinkage: 2%.
- C. Foam must be a noncombustible, Class A building material, shall be non-corrosive, shall not conduct electricity, shall not absorb water, shall be non-toxic, and shall not contain or emit CFCs.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Install foamed-in-place insulation prior to installation of interior finish work; comply with manufacturer's instructions.
- B. Completely fill all open cells and voids in hollow concrete masonry walls where noted on Drawings.
- C. Allow foam to cure minimum of 2 weeks before coating or sealing walls.

END OF SECTION

SECTION 07 26 20
LIQUID-APPLIED AIR/VAPOR BARRIER SYSTEM

PART 1 – GENERAL DESCRIPTION

1.01 SECTION INCLUDES

A. This section includes following:

1. Materials and installation methods for liquid-applied air/vapor barrier system located in non-accessible part of wall.
2. Materials and installation to bridge and seal following air leakage pathways and gaps:
 - a. Connections of walls to roof air barrier.
 - b. Connections of walls to foundations.
 - c. Openings and penetrations of window frames and aluminum entrances.
 - d. Hollow metal door frames.
 - e. Piping, conduit, duct and similar penetrations.
 - f. Masonry ties, screws, bolts and similar penetrations.
 - g. All other air leakage pathways in building envelope.

1.02 SECTION INCLUDES

- A. Provide air/vapor barrier constructed to perform as continuous air/vapor barrier, and as liquid water drainage plane flashed to discharge to exterior any incidental condensation or water penetration. Membrane shall accommodate movements of building materials by providing expansion and control joints as required, with accessory air seal materials at such locations, changes in substrate and perimeter conditions.
- B. Air Barrier Association of America's (ABAA' s) definition of tested system, to provide tested system air leakage results not to exceed:
 1. 0.01 cfm/sf @ 1.57 psf (0.05 L/s/M2 @ 75 Pa).
 2. 0.02 cfm/sf @ 1.57 psf (0.1 L/s/M2 @ 75 Pa).
 3. 0.03 cfm/sf @ 1.57 psf (0.15 L/s/M2 @ 75 Pa).
 4. 0.04 cfm/sf @ 1.57 psf (0.2 L/s/M2 @ 75 Pa).

1.03 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 and the following:

1. Provide evidence to contractor of licensing and certification under Air Barrier Association of America's (ABAA's) Quality Assurance Program.
2. Submit shop drawings showing locations and extent of air/vapor barrier and details of all typical conditions, intersections with other envelope systems and materials, membrane counter-flashings, and details showing how gaps in construction will be bridged, how inside and outside corners are negotiated and how miscellaneous penetrations such as conduits, pipes, electric boxes and similar items are sealed.
3. Submit manufacturer's product data sheets for each type of membrane, including manufacturer's printed instructions for evaluating, preparing, and treating substrate, temperature and other limitations of installation conditions, technical data, and tested physical and performance properties.
4. Submit manufacturer's installation instructions.

5. Certification by air/vapor barrier manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
6. Certification of compatibility by air/vapor barrier manufacturer, listing all materials on project that it connects to or that come in contact with it.
7. Submit samples, 3 in. by 4 in. minimum size, of each air/vapor barrier material required for Project.

1.04 QUALITY ASSURANCE

A. Installer Qualifications:

1. Air barrier contractor shall be, during bidding period as well as for duration of installation, officially recognized as Licensed Contractor by Air Barrier Association of America (ABAA).
2. Each worker who is installing air barriers must be either Certified Applicator or an installer who is registered with ABAA.
3. Each Lead Certified Applicator can supervise maximum of five registered installers. Certified Applicator shall be thoroughly trained and experienced in installation of air barriers of types being applied. Lead Certified Applicators shall perform or directly supervise all air/vapor barrier work on project.

B. Air/vapor barrier installers must be trained and certified by NECA (National Energy Conservation Association) and PSDI (Professional Skills Development Institute for energy conservation).

C. Single-Source Responsibility: Obtain air/vapor barrier materials from single manufacturer regularly engaged in manufacturing product.

D. Provide products which comply with all state and local regulations controlling use of volatile organic compounds (VOCs).

E. Preconstruction Meeting: Convene one week prior to commencing Work of this section.

F. Sample Panel: Prior to installation of air/vapor barrier, apply air/vapor barrier as follows to verify details under shop drawings submittals and to demonstrate tie-ins with adjoining construction, and other termination conditions, as well as qualities of materials and execution:

1. Apply air/vapor barrier in sample panel of typical exterior wall panel.
2. Typical exterior sample wall panel shall be 8 ft. long by 8 ft. wide, incorporating backup wall, cladding, window and door frame and sill, insulation, flashing, junction with roof system, foundation wall and typical penetrations and gaps; illustrating materials interface and seals.
3. Test mock-up for air and water infiltration in accordance with ASTM E 7983 and ASTM E 1105.
4. Do not cover any installed air and vapor barrier membrane unless it has been inspected, tested and approved.
5. Do not start Work until CONTRACTOR has accepted sample panel.
6. Use panel as standard of comparison for stonework built of same material.
7. Do not destroy or move panel until Work complete and accepted by CONTRACTOR.
8. Sample panel may be part of finished wall.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original packages with seals unbroken, labeled with manufacturer's name, product, date of manufacture, and directions for storage.

- B. Store materials in their original undamaged packages in clean, dry, protected location and within temperature range required by air/vapor barrier manufacturer. Protect stored materials from direct sunlight.
- C. Avoid spillage. Immediately notify CONTRACTOR if spillage occurs and start clean up procedures.
- D. Clean spills and leave area as it was prior to spill.

1.06 DISPOSAL

- A. Place materials defined as hazardous or toxic waste in designated containers. Ensure emptied containers are sealed and stored safely for disposal.

1.07 PROJECT CONDITIONS

- A. Environmental Conditions: Apply air/vapor barrier within range of ambient and substrate temperatures recommended by air/vapor barrier manufacturer. Do not apply air/vapor barrier to damp or wet substrate, unless manufacturer specifically permits that for product.
 - 1. Do not apply air/vapor barrier in snow, rain, fog, or mist.
 - 2. Do not apply air/vapor barrier when temperature of substrate surfaces and surrounding air temperatures are below those recommended by manufacturer.

PART 2 – PRODUCTS

2.01 MATERIALS AND MANUFACTURERS

- A. Liquid Seal Synthetic rubber, spray applied, nominal total thickness of 40 in. (50mm). Mils.
 - 1. Materials:
 - a. Rub-R-Wall Airtight Air/Vapor Barrier, liquid applied 100% rubber copolymer membrane having air leakage rate of 0.0004 cfm / ft² when tested to ASTM E283, nominal total thickness 40 mils manufactured by Rubber Polymer Corporation in accordance with physical properties as stated in manufacturer's literature.
 - b. Or equal.

2.02 AUXILIARY MATERIALS

- A. Furnish auxiliary materials recommended by air/vapor barrier manufacturer for intended use and compatible with air/vapor barrier membrane.
- B. Stainless-Steel Sheet Flashing: ASTM A167, Type 304, soft annealed, with No. 2D finish; minimum, 0.0156 in. (0.4 mm) thick.
- C. Transition Strip: Rub-R-Wall SA manufactured by Rubber Polymer Corporation or equal; self-adhering, smooth surfaced SBS modified bitumen membrane, nominal 40 mil thickness, width as required.
- D. Transition Strip Primer: Rub-R-Wall SA Primer manufactured by Rubber Polymer Corporation or equal.
- E. Substrate Filler for Rub-R-Wall: Rub-R-Wall Mastic manufactured by Rubber Polymer Corporation or equal.

F. Sheet Membrane Flashing and Transition Sheet: Non-reinforced, cured chloroprene polymer sheet (neoprene) complying with ASTM D2000 Designation 2BC415 to 3BC620, 50 to 65 mils thick.

1. Adhesive: Typical contact-type adhesive used for fully-adhered membranes.
2. Lap Sealant: Typical urethane or silicone lap and termination sealant used for membrane edges recommended by manufacturer.
3. Termination bars and fasteners:
 - a. Stainless steel.

PHYSICAL PROPERTIES

PROPERTY	TEST METHOD	TEST RESULTS
Air Leakage Rate	ASTM E283	0.0004 cfm/ft ² on concrete block and drywall
Elongation (%)	ASTM D412 (die C)	1800%
Low-Temperature Flexibility	Bend around 0.5" mandrel	Flexible to -20° F
Abrasion Resistance	700 psi on .06" x .06" point moving 1" per sec.	Less and 0.10% membrane loss
Asphalt Content	Non Applicable	0.0%
180° Peel Adhesion	Metal Plate	18 lbs./inch
Crack Bridging	ASTM 836	Exceeds ten cycles to 1/8 inch at -15°F
Water Vapor Permeance	ASTM E96 (water method)	0.08 perms for 40 mil dry coating grams/ft ² /hr. in Hg
Liquid Water Absorption	ASTM D95	Less than 0.5% (weight)
Resistance to Bacteria	ASTM D4299-83 (modified)	No attack
Resistance to Gust Wind Load	ASTM E330	Resists suction pressure of 62.8 lbs./ft ² maintained for 10 seconds with no delamination and no increase in air leakage rate when tested at 1.6 lbs./ft ²
Resistance to Sustained Wind Load	ASTM E283	Resists suction pressure of 20.9 lbs./ft ² maintained for 1 hour with no delamination and no increase in air leakage rate when tested at 1.6 lbs./ft ²
Resistance to Chemical Attack	Visual	Unaffected by chemicals in concentrations typically found in soils
Solvent Resistance	Visual	Exceeds performance of modified asphalts
Life Expectancy	ASTM D412 ASTM D2240	Exceeds 100 years
Density		6.8 – 7.8 lbs./gal

PART 3 – EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions under which air/vapor barrier systems will be applied, with Installer present, for compliance with requirements. Verify that surfaces and conditions are suitable prior to commencing work of this section. Do not proceed with installation until unsatisfactory conditions have been corrected.

1. Do not proceed with installation until after minimum concrete curing period recommended by air/vapor barrier manufacturer.
2. Ensure that:
 - a. Surfaces are sound, dry, even, and free of oil, grease, dirt, excess mortar or other contaminants.
 - b. Concrete surfaces are cured and dry, smooth without large voids, spalled areas or sharp protrusions.
 - c. Masonry joints are flush and completely filled with mortar, and all excess mortar
3. Verify substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D4263.
4. Notify CONTRACTOR in writing of anticipated problems using air/vapor barrier over substrate.

3.02 SURFACE PREPARATION

- A. Clean, prepare, and treat substrate according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for air/vapor barrier application.
- B. Prime masonry, concrete substrates with conditioning primer when installing modified asphalt membrane transition membranes.
- C. Prime glass-fiber surfaced gypsum sheathing adequate number of coats to achieve required bond to transition membranes, with adequate drying time between coats.
- D. Prime wood, metal, and painted substrates with primer recommended by membrane manufacturer.
- E. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through air/vapor barrier and at protrusions according to air/vapor barrier manufacturer's written instructions [and approved tested system in accordance with ABAA air barrier testing procedures].

3.03 INSTALLATION

- A. Air/Vapor Barrier:
 1. Install materials in accordance with manufacturer's instructions.
 2. Transition joints: Seal with transition strip at beams, columns, changes in substrate material, and similar joints or connections to provide continuity of air/vapor barrier assembly. Generally, apply transition strips so that minimum of 3 in. coverage is achieved over both substrates. Position strip over firm bearing to window frame perimeter, and doorframes: Lap transition strip from wall substrate with 3 in. of full contact over firm bearing to window or doorframe with 1 in. of full contact.
 3. Apply air/vapor barrier membrane within recommended application temperature ranges. Consult manufacturer when membrane cannot be applied within these temperature ranges.
 4. Using airless spray equipment having minimum pressure of 3000 psi, apply first coat of air/vapor barrier membrane over outer surface of inner wythe masonry.
 5. Use alternating horizontal and vertical passes to ensure complete coverage of substrate and transition strips. Seal masonry anchors or other penetrations air tight.
 6. Check surfaces again and if necessary, fill any remaining gaps with mastic substrate filler prior to covering with membrane.
 7. Complete application of membrane at coverage rate of 20 to 25 sq. ft./gal to provide seamless, monolithic surface to thickness of 40 mils.

8. Adhere insulation to air/vapor barrier membrane after initial set time of approximately 1 to 2 hrs. and while membrane is still tacky, to prevent convection currents occurring behind insulation.

B. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

3.04 PROTECTING AND CLEANING

A. Protect air/vapor barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.

B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

C. Protect air/vapor barrier from exposure to elements as required by manufacturer.

END OF SECTION

SECTION 07 41 10
METAL ROOF AND WALL PANELS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Factory-formed and field-assembled, standing-seam metal roof panels.
2. Metal wall panels.
3. Metal soffit and fascia panels.
4. Metal trim, gutter and downspouts.
5. Metal infill panels.

1.02 DEFINITIONS

- A. Metal Roof Panel Assembly: Metal roof panels, attachment system components, miscellaneous metal framing, and accessories necessary for complete weathertight roofing siding system.

1.03 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal roof panel and accessory.
- B. Shop Drawings: Show fabrication and installation layouts of metal roof panels; details of edge conditions, joints, panel profiles, corners, anchorages, trim, flashings, closures, and accessories; and special details. Distinguish between factory-and field-assembled work.
1. Accessories: Include details of following items, at scale of not less than 1-1/2 in. per 12 in. (1:10):
 - a. Flashing and trim.
 - b. Gutters.
 - c. Downspouts.
 - d. Roof curbs.
 - e. Snow guards.
 - f. Soffit panels.
 - g. Flush panel vertical siding.
- C. Samples for Initial Selection: For each type of metal roof and wall panel indicated with factory-applied color finishes.
1. Include similar Samples of trim and accessories involving color selection.
- D. Maintenance Data: For metal roof panels to include in maintenance manuals.
- E. Warranties: Special warranties specified in this Section.
- F. Submit in accordance with Section 01 33 00.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
 - 1. Engineering Responsibility: Preparation of data for metal roof panels, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
- B. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated, as documented according to ASTM E 548.
- C. Source Limitations: Obtain each type of metal roof panels through one source from single manufacturer.
- D. Product Options: Drawings indicate size, profiles, and dimensional requirements of metal roof panels and are based on specific system indicated.
 - 1. Do not modify intended aesthetic effects, as judged solely by ARCHITECT, except with ARCHITECT'S approval. If modifications are proposed, submit comprehensive explanatory data to ARCHITECT for review.
- E. Preinstallation Conference: Conduct conference at Project site. Review methods and procedures related to metal roof panel assemblies including, but not limited to, following:
 - 1. Meet with OWNER, ARCHITECT, OWNER'S insurer if applicable, testing and inspecting agency representative, metal roof panel Installer, metal roof panel manufacturer's representative, deck, Installer, and installers whose work interfaces with or affects metal roof panels including installers of roof accessories and roof-mounted equipment.
 - 2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 3. Review methods and procedures related to metal roof panel installation, including manufacturer's written instructions.
 - 4. Examine deck substrate conditions for compliance with requirements, including flatness and attachment to structural members.
 - 5. Review structural loading limitations of deck during and after roofing.
 - 6. Review flashings, special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect metal roof panels.
 - 7. Review Governing regulations and requirements for insurance, certificates, and testing and inspecting if applicable.
 - 8. Review temporary protection requirements for metal roof panel assembly during and after installation.
 - 9. Review roof observation and repair procedures after metal roof panel installation.
 - 10. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, sheets, metal roof panels, and other manufactured items so as not to be damaged or deformed. Package metal roof panels for protection during transportation and handling.
- B. Unload, store, and erect metal roof panels in manner to prevent bending, warping, twisting, and surface damage.

- C. Stack metal roof panels on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal roof panels to ensure dryness. Do not store metal roof panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Protect strippable protective covering on metal roof panels from exposure to sunlight and high humidity, except to extent necessary for period of metal roof panel installation.

1.06 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal roof panels to be performed according to manufacturers' written instructions and warranty requirements.
- B. Field Measurements: Verify locations of roof framing and roof opening dimensions by field measurements before metal roof panel fabrication and indicate measurements on Shop Drawings.

1.07 COORDINATION

- A. Coordinate installation of equipment supports and roof penetrations, which are specified in Section 07 72 00 as shown on Drawings.
- B. Coordinate metal panel roof assemblies with rain drainage work, flashing, trim, and construction of decks, walls, and other adjoining work to provide leakproof, secure, and noncorrosive installation.

1.08 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal roof panel assemblies that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, following:
 - a. Structural failures, including rupturing, cracking, or puncturing.
 - b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 2. Warranty Period: Two yrs from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal roof panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Fluoropolymer Finish: Deterioration includes, but is not limited to, following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.
- C. Special Weathertightness Warranty for Standing-Seam Metal Roof Panels: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.

1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PANEL MATERIALS

- A. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet metallic coated by hot-dip process and prepainted by coil-coating process to comply with ASTM A 755/A 755M.
1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.
 2. Surface: Smooth, flat finish.
 3. Exposed Finishes: Apply following coil coating, as specified or indicated on Drawings.
 - a. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 1) Fluoropolymer Three-Coat System: Manufacturer's standard three-coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight, with minimum total dry film thickness of 1.5 mil (0.038 mm); complying with physical properties and coating performance requirements of AAMA 2605, except as modified below:
 - a) Humidity Resistance: 2000 hours.
 - b) Salt-Spray Resistance: 2000 hours.
 4. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil (0.013 mm).
- A. Panel Sealants:
1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 in. (13 mm) wide and 1/8 in. (3 mm) thick.
 2. Joint Sealant: ASTM C 920; elastomeric polyurethane, polysulfide, or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal roof panels and remain weathertight; and as recommended in writing by metal roof panel manufacturer.
 3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

2.02 MISCELLANEOUS MATERIALS

- A. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal roof panels by means of plastic caps or factory-applied coating.
1. Fasteners for Roof Panels: Self-drilling or self-tapping 410 stainless or zinc-alloy steel hex washer head, with EPDM or PVC washer under heads of fasteners bearing on weather side of metal roof panels.
 2. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws with hex washer head.
 3. Blind Fasteners: High-strength aluminum or stainless-steel rivets.

- B. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.03 STANDING-SEAM METAL ROOF PANELS

- A. Provide factory-formed metal roof panels designed to be field assembled by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.

1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1514.
2. Aluminum Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1637.

- B. Vertical-Rib, Standing-Seam Metal Roof Panels:

1. Manufacturers:

- a. Petersen Aluminum Corporation. Pac-Clad Tite-Loc Plus Panels.
- b. CENTRIA Architectural Systems.
- c. McElroy Metal, Inc.
- d. Merchant & Evans, Inc.
- e. Or equal.

2. Formed with vertical ribs at panel edges and intermediate stiffening panel shape between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels, and snapping panels together.

3. Material: Zinc-coated (galvanized) steel sheet, 24 ga thick.

- a. Exterior Finish: Fluoropolymer.
- b. Color: As selected by ARCHITECT from manufacturer's full range including metallic colors.

4. Clips: Floating to accommodate thermal movement.

- a. Material: 0.0625-in.- (1.6-mm-) thick, stainless-steel sheet.

6. Panel Coverage: 16 in. (305 mm).

7. Panel Height: 2.0 in.

8. Uplift Rating: UL 90.

2.04 METAL SOFFIT PANELS

- A. Provide factory-formed metal soffit panels designed to be field assembled by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory-applied sealant in side laps. Include accessories required for weathertight installation.

- B. Metal Soffit and Fascia Panels: Match profile and material of metal roof panels.

1. Finish: Match finish and color of metal roof and wall panels.

C. Flush-Profile Metal Soffit Panels:

1. Manufacturers: Same as roof panel.
2. Perforated panels formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced between panel edges; with flush joint between panels.
3. Material: Zinc-coated 24 ga (galvanized) steel sheet.
 - a. Exterior Finish: Fluoropolymer.
 - b. Color: Match finish and color of metal roof panels.
4. Panel Coverage: 12 in. (305 mm).

2.05 METAL WALL PANEL

- A. Provide factory-formed metal wall panels designed to be field assembled by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners in sidelaps. Include accessories required for weathertight installation.
1. Manufacturers:
 - a. CENTRIA Architectural Systems. Formawall Dimension Series.
 - b. Or equal.
 2. Flush Wall Panel:
 - a. Exterior Finish: Fluoropolymer Three-Coat Metallic System.
 - b. Material 24 gauge steel.
 - c. Smooth 3-inch insulated wall panel (R-22).
 - d. Color: As selected by ARCHITECT from manufacturer's full range including metallic colors.

2.06 METAL INFILL PANEL (BUILDING 600 – INFILLS AT DOOR FRAMES AT D01 AND D02)

- A. Provide factory-formed wall panels consisting of metal facings laminated to solid plastic substrates with an insulating isocyanurate core material. Panels are designed to be glazed into a hollow metal door frame.
1. Manufacturers:
 - a. Mapes-R by Mapes Architectural Panels.
 - b. Or equal.
 2. Flush Wall Panel:
 - a. Exterior Finish: Embossed Baked Enamel.
 - b. Interior Finish: Embossed Baked Enamel.
 - c. Exterior Substrate: Solid Plastic.
 - d. Interior Substrate: Solid Plastic.
 - e. Core: Isocyanurate.
 - f. Embossed 1-inch insulated wall panel (R-6.56).
 - g. Color: As selected by OWNER from manufacturer's full range of available colors.

2.07 ACCESSORIES

- A. Panel System Accessories: Provide components required for complete metal roof panel assembly including trim, copings, fascia, corner units, ridge closures, clips, flashings, sealants,

gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels, unless otherwise indicated.

1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal roof panels.
 2. Clips: Minimum 0.0625-in.- (1.6-mm-) thick, stainless-steel panel clips designed to withstand negative-load requirements.
 3. Cleats: Mechanically seamed cleats formed from minimum 0.0250-in.- (0.64-mm-) thick, stainless-steel or nylon-coated aluminum sheet.
 4. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 5. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-in.- (25-mm-) thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- B. Flashing and Trim: Formed from 0.0179-in.- (0.45-mm-) thick, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal roof panels.
- C. Gutters: Formed from 0.0179-in.- (0.45-mm-) thick, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating. Match profile of gable trim, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-in.- (2400-mm-) long sections, sized according to SMACNA's "Architectural Sheet Metal Manual." Furnish gutter supports spaced 36 in. (900 mm) o.c., fabricated from same metal as gutters. Provide bronze, copper, or aluminum wire ball strainers at outlets. Finish gutters to match metal roof panels.
- D. Downspouts: Formed from 0.0179-in.- (0.45-mm-) thick, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating; in 10-ft- (3-m-) long sections, complete with formed elbows and offsets. Finish downspouts to match metal roof panels.
- E. Snow Guards: Prefabricated, noncorrosive units designed to be installed without penetrating metal roof panels, and complete with predrilled holes, clamps, or hooks for anchoring.
1. Seam-Mounted, Bar-Type Snow Guards:
 - a. Products:
 - 1) Alpine Snow Guards, Div. of Vermont Slate & Copper Services, Inc.; Model No. 05-98.
 - 2) LMCurbs; S-5! SnoFence.
 - 3) Riddell & Company, Inc.; Snobar.
 - 4) Snow Management Systems, division of Contek, Inc.; Vermont Snowguard.
 - b. Stainless-steel rods or bars held in place by stainless-steel clamps attached to vertical ribs of standing-seam metal roof panels.
 - c. Stainless-Steel Finish: Enamel.
- F. Pipe Flashing: Premolded, EPDM pipe collar with flexible aluminum ring bonded to base.

2.08 FABRICATION

- A. Fabricate and finish metal roof panels and accessories at factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- C. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
 - 1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 - 2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
 - 3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 - 4. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
 - 5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
 - 6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended by metal roof panel manufacturer.
 - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal roof panel manufacturer for application but not less than thickness of metal being secured.

2.09 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical and painted finishes on exposed surfaces from damage by applying strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within range of approved Samples and are assembled or installed to minimize contrast.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal roof panel supports, and other conditions affecting performance of work.

1. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation tolerances, metal roof panel supports, and other conditions affecting performance of work.
- B. Examine roughing-in for components and systems penetrating metal roof panels to verify actual locations of penetrations relative to seam locations of metal roof panels before metal roof panel installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment.
- B. Install flashings and other sheet metal to comply with Section 07 62 00.
- C. Install fasciae and copings to comply with Section 07 62 00.
- D. Miscellaneous Framing: Install subpurlins, eave angles, furring, and other miscellaneous roof panel support members and anchorage according to metal roof panel manufacturer's written recommendations.

3.03 UNDERLAYMENT INSTALLATION

- A. Polyethylene Sheet Underlayment: Install polyethylene sheet on roof sheathing under metal roof panels, unless otherwise recommended by metal roof panel manufacturer. Use adhesive for anchorage to minimize use of mechanical fasteners under metal roof panels. Apply at locations indicated on Drawings, in shingle fashion to shed water, with lapped and taped joints of not less than 2 in. (50 mm).
- B. Felt Underlayment: Install felt underlayment and building-paper slip sheet on roof sheathing under metal roof panels, unless otherwise recommended by metal roof panel manufacturer. Use adhesive for temporary anchorage, where possible, to minimize use of mechanical fasteners under metal roof panels. Apply at locations indicated below, in shingle fashion to shed water, with lapped joints of not less than 2 in. (50 mm).
 1. Apply on roof not covered by self-adhering sheet underlayment. Lap edges of self-adhering sheet underlayment not less than 3 in. (75 mm), in shingle fashion to shed water.
- C. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free, on roof sheathing under metal roof panels. Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. Apply at locations indicated below, in shingle fashion to shed water, with end laps of not less than 6 in. (150 mm) staggered 24 in. (600 mm) between courses. Overlap side edges not less than 3-1/2 in. (90 mm). Roll laps with roller. Cover underlayment within 14 days.
 1. Roof perimeter for distance up from eaves of 36 in. (900 mm) beyond interior wall line.
 2. Rake edges for distance of 18 in. (460 mm).
- D. Install flashings to cover underlayment to comply with Section 07 62 00.
- E. Apply slip sheet over underlayment before installing metal roof panels.

3.04 METAL ROOF PANEL INSTALLATION, GENERAL

- A. Provide metal roof panels of full length from eave to ridge, unless otherwise indicated or restricted by shipping limitations. Anchor metal roof panels and other components of Work securely in place, with provisions for thermal and structural movement.
 - 1. Field cutting of metal roof panels by torch is not permitted.
 - 2. Rigidly fasten eave end of metal roof panels and allow ridge end free movement due to thermal expansion and contraction. Pre-drill panels.
 - 3. Provide metal closures at peaks, rake edges rake walls, and each side of ridge caps.
 - 4. Flash and seal metal roof panels with weather closures at eaves, rakes, and at perimeter of all openings. Fasten with self-tapping screws.
 - 5. Locate and space fastenings in uniform vertical and horizontal alignment.
 - 6. Install ridge and hip caps as metal roof panel work proceeds.
 - 7. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid four-panel lap splice condition.
 - 8. Lap metal flashing over metal roof panels to allow moisture to run over and off material.
- B. Fasteners:
 - 1. Steel Roof Panels: Use stainless-steel fasteners for surfaces exposed to exterior and galvanized steel fasteners for surfaces exposed to interior.
 - 2. Aluminum Roof Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to exterior and aluminum or galvanized steel fasteners for surfaces exposed to interior.
 - 3. Copper Roof Panels: Use copper or stainless-steel fasteners.
 - 4. Stainless-Steel Roof Panels: Use stainless-steel fasteners.
- C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.
 - 1. Coat back side of roof panels with bituminous coating where roof panels will contact wood, ferrous metal, or cementitious construction.
- D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal roof panels assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal roof panel manufacturer.
 - 1. Seal metal roof panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal roof panel manufacturer.
 - 2. Prepare joints and apply sealants to comply with requirements in Section 07920.

3.05 FIELD-ASSEMBLED METAL ROOF PANEL INSTALLATION

- A. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface
 - 1. Install clips to supports with self-tapping fasteners.
 - 2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
 - 3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
 - 4. Seamed Joint: Crimp standing seams with manufacturer-approved motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.

- B. Metal Soffit Panels: Provide metal soffit panels full width of soffits. Install panels perpendicular to support framing.
 - 1. Flash and seal panels with weather closures where metal soffit panels meet walls and at perimeter of all openings.
- C. Fascia Panels: Align bottom of panels and fasten with blind rivets, bolts, or self-tapping screws. Flash and seal panels with weather closures where fasciae meet soffits, along lower panel edges, and at perimeter of all openings.
- D. Vertical Wall Panels: Per manufacturer's requirements.

3.06 ACCESSORY INSTALLATION

- A. Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
 - 1. Install components required for complete metal roof panel assembly including trim, copings, ridges closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
- B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
 - 1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
 - 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at maximum of 10 ft (3 m) with no joints allowed within 24 in. (600 mm) of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 in. (25 mm) deep, filled with mastic sealant (concealed within joints).
- C. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 4 ft (1.2 m) o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.
- D. Downspouts: Join sections with 1-1/2-in. (38-mm) telescoping joints. Provide fasteners designed to hold downspouts securely 1 in. (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 in. (1500 mm) o.c. in between.
 - 1. Provide elbow at base of downspouts to direct water away from building.
- E. Roof Curbs: Install curbs at locations indicated on Drawings. Install flashing around bases where they meet metal roof panels.
- F. Bar-Type Snow Guards: Attach bar supports to vertical ribs of standing-seam metal roof panels with clamps or set screws. Do not use fasteners that will penetrate metal roof panels.

1. Provide Two rows of snow guards, at locations indicated on Drawings, equally spaced apart, beginning from gutter.
- G. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to metal roof panels as recommended by manufacturer.

3.07 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align metal roof panel units within installed tolerance of 1/4 in. in 20 ft (6 mm in 6 m) on slope and location lines as indicated and within 1/8-in. (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.08 FIELD QUALITY CONTROL

- A. Testing Agency: Engage qualified independent testing and inspecting agency to perform inspections and prepare reports.
- B. Manufacturer's Field Service: Engage factory-authorized service representative to inspect completed metal roof panel installation, including accessories. Report results in writing.
- C. Remove and replace applications of metal roof panels where inspections indicate that they do not comply with specified requirements.
- D. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.09 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal roof panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal roof panel installation, clean finished surfaces as recommended by metal roof panel manufacturer. Maintain in clean condition during construction.
- B. Replace metal roof panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 07 54 00
THERMOPLASTIC MEMBRANE ROOFING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes following:

1. Adhere membrane roofing system.
2. Mechanically fastened membrane roofing system.
3. Vapor retarder.
4. Roof insulation.
5. Walkway roof pavers.

- B. This Section includes installation of acoustical roof deck rib insulation strips furnished under Division 5 Section "Steel Deck."

- C. Related Sections include following:

1. Division 5 Section "Steel Deck" for furnishing acoustical deck rib insulation.
2. Division 6 Section "Rough Carpentry" for wood nailers, curbs, and blocking.
3. Division 7 Section "Building Insulation" for insulation beneath roof deck.
4. Division 7 Section "Sheet Metal Flashing and Trim" for metal roof penetration flashings, flashings, and counterflashings.
5. Division 7 Section "Joint Sealants."
6. Division 22 Section "Plumbing" for roof drains.

- D. Unit Prices: Refer to Division 1 Section "Unit Prices" for description of Work in this Section affected by unit prices.

1.03 DEFINITIONS

- A. Roofing Terminology: Refer to ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.

- B. Design Uplift Pressure: Uplift pressure, calculated according to procedures in SPRI's "Wind Load Design Guide for Fully Adhered and Mechanically Fastened Roofing Systems," before multiplication by safety factor.

- C. Factored Design Uplift Pressure: Uplift pressure, calculated according to procedures in SPRI's "Wind Load Design Guide for Fully Adhered and Mechanically Fastened Roofing Systems," after multiplication by safety factor.

1.04 PERFORMANCE REQUIREMENTS

- A. General: Provide installed roofing membrane and base flashings that remain watertight; do not permit passage of water; and resist specified uplift pressures, thermally induced movement, and exposure to weather without failure.

- B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing membrane manufacturer based on testing and field experience.
- C. Roofing System Design: Provide membrane roofing system that is identical to systems that have been successfully tested by qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE 7.
- D. FMG Listing: Provide roofing membrane, base flashings, and component materials that comply with requirements in FMG 4450 and FMG 4470 as part of membrane roofing system and that are listed in FMG's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FMG markings.
 - 1. Fire/Windstorm Classification: Class 1A-90.
 - 2. Hail Resistance: SH.
- E. Roofing System Design: Provide membrane roofing system that is identical to systems that have been successfully tested by qualified testing and inspecting agency to resist factored design uplift pressures calculated according to SPRI's "Wind Load Design Guide for Fully Adhered and Mechanically Fastened Roofing Systems."

1.05 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other Work.
 - 1. Base flashings and membrane terminations.
 - 2. Tapered insulation, including slopes.
 - 3. Insulation fastening patterns.
- C. Samples for Verification: For following products:
 - 1. 12-by-12-in. (300-by-300-mm) square of sheet roofing, of color specified, including T-shaped side and end lap seam.
 - 2. 12-by-12-in. (300-by-300-mm) square of roof insulation.
 - 3. 10 lb (4.5 kg) of aggregate ballast in color and gradation indicated.
 - 4. Full-size concrete roof paver in each color and texture required.
 - 5. 12-by-12-in. (300-by-300-mm) square of walkway pads or rolls.
 - 6. 12-in. (300-mm) length of metal termination bars.
 - 7. 12-in. (300-mm) length of battens.
 - 8. Six insulation fasteners of each type, length, and finish.
 - 9. Six roof cover fasteners of each type, length, and finish.
- D. Installer Certificates: Signed by roofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install roofing system.
- E. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
 - 1. Submit evidence of meeting performance requirements.
- F. Qualification Data: For Installer and manufacturer.

- G. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by qualified testing agency, for components of roofing system.
- H. Research/Evaluation Reports: For components of membrane roofing system.
- I. Maintenance Data: For roofing system to include in maintenance manuals.
- J. Warranties: Special warranties specified in this Section.
- K. Inspection Report: Copy of roofing system manufacturer's inspection report of completed roofing installation.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's warranty.
- B. Manufacturer Qualifications: Qualified manufacturer that has UL listing for membrane roofing system identical to that used for this Project.
- C. Testing Agency Qualifications: Independent testing agency with experience and capability to conduct testing indicated, as documented according to ASTM E 548.
- D. Fire-Test-Response Characteristics: Provide membrane roofing materials with fire-test-response characteristics indicated as determined by testing identical products per test method below by UL, FMG, or another testing and inspecting agency acceptable to authorities having jurisdiction. Materials shall be identified with appropriate markings of applicable testing and inspecting agency.
 - 1. Exterior Fire-Test Exposure: Class A; ASTM E 108, for application and roof slopes indicated.
 - 2. Fire-Resistance Ratings: ASTM E 119, for fire-resistance-rated roof assemblies of which roofing system is part.
- E. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at Project site. Review methods and procedures related to roof deck construction and roofing system including, but not limited to, following:
 - 1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing including installers of roof accessories and roof-mounted equipment.
 - 2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
 - 3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
 - 5. Review structural loading limitations of roof deck during and after roofing.
 - 6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
 - 7. Review governing regulations and requirements for insurance and certificates if applicable.

- 8 Review temporary protection requirements for roofing system during and after installation.
 9. Review roof observation and repair procedures after roofing installation.
- F. Preinstallation Conference: Conduct conference at Project site. Review methods and procedures related to roofing system including, but not limited to, following:
1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing including installers of roof accessories and roof-mounted equipment.
 2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
 3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
 5. Review structural loading limitations of roof deck during and after roofing.
 6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
 7. Review governing regulations and requirements for insurance and certificates if applicable.
 8. Review temporary protection requirements for roofing system during and after installation.
 9. Review roof observation and repair procedures after roofing installation.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and mixing with other components.
- B. Store liquid materials in their original undamaged containers in clean, dry, protected location and within temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
 1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
- C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
- D. Handle and store roofing materials and place equipment in manner to avoid permanent deflection of deck.

1.08 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.09 WARRANTY

- A. Special Warranty: Manufacturer's standard form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period. Failure includes roof leaks.
 - 1. Special warranty to be "Total System Warranty" which includes all products supplied by manufacturer.
 - 2. Warranty Period: 15 yrs from date of Substantial Completion.
- B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering Work of this Section, including all components of membrane roofing system such as roofing membrane, base flashing, roof insulation, fasteners, cover boards, substrate boards, vapor retarders, roof pavers, and walkway products, for following warranty period:
 - 1. Warranty Period: Two yrs from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, following requirements apply for product selection:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into Work include, but are not limited to, products specified.
 - 2. Products: Subject to compliance with requirements, provide one of products specified.
 - 3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into Work include, but are not limited to, manufacturers specified.
 - 4. Manufacturers: Subject to compliance with requirements, provide products by manufacturers specified.

2.02 THERMOPLASTIC POLYOLEFIN ROOFING MEMBRANE

- A. Fabric-Reinforced Thermoplastic Polyolefin Sheet: Uniform, flexible sheet formed from thermoplastic polyolefin, internally fabric or scrim reinforced, and as follows:
 - 1. Manufacturers:
 - a. Carlisle SynTec Incorporated.
 - b. Firestone Building Products Company.
 - c. GAF Materials Corporation.
 - d. Johns Manville International, Inc.
 - 2. Thickness: 60 mils, nominal.
 - 3. Exposed Face Color: White.
 - 4. Physical Properties:
 - a. Breaking Strength: 225 lbf (1 kN); ASTM D 751, grab method.
 - b. Elongation at Break: 15 percent; ASTM D 751.
 - c. Tearing Strength: 55 lbf (245 N) minimum; ASTM D 751, Procedure B.
 - d. Brittleness Point: Minus 22 deg F (30 deg C).
 - e. Ozone Resistance: No cracks after sample, wrapped around 3-in.- (75-mm-) diameter mandrel, is exposed for 166 hours to temperature of 104 deg F (40 deg C) and an ozone level of 100 pphm (100 mPa); ASTM D 1149.

- f. Resistance to Heat Aging: 90 percent minimum retention of breaking strength, elongation at break, and tearing strength after 166 hours at 240 deg F (116 deg C); ASTM D 573.
- g. Water Absorption: Less than 4 percent mass change after 166 hours' immersion at 158 deg F (70 deg C); ASTM D 471.
- h. Linear Dimension Change: Plus or minus 2 percent; ASTM D 1204.

2.03 AUXILIARY MATERIALS

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing.
 - 1. Liquid-type auxiliary materials shall meet VOC limits of authorities having jurisdiction.
- B. Sheet Flashing: Manufacturer's standard sheet flashing of same material, type, reinforcement, thickness, and color as PVC sheet membrane.
- C. Sheet Flashing: Manufacturer's standard unreinforced thermoplastic polyolefin sheet flashing, of same color as sheet membrane.
- D. Bonding Adhesive: Manufacturer's standard bonding adhesive for membrane, and solvent-based bonding adhesive for base flashings.
- E. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.
- F. Metal Termination Bars: Manufacturer's standard predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 .in. 25 by 3 mm) thick; with anchors.
- G. Metal Termination Bars: Manufacturer's standard predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 .in. 25 by 3 mm) thick; with anchors.
- H. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening membrane to substrate, and acceptable to membrane roofing system manufacturer.
- I. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, termination reglets, cover strips, and other accessories.
- J. Recovery Board: 1/2 inch high density fiberboard, ASTM C208, R 1.39 @ 2".

2.04 VAPOR RETARDER

- A. Polyethylene Vapor Retarder: ASTM D 4397, 6 mils (0.15 mm) thick, minimum, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).
 - 1. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
 - 2. Adhesive: Manufacturer's standard lap adhesive, FMG approved for vapor-retarder application.
- B. Laminated-Sheet Vapor Retarder: Kraft paper, 2 layers, laminated with asphalt and edge reinforced with woven fiberglass yarn with maximum permeance rating of 0.50 perm (29 ng/Pa x s x sq. m) and manufacturer's standard adhesive.
- C. Glass-Fiber Felts: ASTM D 2178, Type IV, asphalt-impregnated, glass-fiber felt.

2.05 ROOF INSULATION

- A. General: Provide preformed roof insulation boards that comply with requirements and referenced standards, selected from manufacturer's standard sizes and of thicknesses indicated.
- B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, felt or glass-fiber mat facer on both major surfaces.
 - 1. Manufacturers:
 - a. Atlas Roofing Corporation.
 - b. Carlisle SynTec Incorporated.
 - c. Firestone Building Products Company.
 - d. GAF Materials Corporation.
 - e. Hunter Panels, LLC.
 - f. Johns Manville International, Inc.
- C. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 in. per 12 in. (1:48), unless otherwise indicated.
- D. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

2.06 INSULATION ACCESSORIES

- A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatible with membrane roofing.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.

2.07 ASPHALT MATERIALS

- A. Asphalt Primer: ASTM D 41.

2.08 WALKWAY ROOF PAVERS

- A. Concrete Walkway Pavers: Heavyweight, hydraulically pressed, concrete units with top edges beveled 3/16 in. factory cast for use as roof pavers; absorption not greater than 5%, ASTM C140, no breakage and maximum 1% mass loss when tested for freeze-thaw resistance, ASTM C67.
- B. Size: 24 in. by 24 in.: Manufacture pavers to dimensional tolerances of plus or minus 1/16 in. in length, height, and thickness.
- C. Weight: 18 lb./sq. ft.
- D. Compressive Strength: 6500 psi minimum.
- E. Colors and Texture: As selected by Owner from Manufacturer's full range.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with following requirements and other conditions affecting performance of roofing system:
 - 1. Verify that roof openings and penetrations are in place and set and braced and that roof drains are securely clamped in place.
 - 2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
 - 3. Verify that surface plane flatness and fastening of steel roof deck comply with requirements in Division 5 Section "Steel Deck."
 - 4. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
 - 5. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
 - 6. Verify that concrete curing compounds that will impair adhesion of roofing components to roof deck have been removed.
 - 7. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
- C. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.
- D. Install acoustical roof deck rib insulation strips, specified in Division 5 Section "Steel Deck," according to acoustical roof deck manufacturer's written instructions.

3.03 INSULATION INSTALLATION

- A. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at end of workday.
- B. Comply with membrane roofing system manufacturer's written instructions for installing roof insulation.
- C. Install tapered insulation under area of roofing to conform to slopes indicated.
- D. Install one or more layers of insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 1-1/2 in. (38 mm) or greater, install 2 or more layers with joints of each succeeding layer staggered from joints of previous layer minimum of 6 in. (150 mm) in each direction.
- E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.

- F. Install insulation with long joints of insulation in continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 in. (6 mm) with insulation.
 - 1. Cut and fit insulation within 1/4 in. (6 mm) of nailers, projections, and penetrations.
- G. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
 - 1. Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.
 - 2. Set each layer of insulation in solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
 - 3. Set each layer of insulation in cold fluid-applied adhesive.
- H. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
 - 1. Fasten insulation according to requirements in FMG's "Approval Guide" for specified Windstorm Resistance Classification.
 - 2. Fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.
- I. Mechanically Fastened and Adhered Insulation: Install each layer of insulation and secure first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
 - 1. Fasten first layer of insulation according to requirements in FMG's "Approval Guide" for specified Windstorm Resistance Classification.
 - 2. Fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
 - 3. Install subsequent layers of insulation in solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
 - 4. Install subsequent layers of insulation in cold fluid-applied adhesive.

3.04 ADHERED ROOFING MEMBRANE INSTALLATION

- A. Install roofing membrane over area to receive roofing according to membrane roofing system manufacturer's written instructions. Unroll roofing membrane and allow to relax before installing.
 - 1. Install sheet according to ASTM D 5036.
- B. Start installation of roofing membrane in presence of membrane roofing system manufacturer's technical personnel.
- C. Accurately align roofing membrane and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- D. Bonding Adhesive: Apply solvent-based bonding adhesive to substrate and underside of roofing membrane at rate required by manufacturer and allow to partially dry before installing roofing membrane. Do not apply bonding adhesive to splice area of roofing membrane.
- E. Bonding Adhesive: Apply water-based bonding adhesive to substrate at rate required by manufacturer and immediately install roofing membrane. Do not apply bonding adhesive to splice area of roofing membrane.

- F. Hot Roofing Asphalt: Apply solid mopping of hot roofing asphalt to substrate at temperature and rate required by manufacturer and install fabric-backed roofing membrane. Do not apply roofing asphalt to splice area of roofing membrane.
- G. Mechanically or adhesively fasten roofing membrane securely at terminations, penetrations, and perimeter of roofing.
- H. Apply roofing membrane with side laps shingled with slope of roof deck where possible.
- I. Seams: Clean seam areas, overlap roofing membrane, and hot-air weld side and end laps of roofing membrane according to manufacturer's written instructions to ensure watertight seam installation.
 - 1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roofing membrane.
 - 2. Verify field strength of seams minimum of twice daily and repair seam sample areas.
 - 3. Repair tears, voids, and lapped seams in roofing membrane that does not meet requirements.
- J. Spread sealant or mastic bed over deck drain flange at deck drains and securely seal roofing membrane in place with clamping ring.
- K. Install roofing membrane and auxiliary materials to tie in to existing roofing.

3.05 MECHANICALLY FASTENED ROOFING MEMBRANE INSTALLATION

- A. Install roofing membrane over area to receive roofing according to roofing system manufacturer's written instructions. Unroll roofing membrane and allow to relax before installing.
 - 1. Install sheet according to ASTM D 5082
- B. Start installation of roofing membrane in presence of roofing system manufacturer's technical personnel.
- C. Accurately align roofing membranes and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- D. Mechanically or adhesively fasten roofing membrane securely at terminations, penetrations, and perimeter of roofing.
- E. Apply roofing membrane with side laps shingled with slope of roof deck where possible.
- F. Seams: Clean seam areas, overlap roofing membrane, and hot-air weld side and end laps of roofing membrane according to manufacturer's written instructions to ensure watertight seam installation.
 - 1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roofing membrane.
 - 2. Verify field strength of seams minimum of twice daily and repair seam sample areas.
 - 3. Repair tears, voids, and lapped seams in roofing membrane that does not meet requirements.
- G. Spread sealant or mastic bed over deck drain flange at deck drains and securely seal roofing membrane in place with clamping ring.

- H. In-Splice Attachment: Secure one edge of roofing membrane using fastening plates or metal battens centered within membrane splice and mechanically fasten roofing membrane to roof deck. Field-splice seam.
- I. Through-Membrane Attachment: Secure roofing membrane using fastening plates or metal battens and mechanically fasten roofing membrane to roof deck. Cover battens and fasteners with continuous cover strip.
- J. Install roofing membrane and auxiliary materials to tie in to existing roofing.

3.06 BASE FLASHING INSTALLATION

- A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.
- B. Apply solvent-based bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply bonding adhesive to seam area of flashing.
- C. Flash penetrations and field-formed inside and outside corners with sheet flashing.
- D. Clean seam areas and overlap and firmly roll sheet flashings into adhesive. Weld side and end laps to ensure watertight seam installation.
- E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.07 WALKWAY INSTALLATION

- A. Roof-Paver Walkways: Install heavyweight walkway roof pavers according to manufacturer's written instructions in locations indicated, to form walkways. Leave 3 in. (75 mm) of space between adjacent roof pavers.

3.08 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage qualified independent testing and inspecting agency to perform roof tests and inspections and to prepare test reports.
- B. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion and submit report to Architect.
 - 1. Notify Architect or Owner 48 hours in advance of date and time of inspection.
- C. Repair or remove and replace components of membrane roofing system where test results or inspections indicate that they do not comply with specified requirements.
- D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.09 PROTECTING AND CLEANING

- A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in written report, with copies to Architect and Owner.

- B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements, repair substrates, and repair or reinstall membrane roofing system to condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.10 ROOFING INSTALLER'S WARRANTY

- A. WHEREAS **<Insert name>** of **<Insert address>**, herein called "Roofing Installer," has performed roofing and associated work ("work") on following project:
 - 1. Owner: **<Insert name of Owner.>**
 - 2. Address: **<Insert address.>**
 - 3. Building Name/Type: **<Insert information.>**
 - 4. Address: **<Insert address.>**
 - 5. Area of Work: **<Insert information.>**
 - 6. Acceptance Date: **<Insert date.>**
 - 7. Warranty Period: **<Insert time.>**
 - 8. Expiration Date: **<Insert date.>**
- B. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,
- C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period he will, at his own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in watertight condition.
 - 1. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
 - 2. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
 - 3. During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to extent said alterations affect work covered by this Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying limitation or termination of this Warranty.
 - 4. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to extent said change affects work covered by this Warranty.
 - 5. Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.

6. This Warranty is recognized to be only warranty of Roofing Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of Contract Documents, regardless of whether Contract was contract directly with Owner or subcontract with Owner's General Contractor.

D. IN WITNESS THEREOF, this instrument has been duly executed this **<Insert day>** day of **<Insert month>**, **<Insert year>**.

1. Authorized Signature: **<Insert signature.>**
2. Name: **<Insert name.>**
3. Title: **<Insert title.>**

END OF SECTION

SECTION 07 62 00
SHEET METAL FLASHING & TRIM

PART – GENERAL

1.01 SUMMARY

A. This Section includes sheet metal flashing and rim in the following categories:

1. Exposed trim, and fascia.
2. Metal flashing.
3. Reglets.

1.02 REFERENCES

- A. ASTM: American Society for Testing and Materials
- B. AMACNA: Architectural Sheet Metal Manual

1.03 PERFORMANCE REQUIREMENTS

A. Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing.

1.04 SUBMITTALS

- A. Product Data including manufacturer's material and finish data, installation instructions, and general recommendations for each specified flashing material and fabricated product.
- B. Samples of sheet metal flashing, trim, and accessory items, in the specified finish. Where finish involves normal color and texture variations, include Sample sets composed of 2 or more units showing the full range of variations expected.
 1. 8-inch square Samples of specified sheet materials to be exposed as finished surfaces.
 2. 6-inch long Samples of factory-fabricated products exposed as finished Work. Provide complete with specified factory finish.
- C. Submit in accordance with the requirements of Section 01 33 00.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experience Installer who has completed sheet metal flashing and trim work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

PART 2 – PRODUCTS

2.01 METALS

A. Copper: ASTM B370; temper H00, cold rolled except where temper 060 is required for forming; not less than 16 ounces per square foot, unless otherwise indicated.

2.02 CONCEALED THROUGH-WALL SHEET METAL FLASHING

A. Material: Fabricate from the following metal:

1. Copper: 10 ounces (0.34 millimeters thick) for full concealed flashing; 16 ounces (0.55 millimeters thick) elsewhere.
2. Fabricate through-wall metal flashings embedded in masonry as follows:
 - a. With ribs formed in dovetail pattern at 3-inch intervals along length of flashing to provide a 3-way integral mortar bond and weep-hole drainage.
- B. Available Products: Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:
- C. Products: Subject to compliance with requirements, provide one of the following:
 1. Cheney Flashing (Dovetail); Cheney Flashing Company, Inc.
 2. Cheney Flashing (Sawtooth); Cheney Flashing Company, Inc.
 3. Keystone Three-Way Interlocking Thruwall Flashing; Keystone Flashing Co.

2.03 REGLETS

- A. General: Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counterflashing pieces and compatible with flashing indicated.
- B. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
- C. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of the counterflashing lower edge.
 1. Material: Copper, 16 ounces per square foot, (0.55 millimeters thick).
- D. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to the following:
- E. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Fry Reglet corporation.
 2. Hickman: W.P. Hickman Co.
 3. Keystone Flashing Company.

2.04 MISCELLANEOUS MATERIALS AND ACCESSORIES

- A. Fasteners: Same metal as sheet metal flashing or other noncorrosive metal as recommended by sheet metal manufacturer. Match finish of exposed heads with material being fastened.

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions under which sheet metal flashing and trim are to be installed and verify that Work may properly commence. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General: Unless otherwise indicated, install sheet metal flashing and trim to comply with performance requirements, manufacturer's installation instructions, and AMACNA. Anchor

units of Work securely in place by methods indicated, providing for thermal expansion of metal units; conceal fasteners where possible, and set units true to line and level as indicated. Install Work with laps, joints, and seams that will be permanently watertight and weatherproof.

- B. Install exposed sheet metal Work that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
- C. Install reglets to receive counterflashing according to the following requirements:
 - 1. Where reglets are shown in masonry, furnish reglets for installation under Section 04 22 00 – Concrete Unit Masonry.
- D. Counterflashings: Coordinate installation of counterflashings with installation of assemblies to be protected by counterflashing. Install counterflashings in reglets or receivers. Secure in a waterproof manner by means of snap-in installation and sealant, lead wedges and sealant, interlocking folded seam, or blind rivets and sealant. Lap counterflashing joints a minimum of 2 inches and bed with sealant.

3.03 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces, removing substances that might cause corrosion of metal or deterioration of finishes.
- B. Provide final protection and maintain conditions that ensure sheet metal flashing and trim Work during construction is without damage or deterioration other than natural weathering at the time of Substantial Completion.

END OF SECTION

SECTION 07 71 33
GUTTERS AND DOWNSPOUTS

PART 1 - GENERAL

1.01 SUMMARY

A Section includes:

1. Prefinished Aluminum gutters and downspouts.
2. Rain chains.
2. Precast concrete splash blocks.

1.02 REFERENCES

- A. ASTM: American Society for Testing and Materials
- B. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Stack preformed and prefinished material to prevent twisting, bending, or abrasion, and to aid ventilation. Slope to drain.
- B. Prevent contact with materials during storage which may cause discoloration, staining, or damage.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Aluminum Sheet: ASTM B209, prefinished with paint coating of color to match fascia and standard color.

2.02 COMPONENTS

- A. Gutters: Rectangular, approximately 4 inches high X 5 inches wide, minimum 36 square inches cross section, minimum 0.032 minimum thickness, Style F profile, shop fabricated.
- B. Downspouts: Rectangular, approximately 3 inches x 4 inches, minimum 20 square inches cross section, minimum 0,025 in. thickness, open-face type, shop fabricated.
- C. End Caps, Downspout Outlets, Gutter and Downspout Straps and Support Brackets, Down Spout Strainers profiled to suit gutters and downspouts.
- D. Splash Blocks: Precast concrete type, of size and profiles indicated; minimum 3000 pounds per square inch at 28 days, with minimum 5 percent air entrainment.
- E. Rain Chains: Grade 316L (low carbon content), Stainless Steel, Welded and Highly Polished.
 1. Model No. Y-9002-SS by RainChains.com
 - a. Top Opening: 3-1/2 in.
 - b. Link Length: 1-1/2 in.
 - c. Cup Height: 3-3/8 in.
 - d. Number Cups Per 8.5 Ft.: 14.

- e. Provide V-Hook for installation.
- f. Provide rain chain in lengths as required to extend from roof drains to finish grade.
- g. Provide rain chain at each canopy and at roof drains located over Vestibule and Reception Area.

2.03 ACCESSORIES

- A. Anchorage Devices: SMACNA requirements.
- B. Gutter Supports: Standard Brackets or Straps, prefinished same as gutters. Spike and ferrel not acceptable.
- C. Downspout Supports: Brackets or Straps, prefinished same as downspouts.
- D. Rain Chain Adapter:
 - 1. Material: 15 ga. Aluminum.
 - 2. Size: 2.5 in. diameter at top. And 2 in. diameter at bottom
 - 3. Length: Size as required to extend from roof thru bottom of soffit.
 - 4. Finish: Mill finish.

2.04 FABRICATION

- A. Form gutters and downspouts of profiles and size indicated and to SMACNA requirements.
- B. Field measure site conditions prior to fabricating work.
- C. Fabricate with required connection pieces.
- D. Form sections square, true, and accurate in size, in maximum possible lengths and free of distortion or defects detrimental to appearance or performance. Allow for expansion at joints.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are ready to receive work.
- B. Beginning of installation means acceptance of substrate.

3.02 INSTALLATION

- A. Join gutter lengths with formed seams sealed watertight. Flash and seal gutters to downspouts and accessories.
- B. Support gutters with standard bracket hangers at 3 feet-0 inches on center maximum.
- C. Install rain chain adapter sealed watertight. Flash and seal adapter to at membrane roofing and soffit. Attach rain chain according to manufacturer's recommendations.

END OF SECTION

SECTION 07 92 00
JOINT SEALANTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Preparation of joint substrates and installation of joint sealants, joint backer materials and accessories needed to ensure a complete and durable weathertight seal at locations indicated.

1.02 REFERENCES

- A. ASTM: American Society for Testing and Materials

1.03 SUBMITTALS

A. Product Data:

1. Manufacturer's specifications and other data needed to prove compliance with the specified requirements.
2. Manufacturer's recommended installation procedures.
3. Catalog illustrations in sufficient detail to show installation and interface of the Work of this Section with the Work of adjacent trades.
4. Standard color card showing full range of colors available for each product exposed to view.

B. Miscellaneous:

1. Written documentation of applicator's qualifications, including reference projects of similar scope and complexity, with current phone contacts of engineers and owners for verification.
2. Certification from sealant manufacturers that their products are suitable for the use indicated and comply with specification requirements.

- C. Submit in accordance with Section 01 33 00.

1.04 QUALITY ASSURANCE

- A. Applicator shall be approved by sealant manufacturer and shall have at least three years experience in installing materials of types specified and shall have successfully completed at least three projects of similar scope and complexity.

- B. Obtain joint sealants from single manufacturer for each different product required to ensure compatibility.

1. Provide joint sealants, joint fillers and accessory joint materials that are compatible with one another and with joint substrates under Project conditions.
2. Provide joint sealants, joint fillers and related joint materials that are nonstaining to visible joint surfaces and surrounding substrate surfaces.
3. Manufacturer shall instruct applicator in procedures for intersecting sealants.

- C. Perform Work in accordance with ASTM C1193 guidelines except where more stringent requirements are indicated or specified.

- D. Schedule applications of waterproofing, water repellents, and preservative finishes after sealant installation unless sealant manufacturer approves otherwise in writing. Ensure that installed sealant is allowed to cure sufficiently prior to subsequent applications.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver the materials to Site in the manufacturer's unopened containers with all labels intact and legible at time of use.
- B. Maintain the products in a dry condition during delivery, storage, handling, installation, and concealment.

1.06 SUBSTRATE CONDITIONS

- A. Surfaces shall be broom clean, dry, sound, and free of voids, bugholes, rockpockets, honeycombs, protrusions, excessive roughness, foreign matter, frost, ice, and other contaminants which may inhibit application or performance of the sealant system.
- B. Provide joints properly dimensioned to receive the approved sealant system.

1.07 WARRANTY

- A. Furnish written warranties against adhesive and cohesive failure of the sealant and against infiltration of water and air through the sealed joint for a period of 3 years from date of substantial completion.
 - 1. Manufacturer's standard warranty covering materials.
 - 2. Installing Subcontractor's standard warranty covering workmanship.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Tremco.
- B. Sonneborn.
- C. Sika.
- D. Emseal.
- E. Pecora.
- F. Polyspec.
- G. Or Equal.

2.02 SEALANTS

- A. The sealant products listed are set as a standard of quality. Sealants of other manufacturers shall meet or exceed the characteristics of the products listed.
- B. Provide colors selected by Engineer from manufacturer's standard color range.
- C. Sealant Type A:
 - 1. For interior and exterior expansion joints in vertical surfaces and horizontal surfaces in concrete tanks containing domestic wastewater.

2. Acceptable Systems:

- a. Sika - Sikadur-Combiflex SG – 20 M on water side of joint.
- b. Emseal – Seismic Colorseal on non-water side of joint.

D. Sealant Type B:

1. For interior and exterior joints in vertical surfaces and non-traffic horizontal surfaces; such as:
 - a. Control and expansion joints in concrete unit or brick masonry.
 - b. Metal panel joints.
 - c. Joints around frames of doors, windows, louvers, and other similar openings.
 - d. Under metal thresholds.
 - e. Joints in sheet metal flashings.
 - f. Trim or finish joints.
2. Single-component or multi-component, non-sag polyurethane sealant having 25% joint movement capability that is suitable for continuous immersion in water; comply with ASTM C920, Type S or M, Grade NS, Class 25.
3. Acceptable Sealants:
 - a. Tremco - Vulkem 116.
 - b. Tremco – Dymeric 240/240FC

E. Sealant Type C:

1. For interior and exterior joints in horizontal and sloped traffic surfaces; such as control, expansion, and isolation joints in concrete pavement and sidewalks.
2. Single-component or multi-component polyurethane sealant having a Shore A hardness of not less than 25 or more than 50 and 25% joint movement capability that is suitable for continuous immersion in water; comply with ASTM C920, Type S or M, Grade P or NS, Class 25.
3. Acceptable Sealants:
 - a. Tremco - Vulkem 45/245.

F. Sealant Type D:

1. In interior joints in horizontal and vertical surfaces inside buildings with occupied areas requiring a virtually odor free sealant.
2. Pure acrylic latex sealant meeting requirements of ASTM C-834, Type OP.
3. Acceptable Sealant:
 - a. Tremco - Tremflex 834.
1. Two-part polysulfide sealant certified by NSF as conforming to the requirements of NSF Standard 61-Drinking Water System Components-Health Effects.
 - a. Comply with ASTM C920, Type M, Grade NS, Class 25.
 - a. Comply with ASTM C920, Type S or M, Grade P or NS, Class 25.
 - b. Select color from listing of those approved.

1. Acceptable Sealants:

- a. Tremco - Vulkem 116.

G. Sealant Type G:

1. In interior vertical and non-traffic horizontal surfaces requiring up to a 3-hour fire and temperature rating.
2. Gun grade silicone sealant and fire blocking designed for use in firestop applications, and rated by UL for up to 3-hour fire and hose stream test.
3. Provide fire rated joint assemblies meeting fire rating indicated, in accordance with manufacturer's recommendations.
4. Acceptable Sealant:
 - a. Tremco - Tremstop Fyre-Sil.
5. Acceptable Fire Blocking.
 - a. FBX Safing Insulation by Fibrex Insulations, Inc.

H. Sealant Type H:

1. In exterior joints in horizontal concrete surfaces subject to fuel spillage.
2. Single-component or Multi-component, self-leveling, jet-fuel resistant polyurethane sealant meeting Federal Specification SS-S-200E, Type H.
3. Acceptable Sealant:
 - a. Tremco - Vulkem 45SSL.

I. Sealant Type I:

1. Interior and exterior joints, excluding expansion joints, in concrete tanks containing domestic wastewater.
2. Polysulfide sealant having a Shore A hardness of not less than 25 or more than 50 and 25% joint movement capability that is suitable for continuous immersion in water; comply with ASTM C920, Type S or M, Grade NS, Class 25.
3. Joints shall be primed.
4. Acceptable Primer:
 - a. As recommended by sealant manufacturer.
5. Acceptable Sealants:
 - a. Pecora – Synthacalk GC2+
 - b. Polyspec – Thiokol 2235M

N. Sealant Type J:

1. Around restroom fixtures.
2. Gun grade silicone sealant.
3. Acceptable Sealant:
 - a. Tremco - Tremsil 200.

2.03 ACCESSORIES

- A. Joint Cleaner: As recommended by sealant manufacturer for substrates indicated.

- B. Joint Primer: As recommended by sealant manufacturer for substrates, conditions and exposures indicated.
- C. Bond Breaker: Polyethylene tape or other adhesive faced tape as recommended by sealant manufacturer to prevent sealant contact where it would be detrimental to sealant performance.
- D. Joint Backer: Polyethylene foam rod or other compatible non-waxing, non-extruding, non-staining resilient material in dimension 25% to 50% wider than joint width as recommended by sealant manufacturer for substrates, conditions and exposures indicated.
- E. Masking Tape: Non-staining, non-absorbent tape product compatible with joint sealants and adjacent joint surfaces that is suitable for masking.
- F. Premolded Joint Filler: Conform to requirements of Section 03 30 00.

2.04 OTHER MATERIALS

- A. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor and approved by the sealant manufacturer as compatible, subject to the approval of the Engineer.

PART 3 - EXECUTION

3.01 SURFACE CONDITIONS

- A. Examine the areas and conditions under which Work of this Section will be performed.
 1. Verify conformance with manufacturer's requirements.
 2. Report unsatisfactory conditions in writing to Engineer.
 3. Correct conditions detrimental to timely and proper completion of the Work.
 4. Do not proceed until unsatisfactory conditions are corrected.

3.02 PREPARATION

- A. Prepare surfaces to receive sealants in accordance with sealant manufacturer's instructions and recommendations except where more stringent requirements are indicated.
- B. Thoroughly clean joint surfaces using cleaners approved by sealant manufacturer whether primers are required or not.
 1. Remove all traces of previous sealant and joint backer by mechanical methods, such as by cutting, grinding and wire brushing, in manner not damaging to surrounding surfaces.
 2. Remove paints from joint surfaces except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer.
 3. Remove wax, oil, grease, dirt, film residues, temporary protective coatings and other residues by wiping with cleaner recommended for that purpose. Use clean, white, lint-free cloths and change cloths frequently.
 4. Remove dust by blowing clean with oil-free, compressed air.
- C. Provide joint backer material to depth required by sealant manufacturer for proper joint design.
 1. Fit securely by compressing backer material 25% to 50% so no displacement occurs during tooling.
 2. Avoid stretching or twisting joint backer.

- D. Provide bond-breaker where indicated or recommended by sealant manufacturer, adhering strictly to the manufacturer's installation requirements.
- E. Prime joint substrates where required.
 - 1. Use and apply primer according to sealant manufacturer's recommendations.
 - 2. Confine primers to sealant bond surfaces; do not allow spillage or migration onto adjoining surfaces.
- F. Taping:
 - 1. Use masking tape where required to prevent sealant or primer contact with adjoining surfaces that would be permanently stained or otherwise damaged by such contact or the cleaning methods required for removal.
 - 2. Apply tape so as not to shift readily and remove tape immediately after tooling without disturbing joint seal.
- G. Premolded Joint Fillers:
 - 1. Where expansion joints having premolded joint fillers are scheduled to be sealed, provide a reservoir to accept the sealant such as by a molded breakaway joint cap or a removable block out.
 - 2. Joint fillers that may contact the sealant should not be impregnated with oil, bitumen, non-curing polymers or similar contaminants.

3.03 INSTALLATION

- 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.
- B. Provide the approved sealant system where shown on the Drawings, and in strict accordance with the manufacturer's recommendations as approved by Engineer.
- C. Install sealants immediately after joint preparation.
- D. Mix and apply multi-component sealants in accordance with manufacturer's printed instructions.
- E. Install sealants to fill joints completely from the back, without voids or entrapped air, using proven techniques, proper nozzles and sufficient force that result in sealants directly contacting and fully wetting joint surfaces.
- F. Install sealants to uniform cross-sectional shapes with depths relative to joint widths that allow optimum sealant movement capability as recommended by sealant manufacturer.
- G. Tool sealants in manner that forces sealant against back of joint, ensures firm, full contact at joint interfaces and leaves a finish that is smooth, uniform and free of ridges, wrinkles, sags, air pockets and embedded impurities.
 - 1. Dry tooling is preferred; tooling liquids that are non-staining, non-damaging to adjacent surfaces and approved by sealant manufacturer may be used if necessary when care is taken to ensure that the liquid does not contact joint surfaces before the sealant.
 - 2. Provide concave tooled joints unless otherwise indicated to provide flush tooling or recessed tooling.
 - 3. Provide recessed tooled joints where the outer face of substrate is irregular.

- H. Remove sealant from adjacent surfaces in accordance with sealant and substrate manufacturer's recommendations as work progresses.
- I. Protect joint sealants from contact with contaminating substances and from damages. Cut out, remove and replace contaminated or damaged sealants, immediately, so that they are without contamination or damage at time of Substantial Completion.

END OF SECTION

DIVISION 8
OPENINGS

SECTION 08 11 13
HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes:
1. Steel doors.
 2. Steel door frames.
 3. Steel window frames.

1.02 REFERENCES

- A. ANSI: American National Standards Institute
- B. ASTM: American Society for Testing and Materials
- C. DHI: The Door and Hardware Institute
- D. SDI: Steel Door Institute

1.03 SUBMITTALS

- A. Product Data: For each type of door and frame indicated, include designation, type, level and model, material description, core description, construction details, label compliance, sound and fire-resistance ratings, and finishes.
- B. Shop Drawings:
1. Elevations of each door and frame design.
 2. Details of doors including vertical and horizontal edge details.
 3. Frame details for each frame type including dimensioned profiles.
 4. Details and locations of reinforcement and preparations for hardware.
 5. Details of each different wall opening condition.
 6. Details of anchorages, accessories, joints, and connections.
 7. Coordination of glazing frames and stops with glass and glazing requirements.
- C. Schedule: Use same reference designations indicated on Drawings in preparing schedule for doors and frames.
- D. Submit in accordance with Section 01 33 00.

1.04 QUALITY ASSURANCE

- A. Steel Door and Frame Standard: Comply with ANSI A250.8, unless more stringent requirements are indicated.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver doors and frames cardboard-wrapped or crated to provide protection during transit and job storage. Provide additional protection to prevent damage to finish of factory-finished doors and frames.

- B. Inspect doors and frames on delivery for damage, and notify shipper and supplier if damage is found. Minor damages may be repaired provided refinished items match new work and are acceptable to Architect. Remove and replace damaged items that cannot be repaired as directed.
- C. Store doors and frames at building site under cover. Place units on minimum 4-inch high wood blocking. Avoid using nonvented plastic or canvas shelters that could create a humidity chamber. If door packaging becomes wet, remove cartons immediately. Provide minimum 1/4-inch spaces between stacked doors to permit air circulation.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Amweld Building Products, Inc.
- B. Ceco Door Products.
- C. Curries Company.
- D. Kewanee Corporation.
- E. Steelcraft.

2.02 MATERIALS

- A. Hot-Rolled Steel Sheets: ASTM A568 or A569.
- B. Cold-Rolled Steel Sheets: ASTM A366.
- C. Metallic-Coated Steel Sheets: ASTM A 653, an A60 zinc-iron-alloy (galvannealed) coating,

2.03 DOORS

- A. General: Provide doors of sizes, thicknesses, and designs indicated.
- B. Interior Doors: Provide doors complying with requirements indicated below by referencing ANSI A250.8 for level and model and ANSI A250.4 for physical-endurance level:
 - 1. Level 1 and Physical Performance Level C, (Standard Duty), Model 1 Full Flush.
 - 2. Level 2 and Physical Performance Level B (Heavy Duty), Model 1 Full Flush.
- C. Exterior Doors: Provide doors complying with requirements indicated below by referencing ANSI 250.8 for level and model and ANSI A250.4 for physical-endurance level:
 - 1. Level 2 and Physical Performance Level B (Heavy Duty), Model 1 Full Flush.

2.04 FRAMES

- A. General: Provide steel frames for doors, transoms, sidelights, borrowed lights, and other openings that comply with ANSI A250.8 and with details indicated for type and profile. Conceal fastenings, unless otherwise indicated.
- B. Frames of 0.042-inch thick steel sheet for:

1. Level 1 steel doors.
 2. Window frames.
- C. Frames of 0.053-inch thick steel sheet for:
1. Door openings wider than 48 inches.
 2. Level 2 steel doors.
- D. Door Silencers: Except on weather-stripped frames, fabricate stops to receive three silencers on strike jambs of single-door frames and two silencers on heads of double-door frames.
- E. Supports and Anchors:
1. Fabricated from not less than 0.042-inch thick, electrolytic zinc-coated or metallic-coated steel sheet.
 2. Wall Anchors in Masonry Construction: 0.177-inch diameter, steel wire complying with ASTM A510 may be used in place of steel sheet.
- F. Inserts, Bolts, and Fasteners: Manufacturer's standard units. Where zinc-coated items are to be built into exterior walls, comply with ASTM A153, Class C or D as applicable.

2.05 FABRICATION

- A. General: Fabricate steel door and frame units to comply with ANSI A250.8 and to be rigid, neat in appearance, and free from defects including warp and buckle. Where practical, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory assembled before shipment, to assure proper assembly at Project site.
- B. Exterior Construction: For exterior locations and elsewhere as indicated, fabricate doors and frames from metallic-coated steel sheet. Close top and bottom edges of doors flush as an integral part of door construction or by addition of 0.053-inch thick, metallic-coated steel channels with channel webs placed even with top and bottom edges.
- C. Interior Construction: For interior locations, fabricate doors and frames from cold-rolled steel sheet or metallic-coated steel sheet.
- D. Core Construction: Expanded polystyrene foam continuously bonded to steel skin.
- E. Clearances for Non-Fire-Rated Doors: Not more than 1/8 inch at jambs and heads, except not more than 1/4 inch between pairs of doors. Not more than 3/4 inch at bottom.
- F. Single-Acting, Door-Edge Profile: Square edge.
- G. Tolerances: Comply with SDI 117.
- H. Fabricate concealed stiffeners, reinforcement, edge channels, louvers, and moldings from either cold- or hot-rolled steel sheet.
- I. Exposed Fasteners: Unless otherwise indicated, provide countersunk flat or oval heads for exposed screws and bolts.
- J. Hardware Preparation:
1. Prepare doors and frames to receive mortised and concealed hardware according to door hardware schedule and templates provided by hardware supplier. Comply with

applicable requirements in ANSI A250.6 and ANSI A115 Series specifications for door and frame preparation for hardware.

2. For concealed overhead door closers, provide space, cutouts, reinforcement, and provisions for fastening in top rail of doors or head of frames, as applicable.

K. Frame Construction:

1. Fabricate frames to shape shown.
2. Fabricate frames with mitered or coped and continuously welded corners and seamless face joints.
3. Provide temporary spreader bars.

L. Reinforce doors and frames to receive surface-applied hardware. Drilling and tapping for surface-applied hardware may be done at Project site.

M. Locate hardware as indicated on Shop Drawings or, if not indicated, according to ANSI A250.8.

P. Glazing Stops: Manufacturer's standard, formed from 0.032-inch thick steel sheet.

1. Provide nonremovable stops on outside of exterior doors and on secure side of interior doors for glass, louvers, and other panels in doors.
2. Provide screw-applied, removable, glazing stops on inside of glass, louvers, and other panels in doors.

2.06 FINISHES

A. Prime Finish: Manufacturer's standard, factory-applied coat of rust-inhibiting primer complying with ANSI A250.10 for acceptance criteria.

B. Final Finish: Conform to Section 09 96 00 and 09 91 00. Color as elected by Owner

PART 3 - EXECUTION

3.01 INSTALLATION

A. General: Install steel doors, frames, and accessories according to Shop Drawings, manufacturer's data, and as specified.

B. Placing Frames:

1. Comply with provisions in SDI 105, unless otherwise indicated.
2. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set.
3. After wall construction is completed, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.
4. Except for frames located in existing walls or partitions, place frames before construction of enclosing walls and ceilings.
5. In masonry construction, provide at least three wall anchors per jamb; install adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Acceptable anchors include masonry wire anchors and masonry T-shaped anchors.
6. Install fire-rated frames according to NFPA 80.
7. For openings 90 inches or more in height, install an additional anchor at hinge and strike jambs.

C. Door Installation:

1. Comply with ANSI A250.8 unless otherwise indicated.
2. Fit hollow-metal doors accurately in frames, within clearances specified in ANSI A250.8.
3. Shim as necessary to comply with SDI 122 and ANSI/DHI A115.1G.

3.02 ADJUSTING AND CLEANING

- A. Prime-Coat Touchup: Immediately after installation, sand smooth any rusted or damaged areas of prime coat and apply touch up of compatible air-drying primer.
- B. Protection Removal: Immediately before final inspection, remove protective wrappings from doors and frames.

END OF SECTION

SECTION 08 11 16
ALUMINUM DOORS AND FRAMES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Exterior aluminum doors.
2. Interior aluminum doors.
3. Aluminum frames for exterior doors.
4. Aluminum frames for interior doors.
5. Aluminum borrowed light framing systems.

1.02 REFERENCES

- A. ASTM: American Society for Testing and Materials
- B. AAMA: American Architectural Manufacture's Association

1.03 SYSTEM DESCRIPTION

A. Performance Requirements:

1. Design and fabricate exterior assemblies to comply with requirements for system performance characteristics listed below as demonstrated by testing manufacturer's corresponding stock systems according to test methods designated.
 - a. Thermal Movement: Allow for expansion and contraction resulting from ambient temperature range of 120°F.
 - b. Wind Loading: Provide capacity to withstand loading indicated below, test in accordance with ASTM E330.
 - 1) Uniform pressure of 20 pounds per square foot inward and 20 pounds per square foot outward.
 - c. Transmission Characteristics of Assemblies: Provide exterior doors with jamb and head frames complying with requirements indicated below for transmission characteristics and test methods.
 - 1) Air Leakage: Air infiltration/linear foot of perimeter crack of not more than 0.50 cubic feet per minute for single doors and 1.0 cubic feet per minute for pairs of doors per ASTM E283 at pressure differential of 1.567 pounds per square foot.
 - 2) Condensation Resistance: Not less than 48 condensation resistance factor per AAMA 1502.7.
 - 3) Thermal Transmittance: U-value of not more than 0.93 Btu/ (hour per square foot per °F) per AAMA 1503.1.

1.04 SUBMITTALS

- A. Product Data: Manufacturer's specifications, standard details, and installation recommendations for components of aluminum doors and frames required for project including test reports certifying products have been tested and comply with performance requirements.

- B. Shop Drawings: Shop drawings for fabrication and installation of aluminum doors and frames including elevations, detail sections of typical composite members, hardware mounting heights, anchorages, reinforcement, expansion provisions, and glazing. Use same designation as indicated on Drawings.
- C. Samples: Samples of each type and color of aluminum finish on 12-inch long sections of extrusions or formed shapes and 6-inch square sheets. Where normal color and texture variations to be expected, include 2 or more units in each set of samples showing limits of such variations.
- D. Submit in accordance with Section 01 33 00.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Kawneer Company, Inc.
- B. Tubelite, Inc.
- C. Cross Aluminum Products
- D. Or equal.

2.02 MATERIALS AND ACCESSORIES

- A. Aluminum Members: Alloy and temper recommended by manufacturer for strength, corrosion resistance, and application of required finish; ASTM B221 for extrusions, ASTM B209 for sheet/plate.
- B. Fasteners: Aluminum, non-magnetic stainless steel, or other materials warranted by manufacturer to be non-corrosive and compatible with aluminum components.
 - 1. Do not use exposed fasteners except where unavoidable. Match finish of adjoining metal.
 - 2. Provide Phillips flat head machine screws for exposed fasteners.
- C. Concealed Flashing: Dead soft stainless steel, 26 gauge minimum or extruded aluminum, 0.062 inch minimum of alloy and type selected by manufacturer for compatibility with other components.
- D. Brackets and Reinforcements: Manufacturer's high strength aluminum units where feasible; otherwise, non-magnetic stainless steel or hot dip galvanized steel complying with ASTM A386.
- E. Concrete/Masonry Inserts: Cast iron, malleable iron, or hot dip galvanized steel complying with ASTM A386.
- F. Bituminous Coatings: Cold applied asphalt mastic.
- G. Compression Weatherstripping: Manufacturer's standard replaceable stripping of either molded neoprene gaskets complying with ASTM D2000 or molded PVC gaskets complying with ASTM D2287.
- H. Sliding Weatherstripping: Manufacturer's standard replaceable stripping of wool, polypropylene, or nylon woven pile with nylon fabric or aluminum strip backing, complying with AAMA 701.2.
- I. Glass and Glazing Materials: Conform to requirements of Section 08 81 00.

2.03 HARDWARE

- A. Conform to requirements of Section 08 71 00.
- B. Hinges: Continuous gear hinge, full length of door minus clearance, color to match door and frame.
- C. Astragal: As recommended by manufacturer.

2.04 FABRICATION

- A. General:
 - 1. Sizes and Profiles: Required sizes for door and frame units, including profile requirements, are indicated on Drawings.
 - 2. Prefabrication: Complete fabrication, assembly, finishing, hardware application, and other work before shipment to project site to greatest extent possible. Disassemble components only as necessary for shipment and installation.
 - 3. Preglaze door and frame units to greatest extent possible in coordination with installation and hardware requirements.
 - 4. Do not drill and tap for surface-mounted hardware items until time of installation at Project site.
 - 5. Perform fabrication operations including cutting, fitting, forming, drilling, and grinding of metal work preventing damage to exposed finish surfaces. For hardware, perform these operations prior to application of finishes.
- B. Welding: Comply with AWS recommendations to avoid discoloration. Grind exposed welds smooth and restore mechanical finish.
- C. Reinforcing: Install reinforcing as necessary for performance requirements. Separate dissimilar metals with bituminous paint or other separator preventing corrosion.
- D. Continuity: Maintain accurate relation of planes and angles, with hairline fit of contacting members.
- E. Fasteners: Conceal fasteners wherever possible.
- F. Weatherstripping: Provide compression weatherstripping against fixed stops for exterior doors. At other edges, provide sliding weatherstripping retained in adjustable strip mortised into door edge.
 - 1. Provide EPDM/vinyl blade gasket weatherstripping in bottom door rail, adjustable for contact with threshold.
 - 2. At interior doors and other locations without weatherstripping, provide neoprene silencers on stops to prevent metal-to-metal contact.

2.05 FRAMING SYSTEM

- A. General: Provide inside/outside matched resilient flush glazed system with provisions for glass replacement. Shop fabricate and preassemble frame components where possible.
- B. Thermal Break Construction: Fabricate aluminum framing system with integrally concealed, low conductance, thermal barrier located between exterior materials and exposed interior members eliminating direct metal-to-metal contact.
- C. Fabricate frames from tubular box type members with four sides closed and min wall thickness of 0.125 inches. Open channel frames not acceptable.

2.06 STILE AND RAIL TYPE ALUMINUM DOORS

A. Systems:

1. Special Lite SL-14 Series
2. Kawneer 350 Series
3. Cross MS-400 Series

B. Frame: Provide tubular frame members fabricated with mechanical joints using heavy inserted reinforcing plates and concealed tie rods or J-bolts, or fabricate with structurally welded joints at manufacturer's option.

C. Design: Provide doors 1-3/4 inch thick and wide stile (over 4 inch width).

D. Glazing: Provide glazed openings in doors as indicated with manufacturer's standard aluminum moldings and stops with removable stops on inside.

2.07 FLUSH TYPE ALUMINUM DOORS

A. Systems:

1. Special Lite SL-16 Series
2. Kawneer Flushline Series
3. Cross FL-400 Series

B. Frame: Provide tubular frame members fabricated with reinforced mechanical or welded joints in accordance with manufacturer's standard fabrication methods. Limit frame exposure to 3/4 inch maximum width on door faces.

C. Core: Fabricate core of resin impregnated kraft paper honeycomb, rigid, closed-cell polyurethane insulation or rigid, noncombustible mineral insulation board.

D. Faces: Fabricate faces of aluminum sheet of 0.064 inches minimum thickness, mechanically interlocked with frame members or laminated to core and framing with waterproof glue to form door thickness of 1-3/4 inch.

E. Glazing: Provide glazed openings in doors as indicated with manufacturer's standard aluminum moldings and stops with removable stops on inside.

2.08 FINISHES

A. Class I Natural Anodized Finish: AA-M12C22A41 (non-specular as fabricated mechanical finish; chemical etch, medium matte; 0.7 mil minimum thick anodic coating).

B. Class I Color Anodized Finish: AA-M12C22A42/A44 (non-specular as fabricated mechanical finish; chemical etch, medium matte; 0.7 mil minimum thick integrally or electrolytically deposited colored anodic coating).

1. Provide color as selected by Architect from within standard industry colors and color density range.

C. Apply temporary protective coating of clear acrylic lacquer, complying with AAMA recommendations.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Field Measurement: Wherever possible, take field measurements prior to preparation of Shop Drawings and fabrication to ensure proper fitting of work.

3.02 INSTALLATION

- A. Comply with manufacturer's instructions and recommendations for installation of aluminum doors and frames.
- B. Set units plumb, level, and true to line without warp or rack of framing members, doors or panels. Anchor securely in place, separating aluminum and other corrodible metal surfaces from sources of corrosion of electrolytic action at points of contact with other materials.
- C. Drill and tap frames and doors and apply surface-mounted hardware items complying with hardware manufacturer's instructions and template requirements. Use concealed fasteners wherever possible.
- D. Set sill members and other members in bed of sealant as indicated or with joint fillers or gaskets as indicated to provide weathertight construction.
- E. Install glass and other panels indicated to be glazed into doors and framing and not preglazed by manufacturer in accordance with Section 08 81 00.

3.03 ADJUST AND CLEAN

- A. Adjust operating hardware to function properly without binding, preventing tight fit at contact points and weatherstripping.
- B. Clean completed system inside and out promptly after erection and installation of glass and sealants. Remove excess glazing and joint sealants, dirt, and other substances from aluminum surfaces.
- C. Institute protective measures and other precautions required to ensure aluminum doors and frames will be without damage or deterioration other than normal weathering at time of acceptance.

END OF SECTION

SECTION 08 16 13
FIBERGLASS DOORS AND FRAMES

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Fiberglass reinforced plastic (FRP) doors.
2. FRP door frames.
3. FRP window frames.

1.02 REFERENCES

- A. ASTM: American Society for Testing and Materials
- B. ANSI: American National Standards Institute

1.03 SUBMITTALS

- A. Product Data: Manufacturer's printed product data indicating characteristics of products specified and installation instructions.
- B. Shop Drawings:
 1. Dimensioned elevation of each type door assembly in project; indicate sizes and locations of door hardware, and lights and louvers, if specified.
 2. Installation details of each type installation condition in project; indicate installation details of glazing, if specified.
 3. Schedule: Indicate each door assembly in project; cross-reference to plans, elevations, and details. Use same designation indicated on Drawings.
- C. Samples: Manufacturer's standard color chips.
- D. Manufacturer's standard warranty documents, executed by manufacturer's representative, countersigned by Contractor.
- E. Submit in accordance with Section 01 33 00.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Packing, Shipping, Handling, and Unloading: Package door assemblies in manufacturer's standard containers.
- B. Store door assemblies in manufacturer's standard containers, on end, to prevent damage to face corners and edges.

1.05 WARRANTY

- A. Manufacturer's Lifetime warranty against failure due to corrosion from specified environment.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. FIB-R-DOR.
- B. Chem-Pruf.
- C. Special-Lite.

2.02 MATERIALS

- A. Fiberglass Mat: Minimum 1.5 ounces per square foot.
- B. Resins: Manufacturer's formulation for fabricating units to meet specified requirements.
- C. Anchors: Manufacturer's standard stainless steel expansion anchors for existing openings, and stainless steel masonry tee anchors for new construction.
- D. Fasteners: Stainless steel.
- E. Glazing Type specified in Section 08 81 00; factory installed.

2.03 DOOR AND FRAME COMPONENTS

- A. Fiberglass Reinforced Plastic (FRP) Doors:
 - 1. Thickness: 1-3/4 inches.
 - 2. Thermal Insulating Value: R-value of 11.
 - 3. Minimum glass fiber to resin ratio: 30%.
 - 4. Core: End-grain balsa wood, resin-impregnated. Core at hinges, locksets, and other hardware mounting locations shall be solid fiberglass reinforced as noted and required.
 - 5. Door Plates: Molded in one continuous piece, resin reinforced with hand-laid glass fiber mat, nominal 1/8 inch thick, minimum 15 mil gel-coated surface.
 - 6. Door Edges: Minimum three (3) layers resin-reinforced glass fiber mat, nominal 3/8 to 1 1/2 inch thick, machine tooled.
 - 7. Mortise for lockset, and recess for strike plate in lock stile.
 - 8. Embed steel reinforcement for hinges in fiberglass matrix; provide for hinge leaf recesses in hinge stile.
 - 9. Sizes: Indicated on drawings.
 - 10. Finish: Smooth gloss or Satin surface, minimum value 88 in accordance with ASTM D523.
 - 11. Color: as per Owner.
- B. Fiberglass Frames: One-piece solid molded fiberglass reinforced plastic, minimum 1/4 inch wall thickness.
 - 1. Jamb-to-head joints mitered and reinforced with FRP clips and stainless steel fasteners; conforming to ANSI A250.8 requirements for performance equivalent to 16 gauge steel frames.
 - 2. Frame profile: 5-3/4 inches deep, 2 inches wide face; double rabbeted with 5/8 inch high stop.
 - 3. Mortise for lock strike, and recess for strike plate in lock jamb.
 - 4. Reinforce for hinges and other indicated hardware.
 - 5. Sizes: Indicated on drawings.
 - 6. Finish: Smooth Gloss or Satin surface, with true and consistent color.
 - 7. Color: to match door.
- C. Lights:

1. Stops: Pultruded fiberglass reinforced plastic stops; same color as doors.
2. Sizes: Indicated on drawings.
3. Fasteners: Stainless steel screws.
4. Glass: as specified in Section 08 81 00.

D. Frame Anchors: Types recommended by manufacturer for project conditions.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that openings are correctly prepared to receive doors and frames and are correct size and depth in accordance with shop drawings.
- B. Examine conditions under which construction activities of this section are to be performed and submit written report if conditions are unacceptable.
- C. Verify that glazing has been factory-installed.

3.02 INSTALLATION

- A. Install door opening assemblies in accordance with shop drawings, ANSI A250.8, and manufacturer's printed installation instructions, using installation methods and materials specified in installation instructions.
- B. Install of door hardware as specified in Section 08 71 00.
- C. Install door hardware in accordance with manufacturer's printed instructions, using through-bolts to secure surface applied hardware.
- D. Installation Tolerances: Maintain plumb and level tolerances specified in manufacturer's printed installation instructions.

3.03 ADJUSTING

- A. Adjust doors in accordance with door manufacturer's maintenance instructions to swing open and shut without binding, and to remain in place at any angle without being moved by gravitational influence.
- B. Adjust door hardware to operate correctly in accordance with hardware manufacturer's maintenance instructions.

3.04 CLEANING

- A. Clean surfaces of door assemblies and exposed door hardware in accordance with manufacturer's maintenance instructions.

3.05 PROTECTION

- A. Protect door assemblies and door hardware from damage by subsequent construction activities until final inspection.

END OF SECTION

SECTION 08 21 10
FLUSH WOOD DOORS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:

1. Solid-core doors with wood-veneer faces.
2. Field finishing flush wood doors.

1.02 SUBMITTALS

A. Product Data: For each type of door. Include details of core and edge construction and trim for openings.

B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; 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.

C. Samples for Verification:

1. Corner sections of doors, approximately 8 by 10 in. (200 by 250 mm), with door faces and edgings representing typical range of color and grain for each species of veneer and solid lumber required.
2. Louver blade and frame sections, 6 in. (150 mm) long, for each material and finish specified.
3. Frames for light openings, 6 in. (150 mm) long, for each material, type, and finish required.

D. Submit in accordance with Section 01 33 00.

1.02 QUALITY ASSURANCE

A. Source Limitations: Obtain flush wood doors through one source from single manufacturer.

B. Quality Standard: Comply with AWI's "Architectural Woodwork Quality Standards Illustrated".

1. Provide AWI Quality Certification Labels or AWI letter of licensing for Project indicating that doors comply with requirements of grades specified.

C. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252.

1. Temperature-Rise Rating: At exit enclosures, provide doors that have temperature-rise rating of 450°F (250°C) maximum in 30 min of fire exposure.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Package doors individually in plastic bags or cardboard cartons.
- C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

1.05 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install doors until building is enclosed, wet work is complete, and HVAC system is operating and will maintain temperature and relative humidity at occupancy levels during the remainder of the construction period.

1.06 WARRANTY

- A. Special Warranty: Manufacturer's standard form, signed by manufacturer, Installer, and Contractor, in which manufacturer agrees to repair or replace doors that are defective in materials or workmanship, have warped (bow, cup, or twist) more than 1/4 in. (6.4 mm) in 42 by 84 in. (1067 by 2134 mm) section, or show telegraphing of core construction in face veneers exceeding 0.01 in. in 3 in. (0.25 mm in 75 mm) span.
 - 1. Warranty shall be in effect 5 years from date of Substantial Completion for solid core interior doors:

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Algoma Hardwoods Inc.
- B. Eggers Industries; Architectural Door Division.
- C. Weyerhaeuser Company.

2.02 DOOR CONSTRUCTION, GENERAL

- A. Doors for Transparent Finish:
 - 1. Grade: Custom (Grade A faces).
 - 2. Species and Cut: White birch, rotary cut.
 - 3. Match between Veneer Leaves: Slip match.
 - 4. Assembly of Veneer Leaves on Door Faces: Running match.
 - 5. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
 - 6. Transom Match: Continuous match.
 - 7. Stiles: Same species as faces or compatible species.
- B. Substantial Properties:
 - 1. Use FSG Wood.
 - 2. Maximize recycled content.
 - 3. Use products manufactured within 500 miles of project site.

2.03 SOLID-CORE DOORS

- A. Interior Veneer-Faced Doors:

1. Core: Either glued block or structural composite lumber.
2. Construction: 5 piles with stiles and rails bonded to core, then entire unit abrasive planed before veneering.

2.04 LIGHT FRAMES

A. Wood Beards for Light Openings in Wood Doors:

1. Wood Species: Species compatible with door faces.
2. Profile: Manufacturer's standard shape.
3. At 20 min, fire-rated, wood-core doors, provide wood beads and metal glazing clips approved for such use.

2.05 FABRICATION

A. Fabricate doors in sizes indicated for Project-site fitting.

1. Comply with clearance requirements of referenced quality standard for fitting. Comply with requirements in NFPA 80 for fire-rated doors.

B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.

1. Coordinate measurements of hardware mortises in metal frames to verify dimensions and alignment before factory machining.
2. Metal Astragals: Premachine astragals and formed-steel edges for hardware for pairs of fire-rated doors.

C. Transom and Side Panels: Fabricate matching panels with same construction, exposed surfaces, and finish as specified for associated doors. Finish bottom edges of transoms and top edges of rabbeted doors same as door stiles.

1. Fabricate door and transom panels with full-width, solid-lumber, rabbeted meeting rails. Provide factory-installed spring bolts for concealed attachment into jambs of metal door frames.

D. Openings: Cut and trim openings through doors to comply with applicable requirements of referenced standards for kind(s) of door(s) required.

1. Light Openings: Trim openings with moldings of material and profile indicated.

2.06 SHOP PRIMING

- ### A. Doors for Transparent Finish: Shop seal faces and edge of doors, including cutouts, with stain (if required), other required pretreatments, and first coat of finish as specified in Section 09 91 00.

PART 3 EXECUTION

3.01 EXAMINATION

- #### A. Examine doors and installed door 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.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Hardware: For installation, see Section 08 71 00.

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. Job-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors. Machine doors for hardware. Seal cut surfaces after fitting and machining.

1. Clearances: Provide 1/8 in. (3.2 mm) at heads, jambs, and between pairs of doors. Provide 1/8 in. (3.2 mm) from bottom of door to top of decorative floor finish or covering. Where threshold is shown or scheduled, provide 1/4 in. (6.4 mm) from bottom of door to top of threshold.

a. Comply with NFPA 80 for fire-rated doors.

2. Bevel non-fire-rated doors 1/8 in. in 2 in. (3-1/2 degrees) at lock and hinge edges.
3. Bevel fire-rated doors 1/8 in. in 2 in. (3-1/2 degrees) at lock edge; trim stiles and rails only to extent permitted by labeling agency.

D. Field-Finished Doors: Refer to Section 09 91 00.

3.03 ADJUSTING

A. Operation: Rehang or replace doors that do not swing or operate freely.

B. Finished Doors: Replace doors that are damaged or do not comply with requirements. Doors may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION

SECTION 08 33 23
OVERHEAD COILING DOORS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Electrically operated door assemblies including insulated door curtains, guides, counterbalance mechanism, hardware, operators, and installation accessories.

1.02 REFERENCES

- A. NEMA: National Electrical Manufacturer's Association

1.03 SYSTEM DESCRIPTION

A. Design Requirements:

1. Wind Loading: Design and reinforce overhead coiling doors to withstand 20 pounds per square foot wind loading pressure unless otherwise indicated.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's product data, roughing-in diagrams, and installation instructions for each type and size of overhead coiling door.

- B. Shop Drawings: Submit Shop Drawings for special components and installations not fully dimensioned or detailed on manufacturer's data sheets.

C. Miscellaneous:

1. Provide setting drawings, templates, instructions, and directions for installation of anchorage devices.

- D. Operation and Maintenance (O&M) Data:

- E. Submit in accordance with Section 01 33 00.

1.05 QUALITY ASSURANCE

- A. Furnish overhead coiling door as complete unit produced by one manufacturer, including hardware, accessories, mounting, and installation components.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Cookson Company.
- B. Overhead Door Corporation.
- C. Cornell Iron Works.

D. Or equal.

2.02 DOOR CURTAIN MATERIALS AND CONSTRUCTION

A. Door Curtain:

1. Fabricate overhead coiling door curtain of interlocking insulated slats.
2. Design to withstand required wind loading of continuous length for width of door without splices.
3. Unless otherwise indicated, provide slats of material gauge recommended by door manufacturer for size and type of door required, and as follows.

a. Stainless Steel Door Curtain Slats: Furnish with powder coated.

- 1) Furnish manufacturer's standard double wall, "S"-configuration, flat slats with foamed in place urethane insulation.
- 2) Nominal Slat Thickness: 1 inch.
- 3) R-Value: 7 (min.)

B. Endlocks:

1. Stainless steel castings, secure to curtain slats with stainless steel rivets.
2. Provide locks on alternate curtain slats for curtain alignment and resistance against lateral movement.

C. Bottom Bar:

1. Consists of two angles, each not less than 1-1/2 inch by 1-1/2 inch by 1/8 inch thick, stainless steel extrusions to suit type of curtain slats.
2. Provide replaceable gasket of flexible vinyl or neoprene between angles as weather seal and cushion bumper.

D. Automatic Reversing Control:

1. Furnish each door with an electric operator with an automatic safety switch, extending full width of door bottom and located within neoprene or rubber astragal mounted to bottom door rail. Contact with switch will immediately reverse downward door travel.

E. Curtain Jamb Guides:

1. Fabricate curtain jamb guides of stainless steel angles or channels and angles with sufficient depth and strength to support curtain loading.
2. Build-up units with minimum 3/16 inch thick stainless steel sections.
3. Slot boltholes for track adjustment.
4. Secure continuous wall angle to wall framing by 3/8 inch minimum bolts at not more than 30 inch on center, unless closer spacing recommended by door manufacturer.
5. Extend wall angles above door opening head to support coil brackets, unless otherwise shown.
6. Place anchor bolts on exterior wall guides so they are concealed when door is in closed position.
7. Provide removable stops on guides to prevent over-travel of curtain and continuous bar for holding windlocks, if any.

F. Weather Seals:

1. Provide vinyl or neoprene weatherstripping for exterior exposed doors.
2. At door heads, use 1/8 inch thick continuous sheet secured to inside of curtain coil hood.
3. At door jambs, use 1/8 inch thick continuous strip secured to exterior side of jamb guide.

2.03 COUNTERBALANCING MECHANISM

- A. Counterbalance doors by means of adjustable steel helical torsion spring, mounted around steel shaft, mounted in spring barrel, and connected to door curtain with required barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.
- B. Counterbalance Barrel:
 1. Fabricate spring barrel of hot-formed structural quality carbon steel, welded or seamless pipe, of sufficient dia and wall thickness to support roll-up of curtain without distortion of slats and limit barrel deflection to not more than 0.03 inches per foot of span under full load.
- C. Provide spring balance of one or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Provide cast steel barrel plugs to secure ends of springs to barrel and shaft.
- D. Torsion Rod for Counterbalance Shaft:
 1. Fabricate of case-hardened steel or required size to hold fixed spring ends and carry torsional load.
- E. Brackets:
 1. Provide mounting brackets of manufacturer's standard design, either cast iron or cold-rolled steel plate with bell mouth guide groove for curtain.
- F. Hood:
 1. Form to entirely enclose coiled curtain and operating mechanism at opening head, and act as weather seal. Contour to suit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Provide closed ends for surface-mounted hoods and any portion of between-jamb mounting projecting beyond wall face. Provide intermediate support brackets required to prevent sag.
 2. Fabricate stainless steel hoods for stainless steel doors of Type #4 304 stainless steel sheet not less than 0.032 inches thick, mill finish.

2.04 PAINTING

- A. Shop clean and prime ferrous metal and galvanized surfaces, exposed and unexposed, except faying and lubricated surfaces, with door manufacturer's standard rust-inhibitive primer.
- B. Finish paint in accordance with Section 09 96 00.

2.05 MANUAL DOOR OPERATORS

- A. Provide manual operators except where electric door operators indicated. Provide chain hoist manual operator unit.
- B. Manual Operation:
 1. Design counterbalance mechanism so required pull for door operation does not exceed 25 pounds.

2. Adjust operating mechanism so curtain can be easily stopped at any point in its travel and remain in position until movement reactivated.
3. Provide galvanized steel lifting handle and slide bolt lock on inside bottom bar.

2.06 ELECTRIC DOOR OPERATORS

- A. The door shall be operated at a speed of 2/3 foot per second by an electric motor with gear reducer in oil bath.
- B. The motor operator shall include a geared limit switch an electrically interlocked emergency chain operator.
- C. The motor starter shall be housed in a NEMA 4X housing and include a magnetic reversing starter size O, a 24 volt control transformer, fused disconnect switch and complete terminal strip to facilitate field wiring.
- D. The motor operator shall be activated by a 3 button push-button station in a NEMA 4X enclosure.
- E. The motor shall be sized as required by the door, 460 volt, 3 phase, 3 horsepower maximum.
- F. The motor operator shall be mounted to the door bracket as shown.
- G. All motor operator components shall be U.L. listed.

2.07 INSERTS AND ANCHORAGES

- A. Furnish inserts and anchoring devices which must be set in concrete or built into masonry for installation of units.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install door and operating equipment complete with necessary hardware, jamb and head mold strips, anchors, inserts, hangers, and equipment supports in accordance with Shop Drawings, manufacturer's instructions, and as specified herein.

3.02 ADJUSTING

- A. Upon completion of installation, including Work by other trades, lubricate, test, and adjust doors to operate easily, free from warp, twist of distortion, and fitting weathertight for entire perimeter.

END OF SECTION

SECTION 08 41 10
ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Exterior and interior aluminum-framed storefronts.
2. Glazed aluminum curtain walls.
3. Exterior and interior swing aluminum entrance doors.

1.02 SYSTEM DESCRIPTION

A. Performance Requirements:

1. General: Provide aluminum-framed systems, including anchorage, capable of withstanding, without failure, effects of following:
 - a. Structure loads
 - b. Thermal movements
 - c. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
 - d. Dimensional tolerances of building frame and other adjacent construction.
2. Structural loads indicated on structural drawings and in compliance with State Building Code.
3. All systems shall be one manufacturer.
4. Systems illustrated are:
 - a. Aluminum Storefront: Kawneer Tri-Fab VG 451T.
 - b. Aluminum Curtain Wall: Kawneer System 1-1600 wall.
 - c. Aluminum Doors: Kawneer 350 Swing Door.
5. System requirements shall meet or exceed published performances for illustrated systems noted herein and shown on plans.

1.03 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of product indicated.
- B. Shop Drawings: Include plans, elevations, sections, and details of aluminum work, and show attachments to other work.
 1. Include structural analysis data, if requested, signed and sealed by qualified structural engineer responsible for their preparation.
 2. Include details of provisions for system expansion and contraction and for draining moisture occurring within system to exterior.
 3. For entrances, include hardware schedule and indicate operating hardware types, functions, quantities, and locations.

- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Fabrication Sample: Of each vertical-to-horizontal intersection of systems, made from 12-in. (300-mm) lengths of full-size components and showing details of following:
 - 1. Joinery.
 - 2. Anchorage.
 - 3. Expansion provisions.
 - 4. Glazing.
 - 5. Flashing and drainage.
 - 6. Welding certificates.
 - 7. Qualification Data: For Installer.
- E. Test Results (if requested):
 - 1. Product Test Reports: Based on evaluation of comprehensive tests performed by qualified testing agency, for aluminum-framed systems.
 - 2. Structural-Sealant-Glazing Quality-Control Program: Developed specifically for Project.
 - 3. Structural-Sealant-Glazing Quality-Control Program Reports: Documenting quality-control procedures and verifying results for aluminum-framed systems.
 - 4. Field quality-control test and inspection reports.
- F. Maintenance Data: For all portions of aluminum-framed systems, including cleaning.
- G. Warranties: Special warranties specified in this Section.
- H. Submit accordance with Section 01 33 00.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Capable of assuming engineering responsibility and performing work of this Section and who is acceptable to manufacturer.
 - 1. Engineering Responsibility: Preparation of data for aluminum-framed systems including Shop Drawings based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Projects and submission of reports of tests performed on manufacturer's standard assemblies.
- B. Product Options: Information on Drawings and in Specifications establishes requirements for systems' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.
 - 1. Do not modify intended aesthetic effects, as judged solely by ARCHITECT, except with ARCHITECT's approval. If modifications are proposed, submit comprehensive explanatory data to ARCHITECT for review.
- C. Preconstruction Sealant Testing: For structural-sealant-glazed systems, perform sealant manufacturer's standard tests for compatibility and adhesion of sealants with each material that will come in contact with sealants and each condition required by aluminum-framed systems.
- D. Accessible Entrances: Comply with ICC/ANSI A117.1. and FED-STD-795, "Uniform Federal Accessibility Standards."

- E. Welding: Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code—Aluminum."
- F. Structural-Sealant Glazing: Comply with recommendations in ASTM C 1401, "Guide for Structural Sealant Glazing."
- G. Structural-Sealant Joints: Design reviewed and approved by structural-sealant manufacturer.

1.05 PROJECT / SITE CONDITIONS

- A. Field Measurements: Verify actual locations of structural supports for aluminum-framed systems by field measurements before fabrication and indicate measurements on Shop Drawings.
 - 1. Established Dimensions: Where field measurements cannot be made without delaying Work, establish dimensions and proceed with fabricating aluminum-framed systems without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions.
- B. Packing, Shipping, Handling and Unloading: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- C. Storage and Protection: Store materials protected from exposure to harmful weather conditions. Handle storefront material and components to avoid damage. Protect storefront material against damage from elements, construction activities, and other hazards before, during and after storefront installation.

1.06 WARRANTY

- A. Special Assembly Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that deteriorate as defined in this Section within specified warranty period.
 - 1. Failures include, but are not limited to, following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Noise or vibration caused by thermal movements.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - d. Adhesive or cohesive sealant failures.
 - e. Water leakage through fixed glazing and framing areas.
 - f. Failure of operating components to function properly.
 - 2. Warranty Period: 10 years from date of Substantial Completion.
- B. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes fail within specified warranty period. Warranty does not include normal weathering.
 - 1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 – PRODUCTS

2.01 MANUFACTURERS SYSTEMS

- A. Kawneer.

1. Trifab® VG 451 Storefront System – 2" x 4 – ½" (50.8 x 114.3) nominal dimension; Non-Thermal; Front, Center, Back, Multi-Plane, Structural Silicone or Weatherseal Glazed (Type B); Screw Spline, Shear Block, Stick or Punched Opening Fabrication.
2. 1600 Wall System® - 2 – ½" x 6" (63.5 x 152.4) or 7- ½" (63.5 x 190.5) outside glazed pressure plate format.
3. 350 Swing Door; Medium Stile, 3 – ½ in. vertical face dimension, 1 – ¾ in. depth, high traffic applications, as detailed on Drawings.

B. Or equal.

2.02 MATERIALS – GENERAL

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
1. Sheet and Plate: ASTM B 209 (ASTM B 209M).
 2. Extrudes Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
 3. Extrudes Structural Pipe and Tubes: ASTM B 429.
 4. Structural Profiles: ASTM B 308/B 308M.
 5. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M
- B. Steel Reinforcement: With manufacturer's standard corrosion-resistant primer complying with SSPC-PS Guide No. 12.00 applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- D. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
1. Where fasteners are subject to loosening or turning out from thermal and structural movements. Wind loads, or vibration, use self-locking devices.
 2. Reinforce members as required to receive fastener threads.
- E. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.
- F. Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials. Form exposed flashing from sheet aluminum finished to match framing and of sufficient thickness to maintain flat appearance without visible deflection.

2.03 MATERIALS, ACCESSORIES AND FABRICATION (ALUMINUM STOREFRONT)

- A. Aluminum (Framing and Components):
1. Material Standard: ASTM B 221: 6063-T6 alloy and temper.
 2. Member Wall Thickness: Each framing member shall provide structural strength to meet specified performance requirements.
 3. Tolerances: Reference to tolerances for wall thickness and other cross-sectional dimensions of storefront members are nominal and in compliance with AA Aluminum Standards and Data.
- B. Fasteners: Where exposed, shall be Stainless Steel.
- C. Gaskets: Glazing gaskets shall be extruded EPDM rubber.

- D. Perimeter Anchors: Aluminum. Wheel steel anchors are used, provide insulation between steel material and aluminum material to prevent galvanic action.
- E. Thermal Barrier (Trifab® VG 451T):
 - 1. Kawneer IsoLock® Thermal Break or equal with a ¼" (6.4) separation consisting of a two-part chemically curing, high-density polyurethane, which is mechanically and adhesively joined to aluminum storefront sections.
 - a. Thermal Break shall be designed in accordance with AAMA TIR-A8 and tested in accordance with AAMA 505.
- F. Fabrication:
 - 1. Fabricate components per manufacturer's installation instructions and with minimum clearances and shim spacing around perimeter of assembly, yet enabling installation and dynamic movement of perimeter seal.
 - 2. Accurately fit and secure joints and corners. Make joints flush, hairline and weatherproof.
 - 3. Prepare components to receive anchor devices. Fabricate anchors.
 - 4. Arrange fasteners and attachments to conceal from view.

2.04 MATERIALS, ACCESSORIES AND FABRICATION (ALUMINUM CURTAINWALL)

- A. Aluminum (Curtain Wall and Components):
 - 1. Material Standard: Extruded Aluminum, ASTM B 221, 6063-T6 alloy and temper.
 - 2. Member Wall Thickness: Each framing member shall have a wall thickness sufficient to meet specified structural requirements.
 - 3. Tolerances: Reference to tolerances for wall thickness and other cross-sectional dimensions of curtain wall members are nominal and in compliance with AA Aluminum Standards and Data.
- B. Fasteners: Where exposed, shall be Stainless Steel.
- C. Gaskets: Glazing gaskets shall comply with ASTM C 864 and be extruded of silicone compatible EPDM rubber that provides for silicone adhesion.
- D. Perimeter Anchors: Aluminum. When steel anchors are used, provide insulation between steel material and aluminum material to prevent galvanic action.
- E. Thermal Barrier: Thermal separator shall be extruded of a silicone compatible elastomer that provides for silicone adhesion.
- F. Fabrication:
 - 1. Fabricate components per manufacturer's installation instructions and with minimum clearances and shim spacing around perimeter of assembly, yet enabling installation and dynamic movement of perimeter seal.
 - 2. Accurately fit and secure joints and corners. Make joints flush, hairline and weatherproof.
 - 3. Prepare components to receive anchor devices. Fabricate anchors.
 - 4. Arrange fasteners and attachments to conceal from view.
- G. Hardware:
 - 1. Awning: Four-bar hinges, roto operator, screens, 1 point keeper.

H. Finish:

1. Four-bar Hinges: Steel components 300 Series stainless steel (SS).
2. Roto Operator Keepers: Brushed copper nickel.

I. Sealants:

1. Non-Working Joints: AAMA 800.
2. Window Components: Suitable for application specified and as tested and approved by window manufacturer.

J. Insect Screens:

1. Tubular Extruded Aluminum Frames: ANSI/SMA 1004.
2. Aluminum Cloth: GSA-FS-RR-W-365 AND USDC-CS-138 with 18 x 16 mesh.
 - a. Color: As selected by ARCHITECT from manufacturer's complete line of available colors.

K. Weatherstripping:

1. Closed cell extruded dense EPDM.
2. Bulb-type at exterior vent member.
3. Fin-type at exterior frame member; bulb type at interior vent member.
4. Securely stake and join at corners.

2.05 MATERIALS, ACCESSORIES, FABRICATION AND HARDWARE (ALUMINUM ENTRANCE DOORS)

A. Aluminum (Entrances and Components):

1. Material Standard: ASTM B 221; 6063-T6 alloy and temper.
2. Door Stile and Rail Face Dimensions of 350 entrance door will be as shown on plans and as follows:

Door	Vertical Stile	Top Rail	Bottom Rail
190	2-1/8 in (54)	2-1/8 in (54)	3-7/8 in. (99)
350	3-1/2 in. (89)	3-1/2 in. (89)	6-1/2 in. (166)
500	5 in. (127)	5 in. (127)	6-1/2 in. (166)

3. Major portions of door members to be 0.125 in. (3.2) nominal in thickness and glazing molding to be 0.05 in. (1.3) thick.
4. Tolerances: Reference to tolerances for wall thickness and other cross-sectional dimensions of entrance members are nominal and in compliance with aluminum Standards and Data, published by The Aluminum Association.

B. Glazing gaskets shall be either EPDM elastomeric extrusions or thermoplastic elastomer.

C. Provide adjustable glass jacks to help center glass in door opening.

D. Fasteners: Where exposed, shall be aluminum, stainless steel or plated steel.

E. Perimeter Anchors: Aluminum. When steel anchors are used, provide insulation between steel material and aluminum material to prevent galvanic action.

F. Standard Entrance Hardware:

1. Weatherstripping:

- a. Meeting stiles on parts of doors shall be equipped with adjustable astragal utilizing wool pile with polymeric fin.
 - b. Door weathering on single acting offset pivot r butt hung door and frame (single or pairs) shall be Kawneer Sealair® weathering. This is comprised of thermoplastic elastomer weathering on tubular shape with semi-rigid polymeric backing.
2. Sill Sweep Strips: EPDM blade gasket sweep strip in aluminum extrusion applied to interior exposed surface of bottom rail with concealed fasteners.
 3. Threshold: Extruded aluminum, one piece per door opening, with ribbed surface.
 4. Offset Pivots: Manufacturer's standard for condition.

G. Fabrication:

1. Door corner construction shall consist of mechanical clip fastening, SIGMA deep penetration plug welds and 1-1/8 in. (29) long fillet welds inside and outside of all four corners. Glazing stops shall be hook-in type with EPDM glazing baskets reinforced with non-stretchable cord.
2. Accurately fit and secure joints and corners. Make joints hairline in appearance.
3. Prepare components with internal reinforcement for door hardware.
4. Arrange fasteners and attachments to conceal from view.
5. Prepare door to receive additional hardware shown on Door Schedule.

2.06 GLAZING

- A. Glazing: As specified Section 08 81 00.

2.07 ALUMINUM FINISHES

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish designations prefixed by AA comply with system established by Aluminum Association for designating aluminum finishes.
- C. Class I, Natural Anodized Finish: AA-M12C22A41 (nonspecular as fabricated mechanical finish; chemical etch, medium matte, 0. Mil minimum thick anodic coating).

2.08 SOURCE QUALITY CONTROL

- A. Structural-Sealant-Glazed Systems: Perform quality-control procedures complying with ASTM C 1401 recommendations including, but not limited to, system material qualification procedures, sealant testing, and system fabrication reviews and checks.

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. General:

1. Comply with manufacturer's written instructions and applicable AAMA guide specifications.
2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure nonmovement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration.
6. Seal joints watertight, unless otherwise indicated.

B. Metal Protection:

1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape or installing nonconductive spacers as recommended by manufacturer for this purpose.
2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Install components to drain water passing joints. Condensation occurring within framing members, and moisture migrating within system to exterior as applicable for storefront or curtain wall system.

D. Set continuous sill members and flashing in full sealant bed as specified in Section 07920 and to produce weathertight installation.

E. Install components plumb and true in alignment with established lines and grades, without warp or rack.

F. Install glazing as specified in Section 08800. Comply with ANSI Z97.1, CPSC 16 CFR 1201 and GANA Glazing Manual.

G. Entrances: Install to produce smooth operation and tight fit at contact points.

1. Exterior Entrances: Install to produce tight fit at weather stripping and weathertight closure.
2. Field-Installed Hardware: Install surface-mounted hardware according to hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

H. Install insulation materials as specified in Section 07 21 00.

I. Install perimeter joint sealants as specified in Section 07 92 00 and to produce weathertight installation.

3.03 ADJUSTING

A. Entrances: Adjust operating hardware for smooth operation according to hardware manufacturers' written instructions.

1. For doors accessible to people with disabilities, adjust closers to provide 3-second closer sweep period for doors to move from 70-degree open position to 3 in. (75 mm) from latch measured to leading door edge.

3.04 PROTECTION AND CLEANING

A. Protection: Protect installed product's finish surfaces from damage during construction. Protect aluminum curtain wall system from damage from grinding and polishing compounds, plaster, lime, acid, cement, or other harmful contaminants.

- B. Cleaning: 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.

END OF SECTION

SECTION 08 71 00
DOOR HARDWARE

PART 1 - GENERAL

1.01 SUMMARY

A Section includes:

1. Hardware for steel, aluminum, wood, and fiberglass doors.

1.02 REFERENCES

- A. NEMA: National Electrical Manufacture's Association

1.03 QUALITY ASSURANCE

- A. Manufacturers: Companies specializing in manufacturing door hardware with minimum three years experience.

1.04 SUBMITTALS

- A. Shop Drawings.
B. Product Data.
C. Submit in accordance with Section 01 33 00.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Package hardware items individually; label and identify package with door opening code to match hardware schedule.
B. Protect hardware from theft by cataloging and storing in secure area.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

A. Locksets.

1. Privacy Lockset x lever action x stainless steel x US 32D x removable core x Box Strike.

a. L9040 x 03 Schlage

2. Office Lockset x lever action x stainless steel x US 32D x removable core x Box Strike.

a. L9050 x 03 Schlage

3. Storeroom Lockset x lever action x stainless steel x US 32D x removable core x Box Strike.

a. L9080 x 03 Schlage

4. Passage Set x lever action x stainless steel x US 32D x removable core x Box Strike.
 - a. L9010 x 03 Schlage

5. Entrance Lockset x lever action x stainless steel x US 32D x removable core x Box Strike.
 - a. L9453 x 03 Schlage

6. Dummy Trim Lockset x lever action x stainless steel x US 32D. Do not provide lever on inside face.
 - a. L9176 x 03 Schlage

- B. Exit Devices: Rim type x stainless steel x US 32D., Vertical rod type x stainless steel x US 32D. Provide compatible F08 heavy duty exit device trim for exterior doors and compatible passage type exit device trim for interior doors.
 1. Single doors:
 - a. ED5200 Corbin Russwin
 - b. 8300 Adams Rite

 2. Double doors:
 - a. ED5400 Corbin Russwin
 - b. 8100 Adams Rite

- C. Hinges x 4-1/2 x 4-1/2 x US 32D.
 1. BB 1191 Hager
 2. FBB 191 Stanley
 3. BB 4101 Lawrence

- D. Hinges: Continuous gear hinge, full length of door, color to match door.

- E. Closers x delayed action x AL - size as recommended by manufacturer. Install closers on room side, using parallel arms where necessary.
 1. DC6000 Series Corbin Russwin
 2. 4010 / 4110 Smoothee Series LCN
 3. 7500 Series Norton
 4. 5100 Series Hager

HO - indicates hold open

- F. Kick Plates – 10 inch x 2 inch LDW x US 32D x 16GA.
 1. Brookline

2. Ives
 3. Hiawatha
 4. Rockwood
- G. Thresholds - set in sealant 5 inch x 1/2 inch Clear Anodized Aluminum Thermally Broken Saddle x frame width.
1. S282A x AL Reese
 2. 252 x 3AFG x AL Pemko
 3. 8425 x AL National Guard
 4. 421S x AL Hager
- H. Automatic Door Bottoms.
1. 420 APKL Pemko
 2. 320 x AL National Guard
 3. 742S Hager
- I. Door Bottom - Mill Aluminum with thermoplastic rubber.
1. DB594AU Reese
 2. 222APK Pemko
 3. 15NA National Guard
 4. 779SNMIL Hager
- J. Weatherstrip – Clear Anodized Aluminum.
1. DS 69C Reese
 2. 110 NA National Guard
 3. 332 CR Pemko
 4. 873SNMIL Hager
- K. Wall Stops x Concealed Fasteners.
1. 406/407 x convex Ives
 2. 406 Rockwood
- L. Flush Bolts with Dustproof Strike long enough to pass through threshold.
1. FB458 x 26D Ives
 2. 0600 x 26D Baldwin
 3. 555 x 26D Rockwood
 4. 282D x 26D Hager
- M. Overhead Stop – Hold Open.
1. 70H x 26D Glynn Johnson
- N. Astragals x Full Height Door - Clear Anodized Aluminum with thermoplastic rubber.
1. Doors with one active leaf:

- a. 158NA National Guard
- b. 355CS Pemko

2. Doors with two active leaves:

- a. 137NA (SET) National Guard
- b. 303CS Pemko

O. Pneumatic Swing Door Operators:

- 1. Series 5000 Horton.
- 2. Series 4820 LCN.
- 3. Alternate action switch: On to open, off to close.
- 4. Step down transformer: 120V to 24V AC.
- 5. Electrical controls shall be housed in NEMA 7 enclosure suitable for Class I, Div. II, Group D exposure.

P. Electrified Strikes x stainless steel

- 1. 310-2 ¾ x 26D Folger Adams
 - a. 24V DC

2.02 KEYING

- A. Key in accordance with schedule provided by Owner.
- B. Supply 5 keys for each lock.
- C. Cylinder locks on doors to match existing master keying.

2.03 FINISHES

- A. Manufacturer responsible for surface preparation and priming. Finish coating of doors either in plant or field. System shall comply with Section 09 96 00 and 09 91 00, refer to Schedule. Coordinate finish color with Engineer.
- B. Finishes are US 32D satin stainless steel unless otherwise noted. Closer finishes may be paint.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Verify that doors and frames are ready to receive work and dimensions are as indicated on shop drawings.
- B. Beginning of installation means acceptance of existing conditions.

3.02 INSTALLATION

- A. Install hardware in accordance with manufacturer's instructions.
- B. Use the templates provided by hardware item manufacturer.

3.03 HARDWARE SCHEDULE

- A. Set No. 1.
 - 1-1/2 PR Butts
 - 1 Exit Device
 - 1 Closer
 - 2 Kickplates
 - 1 Wall Stop or Floor Stop

- B. Set No. 2.
 - 1-1/2 PR Butts
 - 1 Passage Set
 - 1 Closer
 - 2 Kickplates
 - 1 Wall Stop or Floor Stop

- C. Set No. 3.
 - 1-1/2 PR Butts
 - 1 Office Lockset
 - 1 Closer
 - 2 Kickplates
 - 1 Wall Stop or Floor Stop

- D. Set No. 4.
 - 1-1/2 PR Butts
 - 1 Storeroom Lockset
 - 1 Closer
 - 2 Kickplates
 - 1 Wall Stop or Floor Stop

- E. Set No. 5.
 - 1-1/2 PR Butts x NRP
 - 1 Entrance Lockset
 - 1 Closer x 110 degrees x HO
 - 1 Kickplate
 - 1 Weatherstripping
 - 1 Door Bottom
 - 1 Threshold

- F. Set No. 6.
 - 3 PR Butts x NRP
 - 2 Exit Devices
 - 2 Closers x 110 degrees x HO
 - 2 Kickplates
 - 2 Weatherstripping
 - 2 Door Bottoms
 - 1 Threshold
 - 1 Astragal

- G. Set No. 7.
 - 1-1/2 PR Butts
 - 1 Privacy Set
 - 1 Closer
 - 2 Kickplates

1 Wall Stop of Floor stop

H. Set No. 8.

1-1/2 PR Butts x NRP
1 Exit Device
1 Closer x 110 degrees x HO
1 Kickplate
1 Weatherstrip
1 Door Bottom
1 Threshold

I. Set No. 9.

3 PR Butts x NRP
1 Entrance Lockset + 1 Dummy Trim Lockset
1 Closer x 110 degrees x HO
1 Overhead Stop
2 Flushbolts (top & bottom)
2 Kickplates
1 Weatherstripping
2 Door Bottoms
1 Threshold
1 Astragal

J. Set No. 10

3 PR Butts x NRP
1 Dummy Trim Lockset
1 Exit Device
1 Closer x 110 degrees x HO
1 Overhead Stop
2 Flushbolts (top & bottom)
2 Kickplates
1 Weatherstripping
2 Door Bottoms
1 Threshold
1 Astragal

J. Set No. 11

1-1/2 PR Butts x NRP
1 Exit Device
1 Closer x 110 degrees x HO
1 Electrified Strike
1 Kickplate
1 Weatherstripping
1 Door Bottom
1 Threshold

K. Set No. 12

3 PR Butts x NRP
2 Exit Devices
2 Closer x 110 degrees x HO
1 Electrified Strike
1 Pneumatic Swing Door Operator

L. Set No. 13

- 3 PR Butts x NRP
- 2 Exit Devices
- 2 Closer x 110 degrees x HO
- 1 Electrified Strike
- 1 Weatherstripping
- 2 Door Bottom
- 1 Threshold
- 1 Pneumatic Swing Door Operator (Not Required on Door No. 900-D06)

M. Set No. 14

- 1-1/2 PR Butts x NRP
- 1 Exit Device
- 1 Closer x 110 degrees x HO
- 1 Electrified Strike
- 1 Kickplate

N. Set No. 15

- 3 PR Butts x NRP
- 1 Exit Devices
- 1 Closer x 110 degrees x HO
- 2 Flushbolts (top & bottom)
- 2 Kickplates
- 1 Overhead Stop

END OF SECTION

SECTION 08 81 00
GLASS GLAZING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Exterior windows.
2. Exterior entrances.
3. Exterior and Interior doors.
4. Interior windows.
5. Borrowed lites.
6. Clearstories.

1.02 REFERENCES

- A. ASTM: American Society for Testing and Materials
- B. ANSI: American National Standards Institute

1.03 QUALITY ASSURANCE

- A. Safety Glass: Comply with ANSI Z97.1, with label on each piece.
- B. Safety Glazing Materials Act.

1.04 SUBMITTALS

A. Manufacturer's Data, Glass:

1. Manufacturer's specifications and installation instructions for each type of glass required.
2. Include test data substantiating that glass complies with specified requirements.

B. Manufacturer's Data, Glazing Materials:

1. Manufacturer's specifications and installation instructions for each type of glazing sealant and compound, gasket and associated miscellaneous material. Include manufacturer's published data, or letter of certification, or certified test laboratory report indicating that each material complies with the project specifications and is suitable for the applications shown.

C. Samples, Glass:

1. Submit 3, samples of each type of glass specified.
2. Insulating glass samples need not be hermetically sealed, but edge construction shall be included.

1.05 JOB CONDITIONS

- A. Weather Conditions: Do not proceed with installation of liquid sealants under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation.

1.06 GUARANTEES

- A. Insulating Glass: Provide manufacturer's ten year warranty against seal separation.

PART 2 - PRODUCTS

2.01 GLASS TYPES

- A. Type G1: 1/4 inch thick, gray tinted tempered float glass.
- B. Type G2: 1/4 inch thick, clear tempered float glass.
- C. Type G3: 1 inch thick overall gray-tinted and reflective insulating glass units, with makeup of 1/4 inch gray-tinted annealed float outboard glass, 1/2 inch thick dead air space, and 1/4 inch clear annealed float inboard glass with clear pyrolitic low-emissivity coating on #3 surface within unit. Reflective coating on the #2 surface by PPG, Solar cool gray series, LOF Eclipse series or Guardian.
- D. Type G4: 1/4 inch thick, clear polished square wire glass.
- E. Type G5: 1 inch thick overall insulating glass units, with makeup of 1/4 inch annealed float outboard glass, 1/2 inch thick dead air space, and 1/4 inch clear annealed float inboard glass with clear pyrolitic low-emissivity coating on #3 surface within unit.
- F. Type G6: 1 inch thick overall insulating glass units, with makeup of 1/4 inch annealed float outboard glass, 1/2 inch thick dead air space, and 1/4 inch clear annealed float inboard spandrel glass with clear pyrolitic low-emissivity coating on #3 surface within unit and dark gray ceramic frit applied to #4 surface.
- G. Type G7: 1 inch thick overall insulating glass units, with makeup of 1/4 inch obscure annealed float outboard glass, 1/2 inch thick dead air space, and 1/4 inch annealed float inboard glass with clear pyrolitic low-emissivity coating on #3 surface within unit.

2.02 GLAZING SEALANTS/COMPOUNDS

- A. Preformed Butyl Rubber Glazing Sealant:
 - 1. Tape or ribbon (coiled on release paper) of polymerized butyl, of mixture of butyl and polyisobutylene, compounded with inert fillers and pigments, solvent based with minimum of 95% solids, with thread of fabric reinforcement, tack-free within 24 hours, paintable, non-staining.
 - 2. Provide combination tape and encased continuous rubber shim, of approximately 50 durometer hardness.
 - 3. Any caulking or window sealants which come in contact with the insulating glass sealants are to be compatible.

2.03 GLAZING GASKETS

- A. Provide glazing gaskets recommended by manufacturer.
- B. Molded Neoprene Glazing Gaskets:
 - 1. Molded or extruded neoprene gaskets or profile and hardness shown for watertight

construction; comply with ASTM D2000 designation 2BC 415 to 3BC 620, black.

C. Polyvinyl Chloride Glazing Gaskets:

1. Extruded, flexible PVC gaskets of the profile and hardness shown; when not shown, for watertight construction comply with ASTM D2287.

D. Vinyl Foam Glazing Tape:

1. Closed cell, flexible, self adhesive, non-extruding, polyvinyl chloride foam tape; recommended by manufacturer for exterior, exposed, watertight, installation of glass, with only nominal pressure in the glazing channel, comply with ASTM D1667.

2.04 MISCELLANEOUS GLAZING MATERIALS

- A. Setting Blocks: Neoprene, 70-90 durometer hardness, with proven compatibility with sealants used.
- B. Spacers: Neoprene 40-50 durometer hardness, with proven compatibility with sealants used.
- C. Compressible Filler Rod: Closed cell or waterproof jacketed rod stock of synthetic rubber or plastic foam, proven to be compatible with sealants used, flexible and resilient, with 510 pounds per square inch compression strength for 25% deflection.
- D. Cleaners, Primers and Sealers: Type recommended by sealant or gasket manufacturer.

2.05 PERFORMANCE CHARACTERISTICS

- A. Insulated glass units
 1. Visible light transmittance of 18%, solar energy transmittance of 10%, summer daytime U-value of 0.26, winter nighttime U-value of 0.3, shading coefficient of 0.2 visible light reflectance-exterior 14%, visible light reflectance-interior 21%, and solar factor (SHGC) 0.17.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine the framing and glazing channel surfaces, backing, removable stop design, and the conditions under which the glazing will be performed, and notify the Architect/Engineer in writing of all conditions detrimental to the proper and timely completion of the work. Do not proceed with the glazing until unsatisfactory conditions have been corrected in a manner acceptable to the Architect.

3.02 JOB REQUIREMENTS

- A. Provide watertight and airtight installation of each piece of glass. Each installation shall withstand normal temperature changes, wind loading, impact loading (for operating sash and doors) without failure of any kind 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 at all times during handling, installation and operation of the building.

- C. Glazing channel dimensions shown provide for a minimum bite on the glass, minimum edge clearance and adequate sealant thicknesses, with reasonable tolerances. Be responsible for correct glass size for each opening, within the tolerances and dimensions established.
- D. 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 manufacturer's technical representative direct otherwise.
- E. Comply with "Glazing Manual" by Flat Glass Marketing Associating except as shown and specified otherwise, and except as specifically recommended otherwise by the manufacturers of the glass and glazing materials.
- F. Inspect each piece of glass immediately before installation, and eliminate all which have observable edge damage or face imperfections.
- G. 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, draw and bow oriented in the same direction as other pieces.

3.03 PREPARATION FOR GLAZING

- A. Clean the glazing channel, or other framing members to receive glass, immediately before glazing. Remove coatings which are not firmly bonded to the substrate. Remove lacquer from metal surfaces wherever elastomeric sealants are used.
- B. Apply primer or sealer to joint surfaces wherever recommended by sealant manufacturer.

3.04 GLAZING

- A. Comply with ANSI Standard Z97.1-1975 Safety Glazing Code.
- B. Install setting blocks of proper size at quarter points of sill rabbet. Set blocks in thin course of the heelbead compound.
- C. Glazing shall be set with equal bearing for entire width.
- D. Provide spacers inside and out, and of proper size and spacing, for all glass sizes larger than 50 united inches, except where gaskets are used for glazing. Provide 1/8 inch minimum bite of spacers on glass and use thickness equal to sealant width, except with sealant tape use thickness slightly less than final compressed thickness of tape.
- E. Voids and Filler Rods: Prevent exudation of sealant or compound by forming voids or installing filler rods in the channels at the heel of jambs and bead (do not leave voids in the sill channels) except as otherwise indicated, depending on light size, thickness and type of glass, and complying with manufacturer's recommendations.
- F. Do not attempt to cut, seam, nip or abrade glass which is chemically strengthened, tempered, or heat strengthened.
- G. Force sealants into channel to eliminate voids and to ensure complete "wetting" or bond of sealant to glass and channel surfaces.
- H. Tool exposed surfaces of glazing liquids and compounds to provide a substantial "wash" away from the glass. Install pressurized tapes and gaskets to protrude slightly out of the channel to eliminate dirt and moisture pockets.

- I. Clean and trim excess glazing materials from the glass and stops or frames promptly after installation, and eliminate stains and discolorations.
- J. Where wedge shaped gaskets are driven into one side of the channel to pressurize the sealant or gasket on the opposite side, provide adequate anchorage to ensure that gasket will not "walk" out when subjected to dynamic movement. Anchor gasket to stop with matching ribs, or by proven adhesive, including embedment of gasket tail in cured heel bead.

3.05 CURE, PROTECTION AND CLEANING

- 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. Protect exterior glass from breakage immediately upon installation by attachment of crossed streamers to framing held away from glass. Do not apply markers of any type to surfaces of glass.
- C. Remove and replace glass which is broken, chipped, cracked, abraded, or damaged in other ways during the construction period, including natural causes, accidents and vandalism.
- D. Maintain glass in a reasonably clean condition during construction so that it will not be damaged by corrosive action and will not contribute (by washoff) to the deterioration of glazing materials and other work.
- E. Wash and polish glass on both faces not more than four days prior to acceptance of the work in each area. Comply with glass manufacturer's recommendations. Washing shall be done by professional firm.

END OF SECTION

DIVISION 9

FINISHES

SECTION 09 26 00
GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Interior gypsum wallboard.

1.02 DEFINITIONS

- A. Gypsum Board Terminology: Refer to ASTM C 11 for definitions of terms for gypsum board assemblies not defined in this Section or in other referenced standards.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show locations, fabrication, and installation of control and expansion joints including plans, elevations, sections, details of components, and attachments to other units of Work.
- C. Samples:
 - 1. Trim Accessories: Full-size sample in 12-in.- (300-mm-) long length for each trim accessory indicated.
- D. Submit in accordance with Section 01 33 00.

1.04 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: For gypsum board assemblies with fire-resistance ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

1.05 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. Stack gypsum panels flat to prevent sagging.

1.06 PROJECT/SITE CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Steel Framing and Furring:
 - 1. Clark Steel Framing Systems.
 - 2. Consolidated Systems, Inc.
 - 3. Dale Industries, Inc. - Dale/Incor.
 - 4. Dietrich Industries, Inc.
 - 5. MarinoWare; Division of Ware Ind.
 - 6. National Gypsum Company.
 - 7. Scafco Corporation.
 - 8. Unimast, Inc.
 - 9. Western Metal Lath & Steel Framing Systems.

- B. Gypsum Board and Related Products:
 - 1. American Gypsum Co.
 - 2. G-P Gypsum Corp.
 - 3. National Gypsum.
 - 4. United States Gypsum. Co.

2.02 STEEL SUSPENDED CEILING AND SOFFIT FRAMING

- A. Components, General: Comply with ASTM C 754 for conditions indicated.

- B. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-in.- (1.59-mm-) dia wire, or double strand of 0.0475-in.- (1.21-mm-) dia wire.

- C. Hanger Attachments to Concrete:
 - 1. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by a qualified independent testing agency.

- D. Hangers:
 - 1. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162-in. (4.12-mm) dia.
 - 2. Angle Hangers: ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized commercial-steel sheet.

2.03 STEEL PARTITION AND SOFFIT FRAMING

- A. Components, General:
 - 1. Comply with ASTM C 754 for conditions indicated.
 - 2. Steel Sheet Components: Complying with ASTM C 645 requirements for metal and with manufacturer's standard corrosion-resistant zinc coating.

- B. Steel Studs and Runners: ASTM C 645.
 - 1. Minimum Base Metal Thickness: 0.027 in. (0.7 mm) 0.0312 in. (0.79 mm).

2. Depth: 3-5/8 in. (92.1 mm).

C. Metal Furring Channels:

1. Comply with ASTM C 645.
2. Comply with ASTM C 645 requirements for metal and with manufacturer's standard corrosion-resistant zinc coating.
3. Type and Size: 1-1/2 in. "Z" type furring channels.

D. Fasteners:

1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

2.04 INTERIOR GYPSUM WALLBOARD

A. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and correspond with support system indicated.

B. Gypsum Wallboard: ASTM C 36.

1. Regular Type:

- a. Thickness: 5/8 in., unless otherwise indicated.
- b. Long Edges: Tapered and featured (rounded or beveled) for prefilling.
- c. Location: As indicated on Drawings.

2. Type X:

- a. Thickness: 5/8 in. (15.9 mm) 1/2 in. (12.7 mm).
- b. Long Edges: Tapered and featured (rounded or beveled) for prefilling.
- c. Location: As indicated on Drawings.

2.05 EXTERIOR GLASS MAT WATER RESISTANT GYPSUM BACKER BOARD

A. Exterior Gypsum Wallboard: ASTM C 1178.

1. Thickness: 5/8 in. unless otherwise indicated.
2. Location: As indicated on Drawings.
3. Provide in maximum lengths and widths available that will correspond with support system.

2.06 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
2. Shapes:
 - a. Cornerbead: Use at outside corners.
 - b. LC-Bead: J-shaped; exposed long flange receives joint compound; use at exposed panel edges.

2.07 JOINT TREATMENT MATERIALS

A. Comply with ASTM C 475.

- B. Joint Tape:
 - 1. Interior Gypsum Wallboard: Paper.
- C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
 - 1. Prefilling: At open joints, rounded or beveled panel edge and damaged surface areas, use setting-type taping compound.
 - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
 - 3. Fill Coat: For second coat, use drying-type, all-purpose compound.
 - 4. Finish Coat: For third coat, use drying-type, all-purpose compound.

2.08 ACOUSTICAL SEALANT

- A. Acoustical Sealant for Exposed and Concealed Joints:
 - 1. Manufacturers:
 - a. Pecora Corp.; AC-20 FTR Acoustical and Insulation Sealant.
 - b. United States Gypsum Co.; SHEETROCK Acoustical Sealant.
 - 2. Nonsag, paintable, nonstaining, latex sealant complying with ASTM C 834 that effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

2.09 AUXILIARY MATERIALS

- A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
 - 1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 in. (0.84 to 2.84 mm) thick.
 - 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- C. Gypsum Board Nails: ASTM C514.
- D. Fastening Adhesive (for Wood): ASTM C557.
- E. Isolation Strip at Exterior Walls:
 - 1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), nonperforated.
 - 2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 in. (3.2 mm) thick, in width to suit steel stud size.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF STEEL FRAMING, GENERAL

- A. Installation Standards: ASTM C 754, and ASTM C 840 requirements that apply to framing installation.
- B. Install supplementary framing, blocking, and bracing at terminations in gypsum board assemblies to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction. Comply with details indicated and with gypsum board manufacturer's written recommendations or, if none available, with United States Gypsum's "Gypsum Construction Handbook."

3.03 INSTALLATION OF STEEL SUSPENDED CEILING AND SOFFIT FRAMING

- A. Suspend ceiling hangers from building structure as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
 - 3. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail.
 - 4. Secure angle hangers to structure, including intermediate framing members, by attaching to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 - 5. Attach hangers to structural members.
 - 6. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- B. Installation Tolerances: Install steel framing components for light shelves so members for panel attachment are level to within 1/8 in. in 12 ft (3 mm in 3.6 m) measured lengthwise on each member and transversely between parallel members.
- C. Sway-brace suspended steel framing with hangers used for support.
- D. Install suspended steel framing components in sizes and spacings indicated, but not less than that required by the referenced steel framing and installation standards.
 - 1. Hangers: 48 in. (1219 mm).
 - 2. Furring Channels (Furring Members): 16 in. (406 mm) o.c.

3.04 INSTALLATION OF STEEL SOFFIT FRAMING

- A. Install tracks (runners) at floors, ceilings, and structural walls and columns where gypsum board assemblies abut other construction.
 - 1. Where studs are installed directly against exterior walls, install foam-gasket isolation strip between studs and wall.
- B. Installation Tolerance: Install each steel framing and furring member so fastening surfaces vary not more than 1/8 in. (3 mm) from the plane formed by the 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.
 - 1. Cut studs 1/2 in. (13 mm) short of full height to provide perimeter relief.
- D. Install steel studs and furring at the following spacings:
 - 1. Single-Layer Construction: 16 in. (406 mm) o.c., unless otherwise indicated.
- E. Install steel studs so flanges point in the same direction and leading edge or end of each panel can be attached to open (unsupported) edges of stud flanges first.

3.05 APPLYING AND FINISHING PANELS, GENERAL

- A. Gypsum Board Application and Finishing Standards: ASTM C 840 and GA-216.
- B. Install ceiling board panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install gypsum panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 in. (1.5 mm) of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Attach gypsum panels to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- F. Attach gypsum panels to framing provided at openings and cutouts.
- G. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members using resilient channels, or provide control joints to counteract wood shrinkage.
- H. Cover both faces of steel stud partition framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

1. Unless 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. (0.7 sq. m) in area.
 2. Fit gypsum panels around ducts, pipes, and conduits.
 3. Where partitions intersect open concrete coffers, concrete joists, and other structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by coffers, joists, and other structural members; allow 1/4- to 3/8-in.- (6.4- to 9.5-mm-) wide joints to install sealant.
- I. Isolate perimeter of non-load-bearing gypsum board partitions at structural abutments, except floors. Provide 1/4- to 1/2-in.- (6.4- to 12.7-mm-) wide spaces at these locations, and trim edges with U-bead edge trim where edges of gypsum panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
 - J. Floating Construction: Where feasible, including where recommended in writing by manufacturer, install gypsum panels over wood framing, with floating internal corner construction.
 - K. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's written recommendations.
 1. Space screws a maximum of 12 in. (304.8 mm) o.c. for vertical applications.
 - L. Space fasteners in panels that are tile substrates a maximum of 8 in. (203.2 mm) o.c.

3.06 PANEL APPLICATION METHODS

- A. Single-Layer Application:
 1. On ceilings, apply gypsum panels before wall/partition board application to the greatest extent possible and at right angles to framing, unless otherwise indicated.
 2. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing), unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of board.
- B. Single-Layer Fastening Methods: Apply gypsum panels to supports with steel drill screws.

3.07 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.

3.08 FINISHING GYPSUM BOARD ASSEMBLIES

- A. Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Remove residual joint compound from adjacent surfaces.
- B. Prefill open joints, rounded or beveled edges, and damaged surface areas.

- C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below, according to ASTM C 840, for locations indicated:
 - 1. Level 4: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges at panel surfaces that will be exposed to view, unless otherwise indicated.

END OF SECTION

SECTION 09 30 13
CERAMIC TILING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes ceramic tile for floor applications; thin-set application method; and thresholds at door openings.

1.02 SUBMITTALS

- A. Shop Drawings: Indicate tile layout, patterns, color arrangement, perimeter conditions, junctions with dissimilar materials, control and expansion joints, thresholds and setting details.
- B. Product Data: Submit instructions for using grouts and adhesives.
- C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
- D. Samples: Submit manufacturer's complete line of available colors from American Olean "Bright and Matte", Color Group 5. Colors to be selected by OWNER.
- E. Submit in accordance with Section 01 33 00.

1.03 QUALITY ASSURANCE

- A. Perform Work in accordance with TCA Handbook and ANSI A108 Series/A118 Series.

1.04 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum five years documented experience and approved by tile manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect adhesives and grouts from freezing or overheating.

1.06 ENVIRONMENTAL REQUIREMENTS

- A. Do not install adhesives and grouts in unventilated environment.
- B. Maintain ambient and substrate temperature of 50°F during installation of mortar materials.

PART 2 - PRODUCTS

2.01 TILE

- A. Manufacturers:
 - 1. American Olean "Bright and Matte", Color Group 5.

- a. Floor Tile;
 - 1) Mosaics Unglazed (2 inch x 2 inch);
 - 2) Color selected by Owner.
- b. Base Tile;
 - 1) Glazed Ceramic (6 inch x 6 inch MB-5B);
 - 2) Color selected by Owner.
- c. Wall Tile:
 - 1) Glazed Ceramic (6 inch x 6 in MB-5B);
 - 2) Color selected by Owner

B. Other Acceptable Manufacturer's

- 1. Crossville Ceramics Company, L.P.
- 2. Or Equal.

2.02 COMPONENTS

A. Ceramic Mosaic Tile: ANSI A137.1, conforming to the following:

- 1. Moisture Absorption: 0 to 0.5 percent.
- 2. Size: 2 x 2 x 1/4 inch.
- 3. Shape: Square.
- 4. Edge: Square.
- 5. Surface Finish: Unglazed.
- 6. Color: As selected by Owner.

B. Ceramic Glazed Base Tile: Same as floor tile. Match floor tile for moisture absorption, surface finish, and color:

- 1. Size: 6 inch x 6 x 5/16 inch.
- 2. Moisture Absorption: 0 to 0.5 percent.
- 3. Profile: 1 piece base with cove.
- 4. Edge: Plain with cushion edges.
- 5. Surface Finish: Glazed.
- 6. Color: As selected by Owner.

C. Ceramic Glazed Wall Tile: Same as floor tile. Match floor tile for moisture absorption, surface finish, and color:

- 1. Size: 6 inch x 6 x 5/16 inch.
- 2. Moisture Absorption: 0 to 0.5 percent.
- 3. Shape: Square.
- 4. Edge: Plain with cushion edges.
- 5. Surface Finish: Glazed.
- 6. Color: As selected by OWNER.

2.03 ACCESSORIES

A. Adhesive Materials:

1. Epoxy Adhesive: ANSI A118.3, thin-set bond type.
2. Latex-Portland Cement Mortar: ANSI A118.4, thin-set bond type.

B. Grout Materials:

1. Silicone Rubber Grout: Silicone sealant, moisture and mildew resistant type, complying with ANSI A118.6, color as selected, use for toilet floor and shower floor and wall.

C. Thresholds: Extruded aluminum, with integral edge strip.

D. Cementitious Backer Board: Glass mesh mortar units formed of aggregated Portland cement slurry and reinforced with vinyl-coated woven glass-fiber mesh embedded in back surfaces. Minimum thickness shall be 1/2 inch.

E. Grout Sealer: Manufacturer's standard product for sealing grout joints that does not change color or appearance of grout.

F. Tile Cleaner: Neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

PART 3 - EXECUTION

3.01 EXAMINATION

- #### A. Verify surfaces are ready to receive work.

3.02 PREPARATION

- #### A. Protect surrounding work from damage.

- #### B. Vacuum clean surfaces and damp clean.

- #### C. Seal substrate surface cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances.

- #### D. Install cementitious backer board. Tape joints and corners, cover with skim coat of dry-set mortar to feather edge.

- #### E. Prepare substrate surfaces for adhesive installation.

3.03 INSTALLATION

- #### A. Install tile, thresholds, and grout in accordance with applicable requirements of ANSI A108.1 through A108.10, and TCA Handbook recommendations.

- #### B. Request tile pattern. Do not interrupt tile pattern through openings.

- #### C. Place thresholds at exposed tile edges.

- D. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly. Align floor and base joints.
- E. Place tile with joints uniform in width, subject to variance in tolerance allowed in tile size. Make joints watertight, without voids, cracks, excess mortar, or excess grout.
 - 1. Ceramic and Ceramic Mosaic Tile: 1/16 inch.
- F. Form internal angles square and external angles square.
- G. Sound tile after setting. Replace hollow sounding units.
- H. Keep expansion and control joints free of adhesive or grout. Apply sealant to joints.
- I. Allow tile to set for a minimum of 48 hours prior to grouting.
- J. Grout tile joints.
- K. Apply grout sealer to cementitious grout joints according to grout sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer that gotten on tile faces by wiping with soft cloth.
- L. Apply sealant to junction of tile and dissimilar materials and junction of dissimilar planes.
- M. Install cementitious backer board in accordance with ANSI A108.11.
- N. Installation - Thin-Set Methods:
 - 1. Over interior concrete floor substrates, install in accordance with appropriate TCA Handbook Method F116 and ANSI A118.3.
 - 2. Over interior cementitious backer board wall substrates, install in accordance with TCA Handbook Method W244 and ANSI A108.5.
 - 3. Over interior masonry wall surfaces substrates, install in accordance with TCA Handbook Method W202 and ANSI A108.5.

3.04 CLEANING

- A. Section 01 74 00 - Execution Requirements: Final cleaning.
- B. Clean tile and grout surfaces.

3.05 PROTECTION OF INSTALLED CONSTRUCTION

- A. Section 01 70 00 - Execution Requirements: Protecting installed construction.
- B. Do not permit traffic over finished floor surface for 4 days after installation.

END OF SECTION

SECTION 09 51 00
ACOUSTICAL CEILINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide acoustical ceilings where shown on the Drawings, as specified herein, and as needed for a complete and proper installation.

1.02 REFERENCES

- A. ASTM: American Society for Testing and Materials

1.03 SUBMITTALS

A. Product data:

1. Manufacturer's information and specifications and other data needed to prove compliance with the specified requirements.
2. Shop Drawings in sufficient detail to show suspension, layout, lateral restraint, installation, anchorage, and interface of the work of this Section with the work of adjacent trades.
3. Manufacturer's recommended installation procedures.

B. Samples:

1. 12 inch square samples of ceiling tile.
2. 12 inch long samples of "T" grid system.

- C. Comply with Section 01 33 00.

1.04 MAINTENANCE

- A. Deliver to the Owner for his use in future modifications, an extra stock of approximately 10% of each type of acoustical material installed, packaging each type of material separately, distinctly marked, and adequately protected against deterioration.

PART 2 - PRODUCTS

2.01 "T" GRID SYSTEM

- A. Provide a complete system of supporting members, anchors, wall cornices, adapters for light fixtures and grilles, and accessories of every type required for a complete suspended "T" grid system of the arrangements shown on the Drawings, in color or colors selected by the Engineer from standard colors of the approved manufacturer, and complying with pertinent requirements of Underwriters Laboratories, Inc., and the governmental agencies having jurisdiction.

B. Acceptable products:

1. Chicago Metallic Corp.
2. Or Equal.

C. "T" grid for ACT1 shall be coated steel. "T" grid for ACT2 shall be coated aluminum.

2.02 ACOUSTICAL CEILING PANELS

A. Acceptable products:

1. ACT1: Armstrong, or equal.

a. White, tegular edged, fissured, 24" x 24" x 5/8" mineral fiber with paint finish, conforming to ASTM E1264, Type III, Form 1, nodular.

2. ACT2: Sheetrock Climaplus, or equal.

a. White, square edged, 24" x 24" x 1/2" vinyl faced gypsum lay-in ceiling tile.

2.03 OTHER MATERIALS

A. Provide other materials, not specifically described but required for a complete and proper installation.

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 INSTALLATION, GENERAL

A. Install in accordance with recommendations of the manufacturer, ASTM C636, and the pertinent UL design requirements.

B. Lateral bracing:

1. Provide lateral bracing as required by pertinent codes and regulations.

2. Secure lateral bracing to structural members. Secure at right angles to the direction of the partition and four ways in large ceiling areas.

C. Make grid level within a tolerance of one in 1000 and straight within a tolerance of one in 1000.

3.03 INSTALLATION OF ACOUSTICAL MATERIALS

A. Install acoustical ceiling boards so linearity of facing is as shown on Drawings.

3.04 CLEANING UP

A. In addition to other stipulated requirements for cleaning, completely remove fingerprints and traces of soil from the surfaces of grid and acoustical materials, using only those cleaning materials recommended for the purpose by the manufacturer of the material being cleaned.

END OF SECTION

SECTION 09 67 26
QUARTZ FLOORING

PART 1 – GENERAL

1.01 SUMMARY

- A. Section includes colored quartz-filled decorative epoxy flooring.

1.02 DEFINITIONS

- A. Colored quartz-filled flooring includes two-component, modified polyamine epoxy base coats followed by a high performance, two-component, chemical resistant clear modified polyamine epoxy topcoat.

1.03 REFERENCES

- A. ASTM: American Society for Testing and Materials

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data, installation instructions, and general recommendations for each resinous flooring material required. Include certification indicating compliance of materials with requirements.
- B. Samples: Submit, for verification purposes, 4-inch square samples of each type of colored quartz-filled decorative epoxy flooring required, applied to a rigid backing, in color and finish indicated.
 - 1. For initial selection of colors and finishes, submit manufacturer's color charts showing full range of colors and finishes available.

1.05 QUALITY ASSURANCE

- A. Single Source Responsibility: Obtain primary colored quartz-filled decorative epoxy flooring materials including primers, resins, hardening agents, finish of sealing coats from a single manufacturer with not less than ten years of successful experience in manufacturing and installing principal materials described in this section. Contractor shall have completed at least five projects of similar size and complexity.
- B. Pre-Installation Conference
 - 1. General Contractor shall arrange a meeting not less than thirty days prior to starting work.
 - 2. Attendance
 - a. Contactor
 - b. Architect/Owner
 - c. Manufacturer/Installer's representative

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Material shall be delivered to job site and checked by flooring contractor for completeness and shipping damage prior to job start.

- B. All materials used shall be factory pre-weighed and pre-packaged in single, easy to manage batches to eliminate on site mixing errors. No on site weighing or volumetric measurements allowed.
- C. Material shall be stored in a dry, enclosed area protected from exposure to moisture. Temperature of storage area shall be maintained between 60 and 85°F.

1.06 PROJECT / SITE CONDITIONS

- A. Concrete substrate shall be properly cured for a minimum of 30 days. A vapor barrier must be present for concrete subfloors on or below grade. Otherwise, an osmotic pressure resistant grout must be installed prior to the colored quartz-filled flooring.
- B. Utilities, including electric, water, heat (air temperature between 60 and 85°F) and finished lighting to be supplied by Contactor.
- C. Job area to be free of other trades during, and for a period of 24 hours, after floor installation.
- D. Protection of finished floor from damage by subsequent trades shall be the responsibility of the Contactor.

1.07 WARRANTY

- A. Manufacturer shall furnish a single, written warranty covering both material and workmanship for a period of one (1) full year from date of installation.

PART 2 – PRODUCTS

2.01 COLORS

- A. Colors: As selected by Owner from manufacturer's standard color quartz blends.

2.02 EPOXY QUARTZ FLOORING

- A. Nominal 1/8 inch thick system comprised of a manufacturer suggested primer and a decorative double broadcast or slurry broadcast laminated floor topping system. The system consists of two-component modified polyamine epoxy broadcast to rejection with decorative color quartz blend applied in two broadcast applications or mixed together and applied as a slurry followed by a two-component, 100% solids, chemical resistant, clear modified polyamine epoxy coating topcoat.

2.03 MANUFACTURES

- A. Tnemec StrataShield Series 222 Deco-Tread top coated with Series 284 Deco-Clear.
- B. Florock FloroQuartz top coated with Floropoxy 4805.
- C. Or Equal.

2.04 JOINT SEALANT MATERIALS

- A. Type produced by manufacturer of colored quartz-filled decorative epoxy flooring system for type of service and joint condition indicated.

PART 3 – EXECUTION

3.01 PREPARATION

- A. Substrate: Concrete must be at least 28 days old and shall pass a dryness test in accordance to ASTM D4263 Test Method for Indicating Moisture by the Plastic Sheet Method, before coating is applied. Should moisture be detected, perform “Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.” (Reference ASTM F 1869) Moisture content not to exceed three pounds per 1,000 square feet in a 24-hour period. Shot-blast or mechanically abrade in accordance with SSPC-SP13 Surface Preparation of Concrete to remove laitance, curing compounds, hardeners, sealers and other contaminants and to provide surface profile. Surface profile to be in accordance with ICRI CSP3-5. Large voids, bugholes and other cavities should be filled with recommended filler or surfacer. Surface must be clean, dry and free of oil, grease and other contaminants. Substrate and ambient temperature shall be between 55°F-90°.

3.02 APPLICATION

- A. General: Apply each component of colored quartz-filled decorative epoxy flooring system in compliance with manufacturer’s directions to produce a uniform monolithic wearing surface of thickness indicated, uninterrupted except at divider strips, sawn joints or other types of joints (if any), indicated or required.
- B. Prime prepared surface as recommended by manufacturer.
- C. Broadcast Applications: Mix and apply first broadcast coat over properly prepared substrate with strict adherence to manufacturer’s installation procedures at a coverage rate of 80 square feet per gallon. Broadcast colored decorative quartz blend to rejection immediately after application. Allow to dry and sweep off excess quartz material. Mix and apply second broadcast coat over properly cured first broadcast coat with strict adherence to manufacturer’s installation procedures at a coverage rate of 80 square feet per gallon. Broadcast colored decorative quartz blend to rejection immediately after application. Allow to dry and sweep off excess quartz material. Coordinate timing of first and second broadcast application to insure optimal adhesion between colored quartz-filled decorative epoxy flooring materials and substrate.
- D. Topcoat: Mix and apply topcoat over properly cured second broadcast application with strict adherence to manufacturer’s installation procedures at a coverage rate of 160-200 square feet per gallon. A second coat of Series 284 shall be applied at the same coverage rate to achieve a smoother finish. Coordinate timing of first and second topcoat applications to insure optimal adhesion between colored quartz-filled decorative epoxy flooring materials and first topcoat application.

3.03 FIELD QUALITY CONTROL

- A. The right is reserved to invoke the following material testing procedure at any time, and any number of times during period of flooring application.
- B. The Owner will engage service of an independent testing laboratory to sample materials being used on the job site. Samples of material will be taken, identified and sealed, and certified in presence of Contractor.
- C. Testing laboratory will perform tests for any of characteristics specified, using applicable testing procedures referenced herein, or if none referenced, in manufacturer’s product data.

- D. If test results show materials being used do not comply with specified requirements, Contractor may be directed by Owner to stop work; remove non-complying materials; pay for testing; reapply flooring materials to properly prepared surfaces which had previously been coated with unacceptable materials.

3.04 CURING, PROTECTION AND CLEANING

- A. Cure colored quartz-filled decorative epoxy flooring materials in compliance with manufacturer's directions, taking care to prevent contamination during stages of application and prior to completion of curing process. Close area of application for minimum of 24 hours.
- B. Protect colored quartz-filled decorative epoxy flooring materials from damage and wear during construction operation. Where temporary covering is required for this purpose, comply with manufacturer's recommendations for protective materials and method of application. Contractor is responsible for protection and cleaning of surfaces after final coats.
- C. Cleaning: Remove temporary covering and clean colored quartz-filled decorative epoxy flooring just prior to final inspection. Use cleaning materials and procedures recommended by resinous flooring manufacturer.

END OF SECTION

SECTION 09 68 13
TILE CARPETING

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes carpet tile and installation.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated. Include manufacturer's written data on physical characteristics, durability, and fade resistance. Include installation methods.
- B. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
 - 1. Carpet Tile: Full-size Sample.
 - 2. Color: As selected by Owner from manufacturer's complete line of available colors
- C. Maintenance Data: For carpet tile to include in maintenance manuals specified in Division 1. Include the following:
 - 1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
 - 2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

1.02 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Provide products with the critical radiant flux classification indicated in Part 2, as determined by testing identical products per ASTM E 648 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. General: Comply with Carpet and Rug Institute CRI 104, Section 5, "Storage and Handling."

1.04 PROJECT CONDITIONS

- A. General: Comply with CRI 104, Section 6.1, "Site Conditions; Temperature and Humidity."
- B. Environmental Limitations: Do not install carpet tile until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- C. Do not install carpet tile over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.

1.05 WARRANTY

- A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Special Carpet Tile Warranty: Written warranty, signed by carpet tile manufacturer agreeing to replace carpet tile that does not comply with requirements or that fails within specified warranty period. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, and delamination.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 CARPET TILE, (CPT).

- A. Available Product: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
- B. Patcraft Commercial Carpet and Commercial Flooring, Tangible Hue Collection, 24 in. by 24 in.
 - a. Product Type: Modular.
- C. Fiber Content: 100 per cent nylon.
- D. Construction: Multi-Level Pattern Loop pile.
- E. Gauge: 1/12.
- F. Stitches: 10 per inch.
- G. Pile Height: 5/32 inch low – 6/32 inch high for finished carpet tile per ASTM D 418.
- H. Tufted Yarn Weight: 19 oz.
- I. Primary Backing: Synthetic.
- J. Secondary Backing: Ecoworx Tile.
- K. Performance Characteristics: As follows:
 - 1. Traffic Class: Heavy (TARR).
 - 2. Antimicrobial Assessment: Passes (AATCC-174).
 - 3. Methamine Pill Test: Passes (DOCFI-70).
 - 4. Radiant Panel: Class I (ASTM E-648).
 - 5. NBS Smoke: <450 (ASTM E-662).
 - 6. Electrostatic Propensity: Less than 3.5 kV (AATCC-134)
- L. ADA Compliance: Product shall meet guidelines set forth in the American with Disabilities Act for minimum static coefficient of friction of 0.6 for accessible routes.

2.02 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided by or recommended by carpet tile manufacturer.
 - 1. Adhesives: Manufacturers patented modular adhesive, "Self Lock", factory applied.
- B. Carpet Edge Guard: Extruded aluminum bend down carpet edge guard with concealed griper teeth and minimum 1-1/2 inch wide punched anchorage flange and minimum 5/8 inch wide face flange. Provide in hammered texture with anodized aluminum finish of colors selected by OWNER from among standard colors available.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance. Verify that substrates and conditions are satisfactory for carpet tile installation and comply with requirements specified.

PART 4 - Retain paragraph and subparagraphs below if products are adhesively attached to concrete subfloors.

- A. Concrete Subfloors: Verify that concrete slabs comply with ASTM F 710 and the following:
 - 1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet tile manufacturer.

PART 5 - Delete paragraph and subparagraphs below if no wood subfloors.

- A. Proceed with installation only after unsatisfactory conditions have been corrected.

5.02 PREPARATION

- A. General: Comply with CRI 104, Section 6.2, "Site Conditions; Floor Preparation," and carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile installation.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, and depressions in substrates.

PART 6 - Retain paragraph below if products are adhesively attached to concrete substrates.

- A. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet tile manufacturer.

- B. Broom and vacuum clean substrates to be covered immediately before installing carpet tile. After cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust. Proceed with installation only after unsatisfactory conditions have been corrected.

6.02 INSTALLATION

- A. General: Comply with CRI 104, Section 13, "Carpet Modules (Tiles)."

PART 7 - Glue-down installations are appropriate for wheel traffic; partial glue-down, for carpet tiles of moderate dimensional stability and moderate weight and mass; and free-lay, for dimensionally stable carpet tiles with heavy backings.

- A. Installation Method: 100 per cent glue-down using Self-Lock, Pattern Ashlar Monolithic.
- B. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.
- C. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- D. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, non-staining marking device.
- E. Install pattern parallel to walls and borders.

7.02 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet tile:
 - 1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet tile manufacturer.
 - 2. Remove yarns that protrude from carpet tile surface.
 - 3. Vacuum carpet tile using commercial machine with face-beater element.
- B. Protect installed carpet tile to comply with CRI 104, Section 15, "Protection of Indoor Installations."
- C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION

SECTION 09 84 13
FIXED SOUND-ABSORPTIVE PANELS

PART 1 – GENERAL

1.01 SUMMARY

- A. Wall mounted metal encased noise absorbing units.

1.02 REFERENCES

- A. ASTM: American Society for Testing and Materials

1.03 QUALITY ASSURANCE

- A. Components shall be shop manufactured and assembled.
- B. Manufacturer shall demonstrate ten years experience minimum in the manufacture of the specified products.

1.04 SUBMITTALS

- A. Product Data:
 - a. Manufacturer literature including certified acoustical tests by a recognized independent laboratory.
- B. Submit in accordance with Section 01 33 00.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. INC Panl-Sorb by Industrial Noise Control, Inc.
- B. Or equal.

2.02 DESIGN REQUIREMENTS

- A. Noise absorbing units shall be provided in modules of 2 inch thick x 30 inch wide in lengths from 12 inches to 120 inches. Modules shall be self-contained, stand alone, and finished ready for installation.

2.03 PERFORMANCE REQUIREMENTS

- A. Standard units shall provide a minimum noise reduction coefficients (NRC) of 1.05 and minimum NRC at the center octave bands and sabins shown in Tables 1 and 2.

TABLE I

Absorption Coefficients								
Frequency (Hz)		125	250	500	1000	2000	4000	NRC
Version	PS/I	0.22	0.59	1.19	1.25	1.16	1.22	1.05
	PS/C	0.20	0.62	1.18	1.26	1.16	1.29	1.05
	PS//FS	0.45	0.64	1.05	1.16	1.05	1.05	0.95

TABLE 2

Absorption in Sabins – 30” x 120” Unit							
Frequency (Hz)		125	250	500	1000	2000	4000
Version	PS/I	5.38	14.64	29.76	30.63	28.90	30.43
	PS/C	4.96	15.47	29.49	31.39	29.11	32.22
	PS//FS	11.14	15.95	26.22	28.92	26.35	26.36

2.04 ABSORBER CONSTRUCTION

- A. Absorber module body shall be a formed one piece shell fabricated of 22 gauge perforated zinc coated steel. Perforations shall be .093 inch diameter located on staggered .156 inch centers, 33% open area. Spotwelded or otherwise assembled shells will not be acceptable.
- B. Module edges shall provide 13% additional absorptive surface.
- C. Top and bottom mounting rails shall be formed on 18 gauge zinc coated steel with smooth rolled or hemmed edges. Holes for installation fastening shall be pre-punched in the bottom rails.
- D. Shell shall contain inert, mildew, vermin proof fill 2 inch thick, 4 pounds per cubic feet mineral wool or 3 pounds per cubic feet fiberglass, NRC=1.0 and an ASTM E-84 Class 1 (A) fire rating.

2.05 FINISH

- A. Factory applied prime coat of rust-inhibiting primer and finish coat of industrial epoxy color as selected by Owner.

PART 3 – EXECUTION

3.01 EXECUTION

- A. Modules shall be installed in strict accordance with manufacturer's instructions. All required mounting channels shall be provided by manufacturer as part of the modular unit. All fasteners, anchors, etc., shall be provided by the installer.

END OF SECTION

SECTION 09 91 00
PAINTING

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Painting and finishing of interior and exterior exposed items and surfaces, except as otherwise indicated.
2. New and existing surfaces described in Finish Schedules and notes on Drawings. Surface preparation, priming, and cost of paint in addition to shop priming and surface treatment specified under other sections of work.
3. Field painting of exposed bare and covered pipes, conduit, and ducts (including color coding), hangers, exposed steel and iron work, and primed metal surfaces of equipment installed under mechanical and electrical work except as otherwise indicated.

B. Following categories of work are not included as part of field applied finish work:

1. 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, prefinished partition systems, acoustic materials, architectural wood work and casework, elevator entrance doors and frames, elevator equipment, and finished mechanical and electrical equipment including light fixtures, switch gear, and distribution cabinets.
2. 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, utility tunnels, pipe spaces, duct and elevator shafts.
3. Finished metal Surfaces: Unless otherwise indicated, metal surfaces of anodized aluminum, stainless steel, chromium plate, copper, bronze, and similar finished materials will not require finish painting.
4. Operating Parts: Unless otherwise indicated, 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.

C. Following categories of work are included under other sections of these Specifications.

1. Shop Priming:

- a. Unless otherwise specified shop priming of ferrous metal items included under various sections for structural steel, metal fabrications, hollow metal work , and similar items.
 - b. Unless otherwise specified shop priming of fabricated components such as architectural woodwork, wood casework, and shop fabricated or factory built mechanical and electrical equipment or accessories included under other sections of these Specifications.
2. Do not paint over any code-equipped labels, such as UL and Factory Mutual or any equipment identification, performance rating, name or nomenclature plates.

D. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to items exposed in mechanical equipment rooms, storage rooms, and occupied spaces.

1. Mechanical items to be painted include, but are not limited to:
 - a. Piping, pipe hangers, pipe insulations, and supports.
 - b. Ductwork, insulation

- c. Accessory items.
- 2. Electrical items to be painted include, but not limited to:
 - a. Conduit and fittings.
- E. Do not coat over any code-required labels such as UL and Factory Mutual, or any equipment identification, performance rating, name, or nomenclature plates.
- F. Equipment manufacturers are responsible for surface preparation and coating of equipment, motors, and appurtenances. Equipment to be coated and coating system is identified in the equipment specification sections.

1.02 DEFINITIONS

- A. Paint: Coating systems materials including primers, emulsions, enamels, stains, sealers and fillers, and other applied materials whether used as prime, intermediate or finish coats.
- B. Gloss/Sheen Variables/Levels, sheen appearance can vary due to paint formulation differences.
 - 1. Flat:
 - a. Coating which registers up to 5% Reflection on 60% Gloss Meter.
 - b. Dull, matte finish.
 - 2. Eggshell/Low Lustre:
 - a. Coating which registers between 15% to 25% Reflection on 60 degree Gloss Meter.
 - b. Slight angular sheen to Flat finish with added film performance.
 - 3. Pearl/Low Lustre:
 - a. Coating which registers between 15% to 25% Reflection on 60 degree Gloss Meter.
 - b. Finish that is between Eggshell and Semi-Gloss.
 - 4. Satin/Soft Gloss:
 - a. Coating which registers between 35% to 55% Reflection on 60 degree Gloss Meter.
 - b. Finish that is lower than Semi-Gloss yet higher than Pearl Finish.
 - 5. Semi-Gloss/Medium Gloss:
 - a. Coating which registers between 35% to 60% Reflection on 60 degree Gloss Meter.
 - b. Finish that is between Satin and High Gloss.
 - 6. High Gloss:
 - a. Coating which registers 60% Reflection on 60 degree Gloss Meter.
 - b. Highest Gloss available in coating.

1.03 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's technical information including paint label analysis and application instructions for each material proposed for use.
- B. Samples:

1. Manufacturer's standard color samples from complete line of available colors for Owner's review of color and texture only. Provide listing of material and application for each coat of each finish sample.

C. Schedules:

1. Schedules: Submit schedule of proposed coating systems within 60 days after Notice to Proceed.

- a. Schedule of proposed coating systems shall contain all information as indicated in Coating Schedule included herein.

- D. Submit manufacturer's Material Safety Data Sheets (MSDS), for each type of coating, to ENGINEER'S field office for information. CONTRACTOR shall post copy of MSDS on Site at all times coating is in progress.

- E. Submit in accordance with Section 01 33 00.

1.04 QUALITY ASSURANCE

A. Regulatory Requirements:

1. All coatings shall conform to all federal, state and local regulations, including VOC rules at time of application.

B. Applicator Qualifications:

1. Engage an experienced applicator who has successfully completed coating system applications similar in material and extent to those indicated.

C. Single-Source Responsibility:

1. Provide primers and other undercoat paint produced by same manufacturer as finish coats. Use only thinners approved by paint manufacturer within recommended limits.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original, new and unopened packages and containers bearing manufacturer's name, label and following information.

1. Name or title of material.
2. Manufacturer's stock number and date of manufacture.
3. Manufacturer's name.
4. Contents by volume for major pigment and vehicle constituents.
5. Thinning instructions.
6. Application instructions.
7. Color name and number.
8. VOC content.

- B. Protect Store materials not in actual use in tightly covered containers. Maintain containers used in storage of paint in clean condition, free of foreign materials and residue.

1. Protect from freezing where necessary. Keep storage area neat and orderly. Remove oily rags and waste daily. Take precautions to ensure workers and work areas are

adequately protected from fire and health hazards resulting from handling, mixing, and application of paints.

1.06 PROJECT / SITE CONDITIONS

- A. Apply water base paints only when surface temperatures to be painted and surrounding air temperatures are between 50 degrees F and 90 degrees F, unless otherwise permitted by paint manufacturer's printed instructions.
- B. Apply solvent thinned paints only when surface temperature to be painted and surrounding air temperatures are between 45 degrees F and 95 degrees F, unless otherwise permitted by paint manufacturer's printed instructions.
- C. Do not apply paint in snow, rain, fog, or mist; when relative humidity exceeds 85%; or to damp or wet surfaces unless otherwise permitted by paint manufacturer's printed instructions.
 - 1. Painting may be continued during inclement weather if areas and surfaces to be painted are enclosed and heated within temperature limits specified by paint manufacturer during application and drying periods.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Sherwin-Williams company (S-W)
- B. Pittsburg Paints (PPG)
- C. Or Equal

2.02 MATERIALS

- A. Material Quality: Provide best quality grade of various types of coatings as regularly manufactured by paint materials manufacturers. Materials not displaying manufacturer's identification as standard best grade product are not acceptable.
- B. Color Pigments: Pure, non-fading, applicable types to suit substrates and service indicated.
 - 1. Lead content in pigment, if any, limited to contain not more than 0.06% (or statutory limit) lead, as lead metal based on total non-volatile (dry film) of paint by weight.
 - 2. Limitation extended to interior surfaces and those exterior surfaces such as stairs, decks, porches, railings, windows, and doors readily accessible to children under 7.

2.03 PAINTS AND COATINGS - GENERAL

- A. Unless otherwise indicated provide factory-mixed coatings. When required mix coatings to correct consistency in accordance with manufacturer's instruction before application. Do not reduce, thin, or dilute coatings, or add materials to coatings unless such procedure is specifically described in manufacturer's product instructions. VOC numbers used in this document need to be confirmed by using products MSDS sheets.
- B. Requirements:
 - 1. Paints and coatings used on interior of building (defined as inside of weatherproofing system and applied on-site) shall comply with following criteria.
 - a. Architectural paints, coatings and primers applied to interior walls and ceilings: Do not exceed VOC content limits established in Green Seal Standard GS-11, Paints, First Edition, May 20, 1993.

- b. Anti-corrosive and anti-rust paints applied to interior ferrous metal substrates: Do not exceed VOC content limit of 250 g/L established in Green Seal Standard GC-03. Anti-Corrosive Paints, Second Edition, January 7, 1997.
 - c. Clear wood finishes, floor coatings, stains, and shellacs applied to interior elements: Do not exceed VOC content limits established in South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings, rules in effect on January 1, 2004.
- C. Primers: Where manufacturer specifies primers, sealers, or block fillers; VOC limits follow Flat/Non-Flat, rules set forth above. These coatings are intended for on-site application to exterior surfaces of residential, commercial, institutional or industrial buildings.

2.04 COLORS

- A. Colors shall be selected and approved by OWNER.
 - B. Prior to beginning work ARCHITECT will provide color coordinating schedule. Any services system color coding shall comply with Section 15 07 50.
 - C. Coat access doors, grilles, and heating units to match color adjacent wall or ceiling surfaces. Coat electrical distribution panels where exposed in occupied spaces.
 - D. In areas scheduled for finishing, coat exposed piping, conduit, and ducts to match adjacent or near surfaces, except for color coding.
 - E. In areas where existing surfaces are coated, coat new exposed piping, conduit, and ducts to match adjacent or near surfaces, except for color coding.
 - F. Rooms and spaces may have certain walls coated difference color than other walls in same room and ceilings and trim may be difference color or colors than walls.
 - G. Equipment Colors:
 - 1. Equipment includes equipment, motors, and structural supports, fasteners, and attached Portions of electrical conduit.
 - 2. Coat equipment same color as piping equipment serves.
 - H. Final interior finishes (i.e. semi-gloss, flat, etc.) shall be selected by OWNER.
-
- C. Coat access doors of electrical distribution panels and grilles to match color of adjacent wall or ceiling surfaces.
 - D. In areas scheduled for finishing, coat exposed piping, conduit, and ducts to match color of adjacent or near surfaces, except for color-coding.
 - E. In areas where existing surfaces are finished, coat new exposed piping, conduit, and ducts to match color of adjacent or near surfaces, except for color-coding.
 - F. Equipment Colors:
 - 1. Equipment includes pumps, blowers, valves, flow meters, etc, and associated motors, structural supports, hangers, and attached portions of electrical conduit, and other associated components.
 - 2. Color of non-submerged equipment, including equipment with a manufacturer-applied finish coat, shall be same color as piping equipment serves; see Section 15200.
 - 3. Color of submerged equipment can be manufacturer's standard color.

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions under which painting work to be applied and notify CONTRACTOR in writing of conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable in applicator.
- B. Start of painting work will be construed as applicator's acceptance of surfaces and conditions within any particular area.
- C. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces or conditions otherwise detrimental to formation of durable paint film.
- D. Materials removed and replaced to correct defects due to Work placed on unsuitable surfaces shall be at CONTRACTOR'S expense.

3.02 SURFACE PREPARATION

- A. Prepare and clean in accordance with paint manufacturer's instructions and as specified for each particular substrate condition.
 - 1. Provide barrier coats over incompatible primers or remove and reprime as required. Notify ARCHITECT in writing of any anticipated problems using specified coating systems with substrates primed by others.
 - 2. Remove 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 complete painting of items and adjacent surfaces. Following completion of painting of each space or area, reinstall removed items.
 - 3. Clean surfaces to be painted before applying paint or surface treatments. Remove oil and grease prior to mechanical cleaning. Program cleaning and painting so contaminants from cleaning process will not fall onto wert, newly painted surfaces.
- B. Cementitious Materials: Prepare cementitious surfaces of concrete, concrete block, and plaster to be painted by removing efflorescence, chalk, dust, dirt, grease, oils, and roughening as required to remove glaze.
 - 1. Determine alkalinity and moisture content of surfaces to be painted by performing appropriate tests. If surfaces found to be sufficiently alkaline to cause blistering and burning of finish paint, correct condition before application of paint. Do not paint over surfaces where moisture content exceeds that permitted in manufacturer's printed directions.
 - 2. Clean Concrete floor surfaces scheduled to be painted with commercial solution of muriatic acid or other etching cleaner. Flush floor with clean water to neutralize acid and allow to dry before painting.
- C. Wood: Clean wood surfaces to be painted of 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 thin coat of white shellac or other recommended knot sealer before application of priming coat. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler. Sandpaper smooth when dried.
 - 1. Prime, stain or seal wood required to be field painted immediately upon delivery to site. Prime edges, ends, faces, undersides and backsides of such wood including cabinets, counters, cases and paneling.
 - 2. When transparent finish is required use spar varnish for back priming.

3. Back prime paneling on interior partitions only where masonry, plaster or other, wet wall construction occurs on backside.
 4. Seal unprimed tops, bottoms, and cut-outs of wood doors with heavy coat of varnish or equivalent sealer immediately upon delivery to site.
- D. Ferrous Metals: Clean ferrous surfaces not galvanized or shop coated of oil, grease, dirt, loose mill scale, and other foreign substances by solvent or mechanical cleaning.
1. Touch-up shop applied prime coats wherever damaged or bare.
 2. Clean and touch=up with same type shop primer.
- E. Galvanized Surfaces: Clean free of oil and surface contaminants with non-petroleum based solvent.

3.03 MATERIALS PREPARATION

- A. Mix and prepare painting materials in accordance with manufacturer's directions.
- B. Maintain containers used in mixing and application of paint in clean condition, free of foreign materials and residue.
- C. Stir materials before application to produce mixture of uniform density and stir as required during application. Do not stir surface film into material. Remove film and if necessary, strain material before using.

3.04 APPLICATION

- A. Apply paint in accordance with manufacturer's directions. Use applicators and techniques best suited for substrate and type of material being applied.
 1. Paint surface treatments and finishes are as indicated on Drawings.
 2. Provide finish coats compatible with prime paints used.
 3. Apply additional coats when undercoats, stains or other conditions show through final coat of paint, until paint film is of uniform finish, color, and appearance. Give special attention to ensure surfaces including edges, corners, crevices, welds and exposed fasteners receive dry film thickness equivalent to flat surfaces.
 4. Paint surfaces behind moveable equipment and furniture same as similar exposed surfaces. Paint surfaces behind permanently fixed equipment or furniture with prime coat only before final installation of equipment.
 5. Paint interior surfaces of ducts where visible through registers or grilles with flat, non-specular black latex paint.
 6. Do not proceed with painting of concrete masonry units after filler coat has been applied until filler coat has been examined and accepted for uniformity of finish.
 7. Finish exterior doors on tops, bottoms, and side edges same as exterior faces unless otherwise indicated.
 8. Sand lightly between each succeeding enamel or varnish coat.
 9. Omit first coat (primer) on metal surfaces which have been shop primed and touch-up painted unless otherwise indicated.

- B. Surfaces to be Painted: Except where natural finish of material is specifically noted as surface not to be painted, paint exposed surfaces whether or not colors are designated in schedules. Where items or surfaces are not specifically mentioned, Paint same as similar adjacent materials or areas. If color or finish is not designated ARCHITECT will select these from standard colors or finishes available. Paint exposed piping conduit and ductwork to match adjacent or near surfaces, except for color coding.
- C. In areas where existing surfaces are coated, coat new exposed piping, conduit, and ducts to match adjacent or near surfaces, except for color coding.
- D. Scheduling Painting: Apply first coat material to surfaces that have been cleaned, pretreated or otherwise prepared for painting as soon as practical after preparation and before subsequent surface deterioration.
 - 1. Allow sufficient time between successive coatings to permit proper drying. Do not recoat until paint has dried to feel firm, does not deform, or feel sticky under moderate thumb pressure, and application of another coat of paint does not cause lifting or loss of adhesion of undercoat.
- E. Minimum Coating thickness: Apply materials at not less than manufacturer's recommended spreading rate to establish total dry film thickness as indicated or, if not indicated, recommended by coating manufacturer.
- F. Prime Coat: Apply prime coat of material required to be painted or finished, not prime coated by others.
 - 1. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat to ensure finish coat with no burn through or other defects due to insufficient sealing.
- G. Stipple Enamel Finish: Roll and redistribute paint to even and fine texture. Leave no evidence of rolling such as laps, irregularity in texture, skid marks or other surface imperfections.
- H. Pigmented (Opaque) Finishes: Completely cover to provide opaque, smooth surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness or other surface imperfections not acceptable.
- I. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not in compliance with specified requirements.

J.

3.05 CLEANING

- A. Clean up: During progress of work, remove discarded paint materials, rubbish, cans, and rags at end of each work day from site.

3.06 PROTECTION

- A. 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 ARCHITECT.
- B. 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.

3.05 INTERIOR PAINT SCHEDULE

- A. Masonry (CMU-concrete masonry units), (Glazed-concrete masonry units in Building 120):
 - 1. Semi-Gloss Latex System
 - a. 1st Coat: S-W PrepRite Block filler B25W25 (75-125 sq. ft/gal).
PPG 6-7 SpeedHide Interior/Exterior Masonry Latex Block Filler 6.0 to 12.5 mils DFT)
 - b. 2nd Coat: S-W ProMar 200 Zero VOC Latex Semi-Gloss B21-2600 Series (1.6 mils DFT)
PPG 6-500 Series SpeedHide Interior Semi-Glass Latex (1.0 mil DFT)
 - c. 3rd Coat S-W ProMar 200 Zero VOC Latex Semi-Gloss B21-2600 Series (1.6 Mils DFT)
PPG 6-500 Series SpeedHide Interior Semi-Gloss Latex (1.0 mil DFT)
- B. Gypsum Board:
 - 1. Semi-Gloss Latex System:
 - a. 1st Coat: S-W ProMar 200 Zero VOC Latex Primer, B28W2600 (1.0 mils DFT)
PPG 6-2 SpeedHide Interior Quick Drying Latex Sealer (1.0 mil DFT)
 - b. 2nd Coat: S-W ProMar 200 Zero VOC Latex Semi-Gloss B21-2600 Series (1.6 mils DFT)
PPG 6-500 Series SpeedHide Interior Semi-Gloss Latex (1.0 mil DFT)
 - c. 3rd Coat: S-W ProMar 200 Zero VOC Latex Semi-Gloss B21-2600 Series (1.6 mils DFT)
PPG 6-500 Series SpeedHide Interior Semi-Gloss Latex (1.0 mil DFT)
- C. Hollow Metal Doors and Frames:
 - 1. Semi-Gloss Latex System:
 - a. 1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series (2.0 mils DFT)
PPG 60-712 Pitt-Tech Interior/Exterior Primer/Finish DTM Industrial Enamel (2.0 DFT)
 - b. 2nd Coat: S-W ProClassic Waterborne Acrylic Semi-Gloss Enamel, B31 Series (1.3 mils DFT)
PPG 6-500 Series SpeedHide Interior Semi-Gloss Latex (1.0 mil DFT)
 - c. 3rd Coat: S-W ProClassic Waterborne Acrylic Semi-Gloss Enamel, B31 Series (1.3 mils DFT)
PPG 6-500 Series SpeedHide Interior Semi-Gloss Latex (1.0 mil DFT)
- D. Ferrous Metal:
 - 1. Semi-Gloss Latex System:
 - a. 1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series (2.0 mils DFT)
PPG 60-712 Pitt-Tech Interior/Exterior Primer/Finish DTM Industrial Enamel (2.0 DFT)
 - b. 2nd Coat: S-W ProMar 200 Waterbased Acrylic-Alkyd Semi-Gloss, B34-

8200 Series (1.7 mils DFT)
PPG 6-500 Series SpeedHide Interior Semi-Gloss Latex (1.0 mil DFT)

- c. 3rd Coat: S-W ProMar 200 Waterbased Acrylic-Alkyd Semi-Gloss, B34-8200 Series (1.7 mils DFT)
PPG 6-500 Series SpeedHide Interior Semi-Gloss Latex (1.0 mil DFT)

2. Dryfall Waterborne Topcoat, Semi-Gloss Finish:

- a. 1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series (2.0 mils DFT)
PPG 60-712 Pitt-Tech Interior/Exterior Primer/Finish DTM Industrial Enamel (2.0 DFT)
- b. 2nd Coat: S-W Pro Industrial Waterborne Acrylic Dryfall Semi-Gloss, B42-80 Series (2.3 mils DFT)
PPG 6-724XI Speedhide Super Tech WB Interior Dry-Fog Semi-Gloss Latex (2.0 mils DFT)
- c. 3rd Coat: S-W Pro Industrial Waterborne Acrylic Dryfall Semi-Gloss, B42-80 Series (2.0 mils DFT)
PPG 6-724XI Speedhide Super Tech WB Interior Dry-Fog Semi-Gloss Latex (2.0 mils DFT)

E. Wood:

1. Semi-Gloss Latex System:

- a. 1st Coat: S-W Premium Wall & Wood Primer, B28W8111 (1.8 mils DFT)
PPG 17-921 Seal Grip 100 Percent Acrylic Universal Primer (1.6 mils DFT)
- b. 2nd Coat: S-W ProClassic Waterborne Acrylic Semi-Gloss Enamel, B31 Series (1.3 mils DFT)
PPG 6-500 Series SpeedHide Interior Semi-Gloss Latex (1.0 mil DFT)
- c. 3rd Coat: S-W ProClassic Waterborne Acrylic Semi-Gloss Enamel, B31 Series (1.3 mils DFT)
PPG 6-500 Series SpeedHide Interior Semi-Gloss Latex (1.0 mil DFT)

2. Satin Finish Latex System:

- a. 1st Coat: S-W Premium Wall & Wood Primer, B28W8111 (1,8 mils DFT)
PPG 17-921 Seal Grip 100 Percent Acrylic Universal Primer (1.6 mils DFT)
- b. 2nd Coat: S-W ProClassic Waterborne Acrylic Satin, B20 Series (1.2 mils DFT)
PPG 6-3511 Series Speedhide Interior Satin Latex (1.0 mil DFT)
- c. 3rd Coat: S-W ProClassic Waterborne Acrylic Satin, B20 Series (1,,2

Mils DFT)
PPG 6-3511 Series Speedhide Interior Satin Latex (1.0 mil DFT)

- 3, Stain and Varnish System (Wood Doors, Reception Desk Bldg. 900, Wood Trim)
 - a. 1st Coat: S-W Wood Classics 250 Oil Stain, A49-800 Series or S-W Wood Classics Interior Oil Stain, A49 Series
PPG Deft DFT300 Wood Based Wood Stain
 - b. 2nd Coat: S-W Wood Classics Waterborne Polyurethane Varnish, Satin (1.0 mil DFT)
PPG Deft, DFT159 Clear Polyurethane Interior Water Based Acrylic-Satin
 - c. 3rd Coat: S-W Wood Classics Waterborne Polyurethane Varnish, Satin, (1.0 mil DFT)
PPG Deft, DFT159 Clear Polyurethane Interior Water Based Acrylic-Satin

3.06 EXTERIOR PAINT SCHEDULE

A. Galvanized Hollow Metal Doors and Frames

1. Semi-Gloss Latex System

- a. 1st Coat: S-W Solo Acrylic Semi-Gloss A76 Series (1.5 mils DFT)
PPG 90—1210 Series Pitt-Tech Plus Interior/Exterior Semi-gloss DTM Industrial Enamel (2.0 mils DFT)
- b. 2nd Coat: S-W Solo Acrylic Semi-Gloss A76 Series (1.5 mils DFT)
PPG 90—1210 Series Pitt-Tech Plus Interior/Exterior Semi-gloss DTM Industrial Enamel (2.0 mils DFT)

B. Ferrous Metal (Structural Steel, Lintels, Bollards, Misc. Steel)

1. Semi-Gloss Latex System:

- a. 1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series (2.0 mils DFT)
PPG Speedhide Alkyd Metal Primer: (2.0 to 3.0 mils DFT)
- b. 2nd Coat: S-W Solo Acrylic Semi-Gloss A76 Series (1,5 mils DFT)
PPG 90-1210 Series Pitt-Tech Plus Interior/Exterior Semi-gloss DTM Industrial Enamel (2.0 mils DFT)
- c. 3rd Coat: S-W Solo Acrylic Semi-Gloss A76 Series (1,5 mils DFT)
PPG 90-1210 Series Pitt-Tech Plus Interior/Exterior Semi-gloss DTM Industrial Enamel (2.0 mils DFT)

C. Ferrous Metal (Structural Steel, Lintels, Bollards, Misc. Steel)

1. Gloss Latex Finish System:

- a. 1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series (2.0 mils DFT)
PPG Speedhide Alkyd Metal Primer: (2.0 to 3.0 mils DFT)
- b. 2nd Coat: S-W A-100 Exterior Latex Gloss, A8 Series (1.3 mils DFT)
PPG 90-374 Series Pitt-Tech Plus Interior/Exterior High Gloss DTM Industrial Enamel (2.0 mils DFT)
- c. 3rd Coat: S-W A-100 Exterior Latex Gloss A8 Series (1.,3 mil DFT)

PPG 90-374 Series Pitt-Tech Plus Interior/Exterior High
Gloss DTM Industrial Enamel (2.0 mils DFT)

- 3.10 Paints and coatings shall conform to the following schedule and manufacturer's recommendations. Examples of surfaces to be coated may not be all inclusive.

END OF SECTION

SECTION 09 96 00
HIGH-PERFORMANCE COATINGS

PART 1 – GENERAL

1.01 SUMMARY

- A. Coating of surfaces as noted on the Drawings and as specified herein, including:
1. New and existing surfaces described in Finish Schedules and notes on Drawings.
 2. Interior masonry wall surfaces.
 3. Exposed underside of precast concrete roof and floor members.
 4. Exposed interior and exterior ferrous metal, ductile iron, or cast iron piping, regardless of factory-applied finish.
 5. Exposed interior and exterior structural steel surfaces.
 6. Exterior and interior equipment, pumps, valves, motors, etc. and all appurtenances.
 7. Color-coded equipment and piping above ceilings.
 8. Concrete tank and channel surfaces only where noted on drawings.
 9. Galvanized steel piping and conduit mounted to coated surfaces.
 10. Exposed interior and exterior galvanized steel conduit and supports.
 11. Steel doors and frames.
 12. Existing surfaces remodeled or damaged during construction which presently have a finish. Refinish surrounding areas as required so touch-up not visible from 6 feet away.
 13. Existing surfaces exposed by removals where adjacent surface has a finish. Finish areas as required so touch-up not visible from 6 ft away.
 14. Touchup and finish coatings on Owner-furnished equipment, material, and appurtenant items.
- B. Labeling and directional arrows on piping, equipment, valves, and ducts whether coated or not coated is specified in Section 40 05 05.
- C. Do not coat the following unless specifically noted otherwise:
1. Factory-finished electrical motor control center (MCC), main instrument panels (MIP), flow indicators, and related equipment.
 2. Moving parts of operating units, electrical parts, linkages, sensing devices, and motor shafts.
 3. Buried equipment and piping.
 4. Surfaces above ceilings.
 5. Factory-finished trim.
 6. Stainless steel, chrome plate, copper, bronze, galvanized surfaces, and similar finished materials.
 7. Aluminum ductwork or aluminum faced insulation.
 8. Aluminum louvers and trim.
 9. Concrete tanks.
 10. Plastic and FRP piping, equipment, and ductwork.
- D. Do not coat over any code-required labels such as UL and Factory Mutual, or any equipment identification, performance rating, name, or nomenclature plates.
- E. Equipment manufacturers are responsible for surface preparation and coating of equipment, motors, and appurtenances. Equipment to be coated and coating system is identified in the equipment specification sections.

1.02 DEFINITIONS

A. Definitions as used in Finish Schedule shown on Drawings and Coating Schedule included herein.

1. Coatings: Paint or heavy duty finishes for use on surfaces subject to interior and exterior exposure, submergence, high moisture, splash, or chemical environment, including primers, sealers, fillers, and intermediate and finished coats.
2. Submerged P: Surfaces submerged in potable water plus 1 foot-6 inches above high water level.
3. Submerged NP: Surfaces submerged in non-potable liquid plus 1 foot-6 inches above high liquid level.
4. First Coat: Field primer, factory primer, or shop primer. When only one coat is required, first coat is the finished coat.
5. Second, Third, or Intermediate Coats: Successive finished coats applied over first coat.
6. DFT: Dry film thickness (mils/coat).
7. sfp: Square feet per gallon (per coat).

1.03 SUBMITTALS

A. Product Data:

1. Manufacturer's literature including application recommendations and generic makeup for each coating scheduled.
2. Factory or shop-applied primer manufacturer's literature including application recommendations and generic makeup shall be submitted with all material and equipment submittals. All primers shall conform to the requirements of this Section.

B. Samples:

1. Actual color samples available for each coating scheduled.

C. Miscellaneous:

1. Schedules:

- a. Schedule of proposed coating systems within 60 days after Notice to Proceed.
- b. Schedule of proposed coating systems shall contain all information as indicated in Coating Schedule included herein.

2. Submit manufacturer's Safety Data Sheets (SDS), for each type of coating, to Engineer's field office for information. Contractor shall post copy of SDS on Site at all times coating is in progress.

D. Submit in accordance with Section 01 33 00.

1.04 QUALITY ASSURANCE

A. Regulatory Requirements:

1. All coatings shall conform to OSHA requirements for allowable exposure to lead and other hazardous substances.

B. Applicator Qualifications:

1. Engage an experienced applicator who has successfully completed coating system applications similar in material and extent to those indicated.

C. Single-Source Responsibility:

1. Provide coating material produced by same manufacturer for each system.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Materials shall be delivered to site in original containers with labels intact and seals unbroken.
- B. Protect and heat or cool material storage location to maintain temperature ranges recommended by coating manufacturers, but not less than 55°F.
- C. Avoid danger of fire. Oily rags and waste must be removed from buildings each night or kept in appropriate metal containers. Provide fire extinguishers of type recommended by coating manufacturer's in areas of storage and where finishing is occurring. Allow no smoking or open containers of solvent.
- D. Empty containers shall have labels canceled and clearly marked as to use.

1.06 PROJECT / SITE CONDITIONS

A. Environmental Requirements:

1. Dry-heat and ventilate areas to obtain conditions recommended by coating manufacturer.
2. Relative humidity conditions as specified by coating manufacturer shall be adhered to.
3. No unprotected, unheated exterior coating shall be undertaken when cold, damp, foggy, or rainy weather appears probable, nor when the temperature of the substrate is below 55°F, unless approved in writing by coating manufacturer.
4. Maintain manufacturer's environmental requirements until coating is fully cured.
5. Apply no coating in areas where dust is being generated.
6. Testing and disposal of any waste and coating shall be the responsibility of the Contractor.

B. Protection:

1. Drop cloths shall be provided in all areas where coating is done to fully protect other surfaces.
2. Remove hardware, accessories, plates, lighting fixtures, and similar items or provide protection by masking. Upon completion, replace items or remove protection and clean.

- C. It is the intent of this Section that all ferrous metal items scheduled for coating be shop-primed. If items are not shop-primed, surfaces shall be prepared and coated in the field as specified.

- D. Upon Substantial Completion, remaining unused material will become property of Owner. Seal material as required for storage, mark contents with color, type, location, and shelf life, and store on Site where required by Owner. Provide minimum of two gallons of each system component and color used.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Tnemec.
- B. Sherwin-Williams

2.02 MATERIALS

- A. Coatings shall meet surface burning characteristics as required by code and established by ASTM E84.
- B. Coating products listed in the Coating Schedule, are set as a standard of quality. Coatings of substitute manufacturers shall meet or exceed the characteristics of the products listed as established by the following ASTM standards; B117, C307, C413, C579, C580, C868, D870, D1014, D1653, D2047, D2240, D2370, D2794, D3363, D4060, D4141, D4541, D4585, D4587, and G85.
- C. If the Contractor wishes to offer a substitute to the products specified, the request for a substitute shall conform to the requirements of Section 01 61 00.
- D. The Contractor and top coat coating manufacturer shall verify the compatibility of their products with the various primers used on shop primed materials and equipment.

2.03 COLORS

- A. Color shall be formed of pigments free of lead, lead compounds, or other materials which might be affected by presence of hydrogen sulfide or other gases likely to be present at Site.
- B. Colors shall be as selected by Owner. Prior to beginning work, Engineer will provide color-coordinating schedule. System color-coding shall be as specified in Section 40 05 05.
- C. Coat access doors of electrical distribution panels and grilles to match color of adjacent wall or ceiling surfaces.
- D. In areas scheduled for finishing, coat exposed piping, conduit, and ducts to match color of adjacent or near surfaces, except for color-coding.
- E. In areas where existing surfaces are finished, coat new exposed piping, conduit, and ducts to match color of adjacent or near surfaces, except for color-coding.
- F. Equipment Colors:
 - 1. Equipment includes pumps, blowers, valves, flow meters, etc, and associated motors, structural supports, hangers, and attached portions of electrical conduit, and other associated components.
 - 2. Color of non-submerged equipment, including equipment with a manufacturer-applied finish coat, shall be same color as piping equipment serves; see Section 40 05 05.
 - 3. Color of submerged equipment can be manufacturer's standard color.

2.04 THINNING, MIXING, AND TINTING

- A. Where thinning is necessary, only the products of the manufacturer furnishing the coating will be allowed. All such thinning shall be done in strict accordance with coating manufacturer's recommendations.
- B. Mix in accordance with manufacturer's recommendations.

- C. Each coat shall be slightly darker than preceding coat, unless otherwise noted. Tint undercoats similar to finish coat.

PART 3 – EXECUTION

3.01 EXAMINATION

- 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.
- B. Materials removed and replaced to correct defects due to Work placed on unsuitable surfaces shall be at Contractor's expense.

3.02 SURFACE PREPARATION

A. General:

1. All surfaces to be coated shall be prepared as specified herein and in accordance with coating manufacturer's recommendations. The object shall be to obtain a uniform, clean, and dry surface.
2. Quality of surface preparation described herein is considered a minimum. If coating manufacturer requires a higher degree of preparation, comply with coating manufacturer's recommendations.
3. Where surface dryness is questioned, test with dampness indicating instrument. Do not apply coatings over surfaces where moisture content exceeds that permitted by coating manufacturer.
4. Shop primed surfaces shall be scarified before applying top coats. Conform to top coat manufacturers recommendations.
5. If recoat time between application of primer and second coat or between top coats is exceeded, scarify surface before applying coatings. Conform to top coat manufacturers recommendations.
6. Workmanship for surface preparation shall conform to the following SSPC specifications:
 - a. Solvent Clean: SP-1.
 - b. Hand Tool Cleaning: SP-2.
 - c. Power Tool Cleaning: SP-3.
 - d. White Metal Blast Cleaning: SP-5.
 - e. Commercial Blast Cleaning: SP-6.
 - f. Brush-Off Blast Cleaning: SP-7.
 - g. Pickling: SP-8.
 - h. Near-White Blast Cleaning: SP-10.
 - i. Power Tool Cleaning to Bare Metal: SP-11.
 - j. Surface Preparation by Water Jetting: SP-12.

B. Ferrous Metal:

1. Ferrous metal primed in the shop shall have all rust, dust, scale, and other foreign substances removed by abrasive cleaning conforming to SSPC SP-10. Cleaned metal shall be primed or pretreated immediately after cleaning to prevent new rusting.
2. Ferrous metal not primed in the shop shall be abrasive blast cleaned in the field prior to application of primer, pretreatment, or coating. Blast cleaning shall conform to SSPC SP-10 for submerged service. Blast cleaning shall conform to SSPC SP-6 for non-submerged service.
3. Prior to finish coating, primed areas that are damaged shall be cleaned and spot primed.

C. Concrete:

1. Concrete must be at least 28 days old and shall pass the overnight visqueen test for dryness before applying coating.
2. Repair surface defects / voids as recommended by coating manufacturer.
3. Concrete surfaces, including precast concrete, to be coated shall be cleaned of all form oil, curing compound, laitance, and other foreign substances.
4. Surfaces shall be brush-off abrasive blast cleaned in order to prepare the surface for adherence of the coating system. Acid etching will be allowed only where brush blasting is impractical. Resulting surface shall have a toothed or grainy texture.
5. After cleaning, surfaces shall be washed and all dust, sand, and loose particles removed by vacuuming. If Contractor elects to blow off the surfaces with air, it shall be oil-free air and the method shall conform to OSHA requirements.

D. Galvanized Metal:

1. Where galvanized metal items are not submerged or buried, they shall be abrasive sweep blast cleaned and then solvent cleaned in accordance with SSPC SP-1.

E. Plastic and FRP:

1. Where scheduled to coated, plastic and FRP shall be lightly sanded and then solvent cleaned in accordance with SSPC SP-1.

F. Aluminum:

1. Where scheduled to coated, aluminum shall be lightly sanded and then solvent cleaned in accordance with SSPC SP-1.

G. Masonry:

1. Remove loose grit and mortar.
2. Remove grease, oil, dirt, salts, or other chemicals, or other foreign substances by solvent, detergent, or other suitable cleaning methods.

H. Wood:

1. Wood surfaces shall be thoroughly cleaned and free of all foreign substances. Cracks, nail holes, and other defects shall be properly filled and sanded.
2. Wood trim shall be sanded to a fine finish and wiped clean of dust.

I. Gypsum Board:

1. Fill scratches, nicks, and uneven areas with spackling compound and sand smooth flush with adjacent surface.

J. Plaster:

1. Cut scratches, cracks, and abrasions from surfaces as required, fill with plaster of paris, spackling compound, or other approved material, sand smooth flush with adjacent surface, and seal before applying primer.
2. Give suction spots a second coat of primer before applying finish coat.

K. Existing Surfaces:

1. Remove and replace or mask attachments if attachments are not to be coated.

2. Remove surface contamination such as oil, grease, loose or defective coatings, mill scale, dirt, rust, mold, mildew, mortar, efflorescence, and sealers to assure sound bonding to tightly adhered old coatings. Glossy surfaces of old coatings shall be cleaned and dulled before overcoating.
3. Sand surfaces and feather edges where chips have occurred.
4. Cut out and fill cracks or other defects to match adjacent surface.
5. Exact nature of existing coatings is not known. Check compatibility of new coating by application to small area prior to starting coating. If lifting or other problems occur, notify Engineer for direction.
6. Comply with new coating manufacturer's recommendations for preparation of previously coated surfaces.
7. Prepare surfaces subject to submerged service as specified for new surfaces.

3.03 APPLICATION

- A. Surfaces shall be dry at time of application.
- B. The minimum surface temperature shall be 55°F and rising.
- C. Apply in strict accordance with manufacturer's recommendations by brush, roller, spray, or other application method. The number of coats and thickness required is the same regardless of application method.
- D. Each coat shall be allowed to dry in accordance with manufacturer's requirements. Drying time shall be construed to mean "under normal conditions". Where conditions other than normal exist, because of weather or because of confined space, longer times will be necessary. Units shall not be put in service until coatings are thoroughly dry and cured.
- E. Surfaces to be coated that will be inaccessible in the completed work shall receive the final coat before enclosure.
- F. Coatings shall be applied to provide an opaque, smooth surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, or other surface imperfections will not be acceptable. Areas cut-in by brush prior to rolling shall have uniform appearance in comparison with adjoining surfaces.
- G. Make edges of coating adjoining other materials or colors sharp and clean without overlapping.
- H. Concrete block walls shall be back-rolled in conjunction with application of sprayed prime coat.
- I. Crevices and other hard-to-apply areas shall be back-rolled/back-brushed in conjunction with application of field applied prime coat or intermediate coat. This includes, but is not limited to: between pipe flanges, pipe flange/barrel joints, equipment fittings, and other narrow openings.
- J. Finish edges of doors as specified for faces. Apply first finish coat on edges before fitting. After doors fitted and hung apply second finish coat.
- K. Manufacturer-Applied Coatings:
 1. Repair abraded areas on factory-finished items in accordance with equipment manufacturer's recommendations.
 2. Blend repaired areas into original finish.

3.04 FIELD QUALITY CONTROL

- A. Examination of Work on Site by coating manufacturer's representative shall be performed when requested by Engineer.
- B. Sampling of Materials:
 - 1. Engineer reserves the right to select unopened containers of materials furnished for the Project and have the materials tested at an independent laboratory. Owner will pay for first tests.
 - 2. Retests of rejected materials and tests of replacement materials shall be paid for by Contractor.
 - 3. Remainder of contents of containers not required for testing will be returned to Contractor.
- C. Coverage:
 - 1. Before beginning Work, finish one complete room, space, surface, and item of each color scheme required, showing selected colors, finished texture, material, and workmanship. After approval, sample room, space, surface, and item shall serve as standard for similar Work.
 - 2. If coverage is not acceptable to Engineer, Engineer reserves the right to require additional application of coating at no extra cost to Owner.
- D. Work at Site, where coat of material is to be applied, shall be observed by Engineer after surface has been prepared and before application of specified prime coat and each succeeding coat, otherwise no credit for applied coat will be given and Contractor automatically assumes responsibility to recoat Work in question. Surfaces coated without such observation shall be abrasive blast cleaned, reprepared, and recoated at no addition cost to Owner. Notify Engineer when surface preparation complete, coat applied, and when ready for inspection to comply with above.

3.05 FINAL TOUCH-UP AND CLEANING

- A. Prior to Substantial completion, examine coated surfaces and retouch or refinish surfaces to leave in condition acceptable to Engineer.
- B. Remove masking, coatings, and other material from floors, glass, and other surfaces not scheduled to be coated.

3.06 COATING SCHEDULE

- A. Scheduled thickness or coverage rate is minimum as recommended by manufacturer. Manufacturer's recommendations shall be followed, but in no case shall the thickness or coverage rate be less than scheduled.
- B. Coatings shall conform to the following schedule and coating manufacturer's recommendations. Examples of surfaces to be coated may not be all inclusive.

COATINGS SCHEDULE

System No.	Generic Type	Application	Tnemec	Sherwin-Williams
1	Polyamidoamine Epoxy	Interior Concrete Block Walls, Interior Brick walls / Satin	First Coat – Series 66HS @ 105 sfpg, sprayed and backrolled Second Coat – Series 66HS @ 150 sfpg Third Coat – Series 66HS @ 165 sfpg	First Coat – Macropoxy 646 @ 90 sfpg, sprayed and backrolled Second Coat – Macropoxy 646 @ 130 sfpg Third Coat – Macropoxy 646 @ 140 sfpg
2	Acrylic Emulsion	Exterior Concrete, Exterior Concrete Block Walls / Flat	First Coat – Series 180 smooth @ 90 sfpg, sprayed and backrolled Second Coat – Series 180 smooth @ 120 sfpg	First Coat – Loxon XP @ 90 sfpg, sprayed and backrolled Second Coat – Loxon XP @ 120 sfpg
3	Polyamidoamine Epoxy	Interior Concrete Floors / Satin	First Coat – Series 66HS, thinned 10%, @ 115 sfpg, hand broadcast anti-skid aggregate while still wet Second Coat – Series 66HS @ 190 sfpg	First Coat – Macropoxy 646, thinned 10%, @ 100 sfpg, hand broadcast anti-skid aggregate while still wet Second Coat – Macropoxy 646 @ 160 sfpg
4	Polyamidoamine Epoxy	Interior Concrete Walls / Satin	First Coat – Series 66HS @ 115 sfpg Second Coat – Series 66HS @ 190 sfpg	First Coat – Macropoxy 646 @ 100 sfpg Second Coat – Macropoxy 646 @ 160 sfpg
5	Polyamidoamine Epoxy	Exposed Concrete Ceilings / Satin	First Coat – Series 66HS, thinned 10%, @ 115 sfpg Second Coat – Series 66HS @ 190 sfpg	First Coat – Macropoxy 646, thinned 10%, @ 100 sfpg Second Coat – Macropoxy 646 @ 160 sfpg
6	Epoxy Modified Mortar - Polyamidoamine Epoxy	Concrete / Submerged NP / Satin	Filler – Series 218 as needed to fill voids and bugholes First Coat – Series 66HS, thinned 10%, @ 115 sfpg Second Coat – Series 66HS @ 190 sfpg Third Coat – Series 66HS @ 190 sfpg	Filler – Dura-Plate 2300 as needed to fill voids and bugholes First Coat – DuraPlate 235, thinned 10%, @ 100 sfpg Second Coat – DuraPlate 235 @ 160 sfpg Third Coat – DuraPlate 235 @ 160 sfpg
6 ALT	Epoxy Modified Mortar - Glass Flake Reinforced Amine Epoxy	Concrete / Submerged NP		Filler – Dura-Plate 2300 as needed to fill voids and bugholes First Coat – SherGlass FF @ 10 mils DFT Second Coat – SherGlass FF @ 10 mils DFT
7	Modified Aromatic Polyurethane - Polyamidoamine Epoxy	Ferrous Metal, Cast Iron, Ductile Iron / Submerged NP / Satin	First Coat – Series 1 @ 3 mils DFT, touch-up primer prior to second coat Second Coat – Series 66HS @ 5 mils DFT Third Coat – Series 66HS @ 5 mils DFT	First Coat – Corothane I Mio-Zinc @ 3 mils DFT, touch-up primer prior to second coat Second Coat – DuraPlate 235 @ 5 mils DFT Third Coat – DuraPlate 235 @ 5 mils DFT
7 ALT	Modified Aromatic Polyurethane - Hydrophobic Aromatic Moisture-Cured Polyurethane	Ferrous Metal, Cast Iron, Ductile Iron / Submerged NP	First Coat – Series 1 @ 3 mils DFT, touch-up primer prior to second coat Second Coat – Series 446 @ 7-9 mils DFT Third Coat – Series 446 @ 7-9 mils DFT	First Coat – Corothane I Mio-Zinc @ 3 mils DFT, touch-up primer prior to second coat Second Coat – DuraPlate 235 @ 7-9 mils DFT Third Coat – DuraPlate 235 @ 7-9 mils DFT

8	Modified Aromatic Polyurethane - Polyamidoamine Epoxy	Ferrous Metal, Cast Iron, Ductile Iron / Interior Non-Submerged / Satin	First Coat – Series 1 @ 3 mils DFT, touch-up primer prior to second coat Second Coat – Series 66HS @ 5 mils DFT Third Coat – Series 66HS @ 5 mils DFT	First Coat – Corothane I Mio-Zinc @ 3 mils DFT, touch-up primer prior to second coat Second Coat – Macropoxy 646 @ 5 mils DFT Third Coat – Macropoxy 646 @ 5 mils DFT
9	Modified Aromatic Polyurethane - Polyamidoamine Epoxy – Aliphatic Acrylic Polyurethane	Ferrous Metal, Cast Iron, Ductile Iron / Exterior Non-Submerged / Gloss	First Coat – Series 1 @ 3 mils DFT, touch-up primer prior to second coat Second Coat – Series 66HS @ 5 mils DFT Third Coat – Series 1074 @ 3 mils DFT	First Coat – Corothane I Mio-Zinc @ 3 mils DFT, touch-up primer prior to second coat Second Coat – Macropoxy 646 @ 5 mils DFT Third Coat – Hi-Solids Polyurethane Gloss @ 3 mils DFT
10	Polyamide Epoxy – Polyamidoamine Epoxy	Doors, Frames, Motors and other Equipment with Non-Epoxy Primer / Interior / Satin	Lightly Hand Sand Solvent Clean SP-1 First Coat – Series 27-1255 Beige @ 3 mils DFT Second Coat – Series 66HS @ 5 mils DFT	Lightly Hand Sand Solvent Clean SP-1 First Coat – Recoatable Epoxy Primer Tan @ 3 mils DFT Second Coat – Macropoxy 646 @ 5 mils DFT
11	Polyamide Epoxy – Aliphatic Acrylic Polyurethane	Doors, Frames, Motors and other Equipment with Non-Epoxy Primer / Exterior / Gloss	Lightly Hand Sand Solvent Clean SP-1 First Coat – Series 27-1255 Beige @ 3 mils DFT Second Coat – Series 1074 @ 3 mils DFT	Lightly Hand Sand Solvent Clean SP-1 First Coat – Recoatable Epoxy Primer Tan @ 3 mils DFT Second Coat – Hi-Solids Polyurethane Gloss @ 3 mils DFT
12	Polyamidoamine Epoxy	Galvanized Metal, Copper, PVC / Non-Submerged / Interior / Satin	First Coat – Series 66HS-1255 Beige @ 2 mils DFT, touch-up primer prior to second coat Second Coat – Series 66HS @ 3 mils DFT Third Coat – Series 66HS @ 3 mils DFT	First Coat – Macropoxy 646 – SW4004 @ 2 mils DFT, touch-up primer prior to second coat Second Coat – Macropoxy 646 @ 3 mils DFT Third Coat – Macropoxy 646 @ 3 mils DFT
13	Polyamidoamine Epoxy – Aliphatic Acrylic Polyurethane	Galvanized Metal, Copper, PVC / Non-Submerged / Exterior / Gloss	First Coat – Series 66HS-1255 Beige @ 2 mils DFT, touch-up primer prior to second coat Second Coat – Series 66HS @ 3 mils DFT Third Coat – Series 1074 @ 3 mils DFT	First Coat – Macropoxy 646 SW4004 @ 2 mils DFT, touch-up primer prior to second coat Second Coat – Macropoxy 646 @ 3 mils DFT Third Coat – Hi-Solids Polyurethane Gloss @ 3 mils DFT
14	Acrylic Emulsion	Insulation on Piping and Ductwork / Matte	First Coat – Series 1026 @ 200 sfpg Second Coat – Series 1026 @ 200 sfpg	First Coat – DTM Primer/Finish @ 200 sfpg Second Coat – DTM Primer/Finish @ 200 sfpg
15	Vinyl Acrylic – Polyamidoamine Epoxy	Plaster, Gypsum Board / Satin	First Coat – Series 51 @ 400 sfpg Second Coat – Series 66HS @ 400 sfpg Third Coat – Series 66HS @ 400 sfpg	First Coat – ProMar 200 Zero VOC Primer @ 225 sfpg Second Coat – Macropoxy 646 @ 350 sfpg Third Coat – Macropoxy 646 @ 350 sfpg
16	Alkyd	Wood / Exposed / Semi-Gloss	First Coat – Series 10-99W @ 250 sfpg Second Coat – Series 1029 @ 300 sfpg Third Coat – Series 1029 @ 300 sfpg	First Coat – Industrial Enamel HS (self-priming) @ 250 sfpg Second Coat – Metalastic DTM @ 300 sfpg Third Coat – Metalastic DTM @ 300 sfpg

17	Alkyd	Wood / Exposed / Gloss	First Coat – Series 10-99W @ 250 sfpg Second Coat – Series 1028 @ 300 sfpg Third Coat – Series 1028 @ 300 sfpg	First Coat – Industrial Enamel HS (self-priming) @ 250 sfpg Second Coat – Industrial Enamel HS @ 300 sfpg Third Coat – Industrial Enamel HS @ 300 sfpg
19	Silicone Aluminum	Ferrous Metal, Cast Iron, Ductile Iron / Interior & Exterior / High Temperature to 1000°, spikes to 1200°F	SP-10 First Coat – Series 39-1261 @ 1.5 mils DFT Second Coat – Series 39-1261 @ 1.5 mils DFT	SP-10 First Coat – Heat-Flex Hi-Temp 1000 Aluminum @ 1.5 mils DFT Second Coat – Heat-Flex Hi-Temp 1000 Aluminum @ 1.5 mils DFT
20	Polyamide Epoxy Coal Tar	Dissimilar Metal Protection / Semi-Gloss	Scarify the Surface, SP-1 First Coat – Series 46H-413 @ 20 mils DFT	Scarify the Surface, SP-1 First Coat – HiMil Sher-Tar @ 20 mils DFT
21	Polyamine Epoxy – Polyamine Novolac Epoxy	Chemical Containment / Concrete / Interior / Gloss	Filler – Series 218 as needed to fill voids and bugholes First Coat – Series 201 @ 200 sfpg Second Coat – Series 282 @ 200 sfpg, hand broadcast anti-skid aggregate onto floor while still wet Third Coat – Series 282 @ 200 sfpg	Filler – Dura-Plate 2300 as needed to fill voids and bugholes First Coat – Corobond 100 @ 200 sfpg Second Coat – Cor-Cote EN 7000 @ 200 sfpg, hand broadcast anti-skid aggregate onto floor while still wet Third Coat – Cor-Cote EN 7000 @ 200 sfpg
22	Zinc-Rich Aromatic Urethane – Polyamidoamine Epoxy	Ferrous Metal / Interior Non-Submerged / Submerged NP / Satin (Do Not Use on Ductile Iron)	First Coat – Series 90-97 @ 3 mils DFT Second Coat – Series 66HS @ 5 mils DFT Third Coat – Series 66HS @ 5 mils DFT	First Coat – Corothane I Mio-Zinc @ 3 mils DFT Second Coat – DuraPlate 235 @ 5 mils DFT Third Coat – DuraPlate 235 @ 5 mils DFT
23	Zinc-Rich Aromatic Urethane – Polyamidoamine Epoxy – Aliphatic Acrylic Polyurethane	Ferrous Metal / Exterior Non-Submerged / Gloss (Do Not Use on Ductile Iron)	First Coat – Series 90-97 @ 3 mils DFT Second Coat – Series 66HS @ 5 mils DFT Third Coat – Series 1074 @ 3 mils DFT	First Coat – Corothane I Galvapac @ 3 mils DFT Second Coat – Macropoxy 646 @ 5 mils DFT Third Coat – Hi-Solids Polyurethane Gloss @ 3 mils DFT
24	Polyamidoamine Epoxy – Modified Polyurethane	Chemical Containment / Concrete / Interior / Gloss	First Coat – Series 66HS-1255 Beige @ 210 sfpg Filler – Series 265 as needed Liner – Series 262 @ 60 mils DFT	First Coat – DuraPlate 235 @ 180 sfpg Filler – Steel-Seam FT-910 as needed Liner – SherFlex Elastomeric Polyurethane @ 60 mils DFT
25	Vinyl Ester	Ferrous Metal, Cast Iron, Ductile Iron / Interior Non-Submerged / Submerged NP / Satin	SSPC SP-5 with min 3 mil profile First Coat – Series 120-5002 @ 12-18 mils DFT Second Coat – Series 120-5001 @ 12-18 mils DFT	SSPC SP-5 with min 3 mil profile First Coat – Corobond Vinyl Ester Primer @ 3.5 – 4.5 mils DFT Second Coat – Cor-Cote VEN GF @ 12-18 mils DFT

28	Aggregate-Filled Modified Polyamine Epoxy	Interior Concrete Floors / Gloss	First Coat – Series 237, @ 80 sfpg, squeegee and backrolled, hand broadcast to rejection anti-skid 30 mesh flint shot aggregate while still wet, sweep off excess after dry Second Coat – Series 280 @ 100 sfpg	First Coat – Corobond 100, @ 270 sfpg, squeegee and backrolled, hand broadcast to rejection anti-skid 30 mesh flint shot aggregate while still wet, sweep off excess after dry Second Coat – Cor-Cote HP @ 100 sfpg
29	Epoxy Modified Mortar – Modified Polyamine Epoxy	Concrete / Submerged NP	Filler – Series 218 as needed to fill voids and bugholes First Coat – Series 435 @ 30 mils DFT	Filler – Dura-Plate 2300 as needed to fill voids and bugholes First Coat – Dura-Plate 5900 @ 30 mils DFT
30	Epoxy Modified Mortar – Moisture Cured Polyurethane	Concrete / Submerged NP	Filler – Series 218 as needed to fill voids and bugholes First Coat – Series 446 @ 10 mils DFT Second Coat – Series 446 @ 10 mils DFT	Filler – Dura-Plate 2300 as needed to fill voids and bugholes First Coat – SherGlass FF @ 10 mils DFT Second Coat – SherGlass FF @ 10 mils DFT

Foot Notes:

1. Where an Alternative System No. (ALT) is noted the Contractor may substitute the ALT system when approved by the Engineer. If the ALT system is used, it shall be used for all work covered by that system.
2. Series 66HS may be substituted for Series 1.

END OF SECTION

SECTION 09 96 50
HIGH-PERFORMANCE EPOXY COATINGS

PART 1 – GENERAL

1.01 SUMMARY

- A. Spray applied, solvent free, 100% solids, chemical and abrasive resistant, two component, high build, epoxy coating system.
- B. Coat concrete surfaces as noted on Drawings and specified herein.

1.02 REFERENCES

- A. SSPC: Society for Protective Coatings

1.03 SUBMITTALS

A. Product Data:

- 1. Manufacturer's literature including application recommendations and generic makeup of coating system.

B. Samples:

- 1. Actual color samples available for coating system.

C. Miscellaneous:

- 1. Manufacturer's Safety Data Sheets (SDS), for coating, to Engineer's field office for information. Contractor shall post copy of SDS on Site at all times coating is in progress.
- 2. System Warranty.

D. Submit in accordance with Section 01 33 00.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications:

- 1. Manufacturer shall have a minimum three years experience providing epoxy based coatings
- 2. Manufacturer shall be a primary blender of epoxy product with proprietary formulations and capacity to provide field technical services as required.

B. Applicator Qualifications:

- 1. Application subcontractor shall be approved by the manufacturer.
- 2. Lead person on site shall be approved by the manufacturer.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver product in manufacturer's original containers.
- B. Store product in warm dry condition.

C. Replace product damaged by shipment, weather, or job conditions.

1.05 PROJECT/SITE CONDITIONS

A. Schedule pre-installation conference to review installation schedule, shut down and restricted access procedures. Include Owner's Representative and Contractor's Superintendent.

B. Environmental Requirements:

1. Dry-heat, de-humidify, and ventilate areas to obtain conditions recommended by coating manufacturer.
2. Relative humidity conditions as specified by coating manufacturer shall be adhered to.
3. No unprotected, unheated exterior coating shall be undertaken when cold, damp, foggy, or rainy weather appears probable.
4. Maintain manufacturer's environmental requirements until coating is fully cured.

C. Inspect surface preparation, application procedures, and review proposed dry film thickness at each installation location.

D. Ambient installation temperature must be above 50°F.

E. Assure ventilation of enclosed spaces and illumination is adequate for installation.

F. Assure no personal property is within spray fly pattern during installation of spray components.

G. Coating shall be tack free within 4 hours of application, and shall be cured and ready to be put into service in not more than 24 hours after application.

1.06 WARRANTY

A. Manufacturer shall warranty in writing the coating system against defects in material and workmanship for a period of 5 years.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Sherwin Williams, Dura-Plate 6100

B. Raven Lining Systems, Raven 405

C. No Substitutes

2.02 EQUIPMENT

A. Provide spray equipment suitable for use with products specified.

2.03 ACCESSORIES

A. Use primer specified by the manufacturer for the individual application.

B. Provide cant strips as required.

C. Provide closed cell backer rod in expansion joints as required.

- D. Provide Joint Taping Coat as required.
- E. Provide Concrete and Masonry Base Coat as required.
- F. Provide joint sealant and filler as required.
- G. Provide spall repair material as required.

2.04 MIXES

- A. Mix product in accordance with manufacturer's written instructions.
- B. Color shall be as selected by Owner.

PART 3 – EXECUTION

3.01 EXAMINATION

- 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. Materials removed and replaced to correct defects due to Work placed on unsuitable surfaces shall be at Contractor's expense.

3.02 SURFACE PREPARATION

- A. Provide clean sound substrate.
- B. Prepare metal surfaces to SSPC SP-10 near-white blast cleaning, chemical clean as required.
- C. Sandblast and clean all concrete surfaces prior to coating in accordance with SSPC-SP-13/NACE-6. Surface profile to be in accordance with ICRI-CSP 5 or Greater. Remove deteriorated concrete and patch with cementitious resurfacing mortar. Prepare surfaces as required by manufacturer.
- D. Prepare concrete surfaces as required by manufacturer. Conform to the requirements of Section 09 96 00.
- E. Install joint taping coat over construction and contraction joints.
- F. Random cracks wider than 1/16 inch:
 - 1. V-groove to depth of 3/8 inch and top width of 3/8 inch.
 - 2. Install sealant and joint taping coat.
- G. Expansion joints:
 - 1. Cut shoulders plumb.
 - 2. Install backer rod after priming joint.
 - 3. Install sealant and joint taping coat where required.
- H. Spalls:
 - 1. Cut shoulders plumb.
 - 2. Fill with suitable aggregate and install spall repair material to level of adjacent concrete.

- I. Install cant strips where required.
- J. Remove ponded water and ice.
- K. Mask protected surfaces prior to spray applications.

3.03 APPLICATION

- A. Spray or roll primer, if required, over surfaces to receive coating system.
- B. Concrete and masonry surfaces must be dry and cured.
- C. Metal surfaces must be dry and rust-free.
- D. Screen or reapply primer if recoat window has been exceeded.
- E. Spray joint taping coat, if required.
- F. Spray base coat over primed and taping coated surfaces at authorized rate.
- G. Retouch coat by filling low spots or areas with inadequate thickness.
- H. Spray additional base coats to achieve 120 mils DFT. Retouch as required.

3.04 FIELD QUALITY CONTROL

- A. Components of coating may be color-coded. Assure that each subsequent coat completely hides prior coating.
- B. Perform dry film thickness tests as required.
- C. Maintain spray and other installation equipment in proper operating condition throughout installation.
- D. Provide reserve equipment as required.

3.05 CLEANING

- A. Clean spills and oversprays as they occur.
- B. Consult manufacturer's literature and SDS sheets for proper cleaning products and methods.

3.06 PROTECTION

- A. Protect installed work until accepted by Owner.

END OF SECTION

DIVISION 10
SPECIALTIES

SECTION 10 11 10
PLAQUE AND BUILDING IDENTIFICATION LETTERING

PART 1 – GENERAL

1.01 SUMMARY

- A. Furnish and install one cast bronze plaque and one existing plaque furnished by Owner at Vestibule A Room 101 as shown on Drawing 900-AS-8 wall of the Administration Building, at the location shown on the Drawings and as specified herein.

1.02 SUBMITTALS

- A. Submit shop drawings and product data for each item as per Section 01 33 00. Provide not less than 5 color charts showing background colors.

PART 2 – PRODUCTS

2.01 PLAQUE

A. Manufacturers and models

- 1. Seton Identification Products' Style No. M8680 (www.seton.com)
- 2. Architectural Bronze Aluminum Corp. custom equivalent (www.architecturalbronze.com)
- 3. Or equal.

B. Materials

- 1. Plaque shall be constructed of cast bronze, AA356, with satin face and semi-gloss polyurethane finish.
- 2. Mounting shall be via stainless steel machine screws and expansion anchors or toggle bolts with 3/4" diameter rosette covers. Plaque manufacturer shall size the diameter and length of anchors.

C. Lettering, background, color, and border style

- 1. Lettering shall be as shown on Figure 10111-1 provided at the end of this Section. Lettering shall be Times New Roman style, proportionately sized to fit within the confines shown in the figure.
- 2. Background be of leatherette texture.
- 3. Background color shall be one of the following standard colors: dark green, light oxide, metallic gray or dark oxide. Background color will be selected by OWNER during shop drawing review process.
- 4. Border shall be the manufacturer's standard single-line, beveled edge border.

PART 3 – EXECUTION

3.01 GENERAL

- A. Mount plaque in the location as selected by OWNER.
- B. Provide smooth mounting face behind plaque.

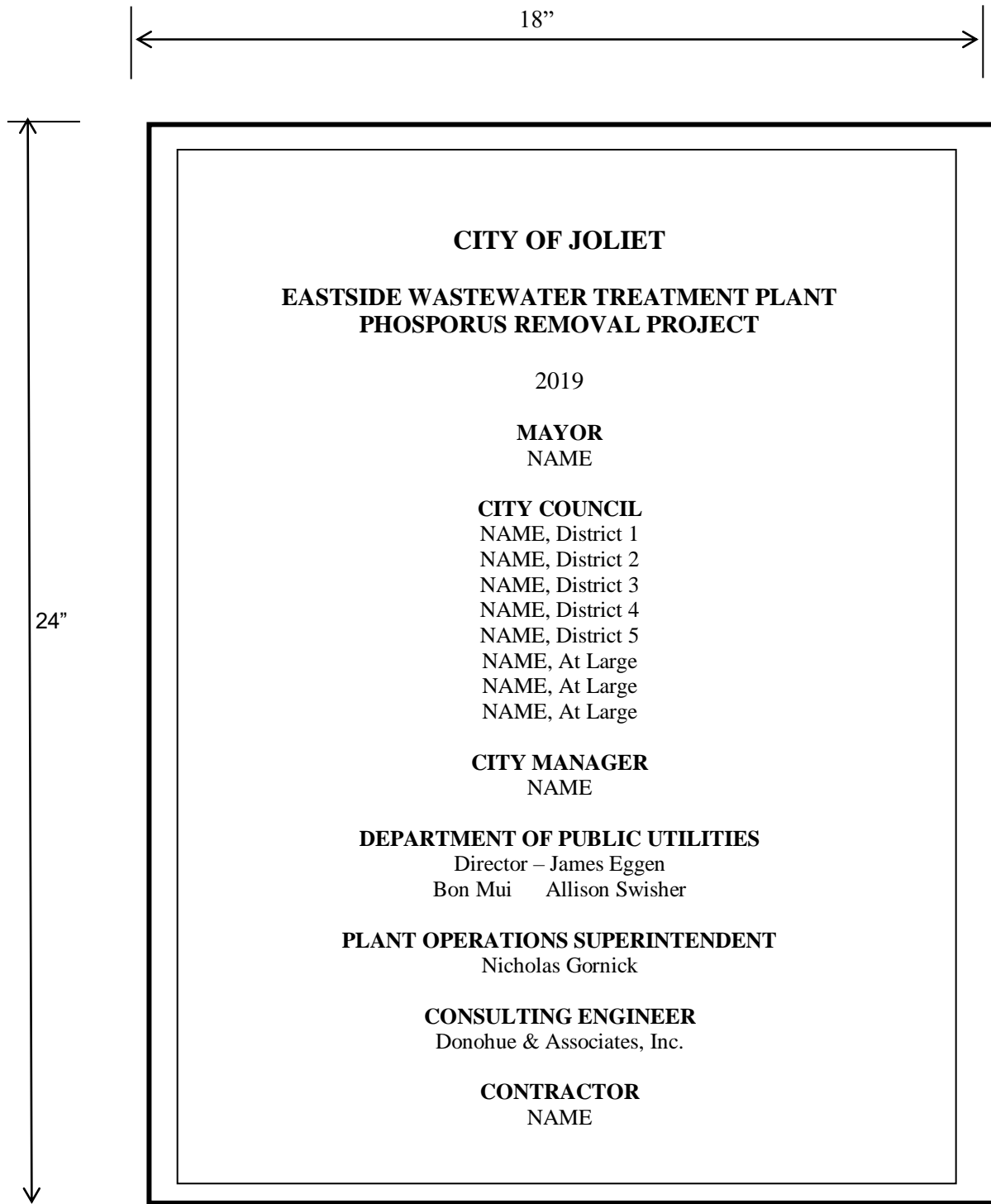


FIGURE 10 11 10- 1
Cast Bronze Plaque

END OF SECTION

SECTION 10 14 00
SIGNAGE

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Engraved plastic laminate door signs.
- B. Refer to Division 26 sections for identification requirements of electrical and instrumentation work, not work of this section.
- C. Refer to Division 40 for identification requirements of piping and equipment, not work of this section.

1.02 DEFINITIONS

- A. ANSI: American National Standards Institute
- B. FS: Federal Specification.

1.03 SUBMITTALS

A. Product Data:

1. For each type of sign specified, include details of construction, materials description, dimensions of individual components and profiles, and finishes.

B. Shop Drawings:

1. Include plans, elevations, and large-scale sections of typical members and other components. Show mounting methods, grounds, mounting heights, layout, spacing, reinforcement, accessories, and installation details.
2. Provide message list for each sign, including large-scale details of wording, lettering and braille layout.
3. Samples: Provide color selector from manufacturer's complete line of available colors for each type of sign that involves color selections.
4. Submit in accordance with Section 01 33 00.

1.04 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 yrs.
- B. Regulatory Requirements:
 1. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Allen Systems, Inc.
- B. Brady (W.H.) Company, Signmark Division.
- C. Marking Services, Inc.
- D. Industrial Safety Supply Company, Inc.
- E. Seton Name Plate Corporation.

2.02 LETTERING AND GRAPHICS

- A. The wording on the signs for mechanical, utility rooms and electrical rooms shall match the room name shown on the drawings.
 - 1. Locations:
 - a. Bldg. 120: Door No. D08 and D15.
 - b. Bldg. 900: Door No. D10, D13, D21, D24, D26 and D29.
- B. Signs for Offices shall be as indicated on drawings.
 - 1. Signs for offices shall be provided with graphics for Joliet logo, department name, slot for interchangeable personnel names as indicated on drawings.
 - 2. Locations:
 - a. Bldg. 120: Door No. D05, D12, and D16.
 - b. Bldg. 900: Door No. D19, D20, D25, D30, D31, and D32.
- C. Coordinate names, abbreviations, and other designations with OWNER.

2.03 ENGRAVED PLASTIC LAMINATE SIGNS

- A. Engraving stock melamine plastic laminate complying with FS L-P-387A(1) in sizes required, engraved with engraver's standard letter style of sizes and wording indicated, contrasting letters with core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting necessary because of substrate.
- B. Thickness: 1/8-inch.
- C. Fasteners: Self-tapping stainless steel screws except contact type permanent adhesive where screws cannot or should not penetrate substrate.
- D. 1 inch high letters.
- E. Copy: Tactile and Braille.

2.04 TOILET ROOM SIGNS

- A. Material: Plastic laminate.
- B. Perimeter: Unframed.
- C. Copy: Tactile and Braille.

- D. Character Style: Helvetica.
- E. Text: According to requirements in ADA.
- F. Message: Fixed.
- G. Size:
 - 1. Sign: 3 inch.
 - 2. Character: Minimum 1 in. high characters.
- H. Color: As selected by Owner.
- I. Location:
 - 1. Bldg. 900: Provide at Men's Toilet and Locker Room, Women's Toilet and Locker Room, and Family Toilet
 - 2. Bldg. 120: Provide at Men's Toilet and Women's Toilet.

PART 3 – EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Where identification is to be applied to surfaces requiring painting or other finish, install identification after completion of finishing and painting.

3.02 DOOR SIGNS

- A. Install engraved plastic laminate sign as shown on drawings.
- B. Install in accordance with manufacturer's instructions.
- C. Install plumb and level, securely anchored to wall as shown on drawings.
- D. Mounting height and location: As required by accessibility regulations. Coordinate with Owner.

3.03 ADJUSTING AND CLEANING

- A. Cleaning: Clean face of identification devices and doors.

END OF SECTION

SECTION 10 21 13
TOILET COMPARTMENTS

PART 1 – GENERAL

1.01 SUMMARY

- A. Section Includes solid plastic water closet compartments and urinal screens

1.02 REFERENCES

- A. ANSI: American National Standards Institute
- B. ASTM: American Society for Testing and Materials

1.03 SUBMITTALS

- A. Shop Drawings.
- B. Coordination Drawings: Before distribution to installer, submit coordination drawings specified under “coordination”: for information.
- C. Samples for initial Selection: Submit manufacturer’s standard color samples for each distinct type of panel system required. Color to be selected by Owner.
- D. Manufacturer’s instructions.
- E. Maintenance data.

1.04 QUALITY ASSURANCE

- A. Regulatory Requirements: Products and finished installations to be used by handicapped persons must comply with requirements of ANSI A117.1.

1.05 COORDINATION

- A. Use manufacturer’s instructions and data to determine anchorage requirements for panel systems. In a timely manner, distribute to affected installers of related work those system components and anchorage devices provided by panel manufacturer for incorporation in to other work.
- B. Coordination Drawings: Prepare coordination drawings for panel system assemblies. Include information necessary to properly coordinate work of this section with other work. Distribute to affected installers related work.

PART 2 – PRODUCTS

2.01 PANEL SYSTEMS

- A. Compartments: Provide compartments fabricated of partitions and erected using the following panel systems at locations indicated on the drawings.
 - 1. High Density Polyethylene (HDPE) material, homogenous color throughout each component with ¼ in. machined edges for uniformity, self-lubricating surface shall resist markings from writing instruments, floor anchored and overhead braced.

- B. Screen Systems: Provide screens using the following panel systems at locations indicated on the drawings: HDPE material, homogenous color throughout each component with ¼ in. machined edges for uniformity, self-lubricating surface shall resist markings writing instruments

2.02 PANEL MATERIALS

- A. HDPE Polymer water resistant and non-absorbant, with heat sink attached to bottom of all doors and panels – Baked Enamel Finish:
 - 1. Material: Manufacturer's high density polyethylene material.
 - 2. Panel Fabrication: 1-inch thick HDPE polymer. Homogeneous color throughout. Use single steel sheet for each face plate and laminate both face plates under pressure to core material. At full length of panel perimeter, form edges of each face plate to interlock directly with opposing face plate, or form edges to receive additional molding strip. If molding strip is used, provide one continuous molding strip for each panel edge. Provide manufacturer's standard neatly-made and finished corners.
 - a. Minimum finished thickness:
 - 1) Panels: 1 inch, unless otherwise indicated.
 - 2) Pilasters: 1-1/4 inch
 - 3) Doors: 1 inch.
 - b. Internal anchorage reinforcement: Galvanized steel sheet, minimum 12 gauge.
 - c. Internal tapping reinforcement: Galvanized steel sheet minimum 14 gauge.
 - d. Finish: Provide ¼ in. machined edges for uniformity, self-lubricating surface resistant from markings from writing instruments.
 - 3. Panel colors: Selected by Owner, after contract award, from manufacturer's complete set of standard colors.
 - 4. Hardware, accessories, and mounting brackets: Manufacturer's standard styles. The following material will be acceptable: Chromium-plated nonferrous cast alloy ("Zamac").
 - 5. Manufacturers: Products of the following manufacturers, provided they comply with requirements of the contract documents, will be among those considered acceptable:
 - a. Accurate Partitions Corporation
 - b. Penco

2.03 ACCESSORIES

- A. General: Provide hardware and accessories as necessary to properly install panel systems indicated.
 - 1. Hinge: Self closing, pivot type hinge, recess-mounted within door; adjustable to permit door to rest at any angle.
 - 2. Latch for nonhandicapped compartments: Surface-mounted type, with emergency access feature. Provide stop and keeper with rubber bumper.
 - 3. Latch for handicapped compartments: Surface mounted sliding latch (for inner side of compartment doors), with emergency access feature, designed for use by handicapped persons.
 - 4. Door pull for handicapped compartments (for outer side of compartment doors): Suitable for use by a handicapped person.

5. Combination coat hook with rubber bumper: Provide unit of sufficient length to prevent compartment door from striking installed toilet accessories.
6. Leveling and anchorage devices: Rust resistant steel devices as recommended by panel manufacturer for installation of panels in conditions indicated.
7. Pilaster Shoes: ASTM A167 (type 302/304) minimum 20 gauge stainless steel, finish to match compartment hardware. Minimum shoe height: 3 inches.
8. Fasteners: Tamper resistant, rust proof, exposed fasteners as recommended by panel manufacturer for installation of panels and hardware in conditions indicated. Finish to match hardware.
9. Overhead bracing: Antigrip headrail bracing fabricated from continuous extruded aluminum, clear anodized finish.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Perform installation in accordance with manufacturer's instructions, except where more restrictive requirements are shown, specified, or are necessary for project conditions.

END OF SECTION

SECTION 10 28 13
TOILET AND MISCELLANEOUS ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Waste receptacles.
2. Toilet tissue dispensers.
3. Grab bars.
4. Soap dispensers.
5. Shower curtain rods.
6. Shower curtain and hooks.
7. Shower seats.
8. Soap dishes.
9. Towel pins.
10. Mop holder.
11. Mirror.
12. Electric hand dryer.
13. Diaper Changing Station.

1.02 SUBMITTALS

- A. Product Data: Manufacturer's technical data and installation instructions for each toilet accessory.
- B. Submit in accordance with Section 01 33 00.

1.03 QUALITY ASSURANCE

- A. Accessory Locations: Coordinate accessory locations with other work to avoid interference and ensure proper operation and servicing of accessory units.
- B. Products: Provide products of same manufacturer for each type of accessory unit and for units exposed in same areas, unless otherwise approved by ARCHITECT.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Bobrick Washroom Equipment, Inc.
- B. Bradley Corporation.
- C. Or equal.

2.02 MATERIALS

- A. Stainless Steel: AISI Type 302/304, with polished No. 4 finish, 22 ga minimum, unless otherwise indicated.
- B. Brass: Leaded and unleaded, flat products, FS QQ-B-613D; Rods, shapes, forgings, and flat products with finished edges, FS QQ-B-626D.

- C. Sheet Steel: Cold-rolled, commercial quality ASTM A366, 20 ga minimum, unless otherwise indicated. Surface preparation and metal pretreatment 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 SC 2.
- F. Mirror Glass: FS DD-G-451, Type I, Class 1, Quality q2, 1/4 in. thick, with silver coating, copper protective coating, and nonmetallic paint coating complying with FS DD-M-411.
- G. Galvanized Steel Mounting Devices: ASTM A123, hot-dip galvanized after fabrication.
- H. Fasteners: Screws, bolts, and other devices of same material as accessory unit or galvanized steel where concealed.
- I. Inserts and Anchorages: Furnish insert and anchoring devices which must be set in concrete or built into masonry; coordinate delivery with other work to avoid delay.
- J. Baked Enamel Finish: Factory-applied gloss white, baked acrylic enamel coating.

2.03 FABRICATION

A. General

- 1. Stamped names or labels on exposed faces of toilet accessory units are not permitted, except where otherwise indicated. Unobtrusive labels on surfaces not exposed to view are acceptable.
 - 2. Where locks are required for particular type of toilet accessory, provide same keying throughout Project. Furnish two keys for each lock.
 - 3. Provide factory-applied, gloss white, baked acrylic enamel coating.
- B. Surface-Mounted Toilet Accessories: Except where otherwise indicated, fabricate units with tight seams and joints, exposed edges rolled. Hang doors or access panels with continuous stainless steel piano hinge. Provide concealed anchorage wherever possible.
 - C. Recessed Toilet Accessories: Except where otherwise indicated, fabricate units of welded construction without mitered corners. Hang doors or access panels with full-length stainless steel piano hinge. Provide fully concealed anchorage when unit closed.

2.04 WASTE RECEPTACLES

A. Open-Top Free-Standing Waste Receptacle (WR):

- 1. Bobrick B-2280. Free-standing stainless steel waste receptacle and heavy-duty reusable vinyl liner.
- 2. Minimum 21 gal capacity.

2.05 TOILET TISSUE DISPENSERS (TTD)

A. Roll-In Reserve Dispenser:

- 1. Fabricate of stainless steel for mounting indicated below, sized to store and dispense either 4-1/2 in. dia or 5-in. dia core tissue rolls, with reserve roll placed in service by automatic release or manual release bar.

2. Hinge front of unit with pivot hinge and secure with tumbler lockset.
3. Mounting: Bobrick B-2888. Surface-mounted, concealed anchorage.

2.06 GRAB BARS (GB)

- A. Provide stainless steel grab bars with wall thickness not less than 18 ga.
- B. Mounting: Concealed, manufacturer's standard flanges and anchorages.
- C. Clearance: 1-1/2 in. clearance between wall surface and inside face of bar.
- D. Gripping Surfaces: Manufacturer's standard nonslip texture.
- E. Size: Heavy-duty, outside dia of 1-1/2 in.
- F. Straight bar in length shown and one-piece shower bars.

2.07 SOAP DISPENSERS (SD-1)

- A. Liquid Soap Dispenser, Bobrick B-4112:
 1. Fabricate for surface mounting, sized for 40 fluid oz minimum capacity.
 2. Provide corrosion resistant valve and corrosion resistant springs, and internal parts.
 3. Design to dispense soap in measured quantity by pump action.
 4. Provide cover in polished stainless with unbreakable refill window.
 5. Equip unit with push type valve for dispensing vegetable oil soap in liquid form.
 6. Concealed wall fastening.
 7. Locked, hinged filler top.

2.08 SHOWER AND BATH ACCESORIES

- A. Shower Curtain Rod, Heavy-Duty: 1-1/4 in. od, 18 ga stainless steel, satin finish; furnish 3 in. od minimum 20 ga stainless steel flanges with satin finish designed for exposed fasteners.
- B. Anti-Bacterial Shower Curtain: 42 in. wide by 72 in. high, 10 oz nylon-reinforced anti-bacterial vinyl fabric with hemmed edges. Fabric to be flameproof, stain resistant and self-deodorizing with stainless steel grommets on 6-in. centers through top hem. Furnish in surgical green color unless otherwise indicated.
- C. Shower Curtain Hooks: Stainless steel spring wire curtain hooks with snap fasteners, sized to accommodate curtain rod size specified above.
- D. Soap Dish (SD): Bobrick B-6807. One piece construction of stainless steel for surface wall mount. Concealed mounting plate.
- E. Robe Hook: Bobrick B-6777. Satin finished stainless steel pin projecting minimum of 3 in. from wall surface; rectangular escutcheon with backplate for concealed mounting.
- F. Folding Shower Seat (FSS):
 1. Heavy-duty hinged seat designed to fold up against wall when not in use. Provide support braces, hinges, frame and fasteners of Type 304 stainless steel. Construct frame of welded tubular construction for maximum strength.
 2. Provide seat with configuration and seating surface material as follows:

- a. Configuration: Bobrick B-5181 or B-5171. "L"-shaped seat, designed for easy wheelchair access. Left Hand or Right Hand.
- b. Seat material Phenolic or polymeric composite of either slat type or one-piece construction. Color as selected from manufacturer's standard selections.

2.09 MOP HOLDER

- A. Bobrick B-224. Combination unit with 18 ga stainless steel satin finish shelf with 1/2 in. returns, 16 ga support brackets for wall mounting.
- B. Provide 16 ga stainless steel hooks for wiping rags on front of shelf, together with rubber cam type mop holders; 1/4 in. dia stainless steel drying rod suspended beneath shelf.
- C. Provide 36 in. long by 8 in. wide unit with 4 mop holders and 3 hooks.

2.10 MIRROR (M)

- A. Steel Framed Mirror:
 1. 1/4 in. float/plate glass mirror, electrolytically copper plated.
 2. 3/4 in. by 3/4 in. stainless steel satin finish angle frame with corners welded, ground, and polished smooth.
 3. Overall size, 18 in. wide by 30 in. high or as noted in Schedule.
 4. Wall Mounted: Bobrick B-290. Concealed wall hanger and theft-resistant locking screws.

2.11 ELECTRIC HAND DRYER (EHD)

- A. Dyson Air Blade or equal.

2.12 DIAPER CHANGING STATION (DCS)

- A. KB200-11, KOALA Horizontal Earth Baby Changing Station or equal.
- B. Earth-colored, surface mounted.

2.12 SANITARY NAPKIN DISPOSAL

- A. Bobrick B-254. Type 18-8, Type 304, Welded, Satin finished stainless steel for surface wall mount. Concealed mounting plate.
- B. Door secured to cabinet with full-length stainless steel, piano hinge and equipped with keyed tumbler lock.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install toilet accessory units in accordance with manufacturer's instructions and setting drawings, using fasteners appropriate to substrate and recommended by unit manufacturer.
- B. Install units plumb and level, firmly anchored in locations and at heights indicated.
- C. Mounting Dimensions:
 1. Paper Towel Dispenser: 48 in. max. height from floor to dispenser opening.
 2. Sanitary Napkin Disposal Unit: 48 in. max. height from floor to top of unit.

3. Toilet Tissue Dispenser: Forward edge max. 36 in. from back wall, centerline height not less than 19 in.
4. Grab Bar, Toilet: Back bar 6 in. from side wall, 33 in. to 36 in. above floor. Side bar 12 in. from backwall, 33 in. to 36 in. above floor.
5. Grab Bar, Shower: 33 in. to 36 in. above floor.
6. Liquid Soap Dispenser: 44 in. max. height from floor to pushbutton.
7. Shower Curtain Rod: 76 in. Above floor or curb to centerline of rod.
8. Folding Shower Seat: Mount on wall opposite controls and 17 in. to 19 in. above finished floor.
9. Soap Dish: 38 in. to 48 in. above floor.
10. Towel Pin: 38 in. to 48 in. above floor.
11. Shelf: 38 in. to 48 in. above floor.
12. Mop and Broom Holder and Utility Shelf: 60 in. max height above floor.
13. Mirror, Laboratory: 40 in. max. height from floor to bottom edge of mirror.
14. Mirror, Dressing: Mount vertically with top 72 in. above floor.
15. Electric Hand Dryer: Mount 48 in. max. height from floor to top of unit.
16. Diaper Changing Station: 27 in. to 34 in. above floor.

3.02 ADJUSTING

- A. Adjust toilet accessories for proper operation and verify mechanisms function smoothly. Replace damaged or defective items.

3.03 CLEANING

- A. Clean and polish exposed surfaces after removing labels and protective coatings.

3.02 SCHEDULE OF TOILET ACCESSORIES

- A. Building 900 Administration Building:

1. Break Room – Room 108:

- a. 1 – Liquid Soap Dispenser.
- b. 2 – Waste Receptacles.

2. Janitor Room 112:

- a. 1 – Mop Holder.
- b. 1 – Liquid Soap Dispenser.

3. Women's Toilet Room 111:

- a. 2 - Liquid Soap Dispenser.
- b. 3 – Toilet Tissue Dispenser.
- c. 1 – 36 in. Grab Bar (GB-2).
- d. 1 – 42 in. Grab Bar (GB-1).
- e. 1 – 18 in. Grab Bar (GB-3).
- f. 1 – Waste Receptacle.
- g. 1 – Electric Hand Dryer.
- h. 1 – 5 ft-0 in. Long x 3 ft-0 in. High Mirror.
- i. 1 – Sanitary Napkin Dispenser

4. Women's Shower Room 111:

- a. 6 – Robe Hook.
- b. 1 – Soap Dish.
- c. 1 – Shower Grab Bar.
- d. 1 – Shower Curtain, Rod and Hooks.
- e. 1 – Shower Seat.

5. Men's Toilet Room 113:

- a. 2 – Liquid Soap Dispenser.
- b. 2 – Toilet Tissue Dispenser.
- c. 1 – 36 in. Grab Bar (GB-2).
- d. 1 – 42 in. (GB-1).
- e. 1 – 18 in. Grab Bar (GB-3).
- f. 1 – Waste Receptacle.
- g. 2 – Electric Hand Dryer.
- h. 3 – 1 ft-6 in. Long x 3 ft-0 in. High Mirror.

6. Men's Shower Room 113:

- a. 6 – Robe Hook.
- b. 1 – Soap Dish.
- c. 1 – Shower Grab Bar.
- d. 1 – Curtain, Rod and Hooks.
- e. 1 – Shower Seat.

7. Family Toilet Room 122:

- a. 1 – Liquid Soap Dispenser.
- b. 1 – Toilet Tissue Dispenser.
- c. 1 – Waste Receptacle.
- d. 1 – 42 in. Grab Bar (GB-2).
- e. 1 – 18 in. Grab Bar (GB-3).
- f. 1 – 1 ft.-6 in. Long x 3 ft-0 in. High Mirror.
- g. 1 – Sanitary Napkin Dispenser.
- h. 1 – Diaper Changing Station.

8. Laundry Room 110:

- a. 1 – Waste Receptacle.

B. Building 120 Control Building:

1. Janitor Room 109:

- a. 1 – Mop Holder.
- b. 1 – Liquid Soap Dispenser.

2. Break Room 105:

- a. 1 – Liquid Soap Dispensers.
- b. 2 – Waste Receptacles.

3. Women's Toilet Room 107:

- a. 1 – Toilet Tissue Dispenser.
- b. 1 – 36 in. Grab Bar (GB-2).
- c. 1 – 42 in. Grab Bar (GB-1).
- d. 1 – 18 in. Grab Bar (GB-3).
- e. 1 – Electric Hand Dryer.
- f. 1 – Sanitary Napkin Dispenser.
- g. 1 – 5 ft-0 in. Long x 3 ft-0 in. High Mirror.

4. Men's Toilet Room 108:

- a. 1 – Toilet Tissue Dispenser.
- b. 1 – 36 in. Grab Bar (GB-2).
- c. 1 – 42 in. Grab Bar (GB-1).
- d. 1 – 18 in. Grab Bar (GB-3).
- e. 1 – Electric Hand Dryer.
- f. 1 – 5 ft-0 in. Long x 3 ft-0 in. High Mirror.

5. Laboratory Room 103:

- a. 2 – Liquid Soap Dispensers.
- b. 3 – Waste Receptacles.

6. Sample Receiving Room 101:

- a. 1 – Liquid Soap Dispensers.
- b. 1 – Waste Receptacle.

7. Water laboratory Room 111:

- a. 1 – Liquid Soap Dispenser.
- b. 1 – Waste Receptacle.

END OF SECTION

SECTION 10 44 16
FIRE EXTINGUISHERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide portable fire extinguishers and fire protection cabinets and fire extinguishers and mounting brackets for surface mounted fire extinguishers as specified herein, and as needed for a complete and proper installation.

1.02 SUBMITTALS

- A. Product data:
 - 1. Manufacturer's information and specifications and other data needed to prove compliance with the specified requirements.
 - 2. Mounting instructions.
- B. Shop Drawings: Fire protection cabinets. Mounting brackets. Include plans, elevations, section, details and attachments to other work.
- C. Maintenance Data: Contractor shall provide manufacturer's maintenance data and coordinate with the Owner's existing fire extinguisher service to ensure fire extinguishers submitted are capable of being integrated into the Owner's current maintenance system.
- D. Warranty: Sample of special warranty.
- E. Comply with pertinent provisions of Section 01 33 00.

1.03 QUALITY ASSURANCE

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10; "Portable Fire Extinguishers"
- B. Listed and labeled for type, rating and classification by an independent testing agency acceptable to authorities having jurisdiction.
- C. Coordinate sizes and locations of fire protection cabinets with wall surfaces.
- D. Obtain fire extinguishers and fire-protection cabinets through one source from a single manufacturer.

1.04 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to the following:
 - a. Failure of hydrostatic test according to NFPA 10.
 - b. Faulty operation of valves or release levers.
 - 2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 FIRE EXTINGUISHERS

- A. Provide six (6) multi-purpose dry chemical fire extinguishers with UL rating of 4A:60B:C; 10 pound capacity, enameled steel tank with flexible hose and pressure gage, completely rechargeable.
- B. Provide manufacturer's standard wall-mounting bracket for each fire extinguisher.
- C. Service, charge, and tag each fire extinguisher not more than five calendar days prior to the Date of Substantial Completion.

2.02 FIRE-PROTECTION CABINET

- A. Cabinet Type: Manufacturer's standard steel box with white baked enamel exterior finish.
 - 1. Semi-recessed, 2-1/2 inch rolled edge, cabinet for shallow wall installation.
 - 2. One-piece tubular door frame, mitered and welded.
 - 3. One-piece metal trim frame, to suit cabinet style required.
 - 4. Weld joints and grind smooth.
- B. Doors
 - 1. Doors shall be bubble type, one-piece molded clear 1/4-inch acrylic, with catch.
 - 2. Continuous type door hinge, opening to 180 degrees.
 - 3. Lever handle with cam action latch or door pull and friction latch.

2.03 MOUNTING BRACKETS

- A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or black-enamel finish.
- B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
- C. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
 - 1. Orientation: Vertical.

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 INSTALLATION

- A. Install in strict accordance with the manufacturer's recommended installation procedures, anchoring all components firmly into position for long life under hard use.

- B. Locate and install extinguishers, cabinets and brackets in accordance with NFPA 10 and where directed by the Fire Department official.
- C. Fire Protection Cabinets and Mounting: Fasten to structure, square and plumb.
- D. Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- E. Install fire protection cabinets and mounting brackets so that the top of fire extinguishers is 54 inches above finish floor
- F. Adjust fire protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

END OF SECTION

SECTION 10 51 00
METAL LOCKERS

PART 1 – GENERAL

1.01 SUMMARY

- A. Section includes:
1. Knocked-down, standard metal lockers.
 2. Locker benches.

1.02 DEFINITIONS

- A. Uncoated Steel Sheet Thicknesses: Indicated as minimum thicknesses.

1.03 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal locker and bench.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
1. Show base, sloping tops, filler panels, recess trim and other accessories.
 2. Include locker identification system.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals.
- E. Submit in accordance with Section 01 33 00.

1.03 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative of metal locker manufacturer for installation and maintenance of units required for this Project.
- B. Source Limitations: Obtain metal lockers and accessories through one source from single manufacturer.
- C. Regulatory Requirements: Where metal lockers are indicated to comply with accessibility requirements, comply with ICC A117.
1. Provide not less than 1 shelf located no higher than 48 in. (1219 mm) above floor for forward or 54 in. (1372 mm) above floor for side reach.
 2. Provide 1 shelf located at bottom of locker no lower than 15 in. (381 mm) above floor for forward or 9 in. (230 mm) above floor for side reach.
 3. Provide hardware that does not require tight grasping, pinching, or twisting of wrist, and that operates with force of not more than 5 lbf (22.2 N).

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver metal lockers until spaces to receive them are clean, dry, and ready for metal locker installation.

1.05 PROJECT/SITE CONDITIONS

- A. Field Measurements: Verify following by field measurements before fabrication and indicate measurements on Shop Drawings:
 - 1. Concealed framing, blocking, and reinforcements that support metal lockers before they are enclosed.
 - 2. Recessed openings.

1.06 COORDINATION

- A. Coordinate size and location of concrete bases for metal lockers.
- B. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that metal lockers can be supported and installed as indicated.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008, Commercial Steel (CS) Type B, suitable for exposed applications.
- B. Expanded Metal: ASTM F 1267, Type II (flattened), Class I, 3/4-in. (19-mm) steel mesh, with at least 70 percent open area.
- C. Stainless-Steel Sheet: ASTM A 666, Type 304.
- D. Extruded Aluminum: ASTM B 221 (ASTM B 221M), alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated.
- E. Fasteners: Zinc-or nickel-plated steel, slotless-type exposed bolt heads, and self-locking nuts or lock washers for nuts on moving parts.
- F. Anchors: Select material, type, size, and finish required for secure anchorage to each substrate.
 - 1. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance.
 - 2. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

2.02 KNOCKED-DOWN, METAL LOCKERS

- A. Manufacturers:
 - 1. Lyon Workspace Products; Standard Lockers.
 - 2. Penco Products, Inc., Subsidiary of Vesper Corporation.
 - 3. Republic Storage Systems Company.
 - 4. Or equal.
- B. Locker Arrangement: Single tier.

- C. Body: Assembled by riveting or bolting body components together. Fabricate from unperforated, cold-rolled steel sheet with thicknesses as follows:
1. Tops, Bottoms, and Intermediate Dividers: 0.0209 in. (0.55 mm) (24 ga) thick, with single bend at sides.
 2. Backs and Sides: 0.0209 in. (0.55 mm) (24 ga) thick, with full-height, double-flanged connections.
 3. Shelves: 0.0209 in. (0.55 mm) (24 ga) thick, with double bend at front and single bend at sides and back.
- D. Frames: Channel formed; fabricated from 0.0528-in.- (1.35-mm-) (16 ga) thick, cold-rolled steel sheet; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral door strike full height on vertical main frames.
1. Cross Frames between Tiers: Channel formed and fabricated from same material as main frames; welded to vertical frame members.
- E. Doors: One-piece; fabricated from 0.0528-in.- (1.35-mm-) (16 ga) thick, cold-rolled steel sheet; formed into channel shape with double bend at vertical edges, and with right-angle single bend at horizontal edges.
1. Doors less than 12 in. (305 mm) wide may be fabricated from 0.0428-in.- (1.1-mm-) (18 ga) thick, cold-rolled steel sheet.
 2. Box lockers less than 15 in. (381 mm) wide may be fabricated from 0.0428-in.- (1.1-mm-) (18 ga) thick, cold-rolled steel sheet.
 3. Reinforcement: Manufacturer's standard reinforcing angles, channels, or stiffeners for doors more than 15 in. (381 mm) wide; welded to inner face of doors.
 4. Stiffeners: Manufacturer's standard full-height stiffener fabricated from 0.0428-in.- (1.1-mm-) (18 ga) thick, cold-rolled steel sheet; welded to inner face of doors.
 5. Door Style: Vented panel as follows:
 - a. Louvered Vents: Not less than six louver openings at top and bottom for single-tier lockers.
 - b. Perforated Vents: Manufacturer's standard shape and configuration.
- F. Hinges:
1. Self-closing.
 2. Weld to door and attached to door frame with not less than 2 factory-installed rivets per hinge that are completely concealed and tamper resistant when door is closed.
 3. Fabricate to swing 180 degrees.
 4. Manufacturer's standard, steel continuous or knuckle type.
- G. Recessed Door Handle and Latch: Stainless-steel cup with integral door pull, recessed so locking device does not protrude beyond face of door; pry resistant.
1. Multipoint Latching: Finger-lift latch control designed for use with built-in combination locks, built-in key locks, or padlocks; positive automatic and prelocking.
 - a. Latch Hooks: Equip doors 48 in. (1219 mm) and higher with 3 latch hooks; fabricated from minimum 0.0966-in.- (2.5-mm-) thick steel; welded or riveted to full-height door strikes; with resilient silencer on each latch hook.

- b. Latching Mechanism: Manufacturer's standard rattle-free latching mechanism and moving components isolated to prevent metal-to-metal contact, and incorporating prelocking device that allows locker door to be locked while door is open and then closed without unlocking or damaging lock or latching mechanism.

H. Combination Padlocks: Provided by OWNER.

I. Equipment: Equip each metal locker with identification plate and following, unless otherwise indicated:

- 1. Single-Tier Units: Shelf, one double-prong ceiling hook, and two single-prong wall hooks.

J. Accessories:

- 1. Continuous Sloping Tops: Fabricated from cold-rolled steel sheet, manufacturer's standard thickness, but not less than 0.0329 in. (0.85 mm) (20 ga) thick.
 - a. Closures: Hipped-end type.
 - b. Sloped top corner fillers, mitered.

K. Finish: Baked enamel or powder coat.

- 1. Color(s): Two colors, with door one color and frame and body another color as selected by Owner from manufacturer's full range.

2.03 LOCKER BENCHES

A. Provide locker benches fabricated by same manufacturer as metal lockers.

B. Bench Tops: Manufacturer's standard 1-piece units, of following material, minimum 9-1/2 in. (240 mm) wide by 1-1/4 in. (32 mm) thick, with rounded corners and edges:

- 1. Laminated maple with one coat of clear sealer on all surfaces, and one coat of clear lacquer on top and sides.

C. Supports:

- 1. Fixed Pedestals: Manufacturer's standard supports, with predrilled fastener holes for attaching bench top and anchoring to floor, complete with fasteners and anchors.
 - a. Color: As selected by Owner from manufacturer's full range.
- 2. Wall Brackets: Stainless steel as indicated on Drawings complete with fasteners and anchors.

2.04 FABRICATION

A. Fabricate metal lockers square, rigid, and without warp; with metal faces flat and free of dents or distortion. Make exposed metal edges free of sharp edges and burrs, and safe to touch.

- 1. Form body panels, doors, shelves, and accessories from one-piece steel sheet, unless otherwise indicated.
- 2. Provide fasteners, filler plates, supports, clips, and closures as required for complete installation.

- B. Unit Principle: Fabricate each metal locker with an individual door and frame; individual top, bottom, and back; and common intermediate uprights separating compartments.
- C. Knocked-Down Construction: Fabricate metal lockers for nominal assembly at Project site using nuts, bolts, screws, or rivets. Factory weld frame members together to form rigid, one-piece assembly.
- D. Hooks: Manufacturer's standard ball-pointed type, aluminum or steel; zinc plated.
- E. Identification Plates: Manufacturer's standard etched, embossed, or stamped aluminum plates; with numbers and letters at least 3/8 in. (9 mm) high.
- F. Continuous Sloping Tops: Fabricated in lengths as long as practicable, without visible fasteners at splice locations; finished to match lockers.
 - 1. Sloped top corner fillers, mitered.
- G. Recess Trim: Fabricated with minimum 2-1/2-in. (64-mm) face width and in lengths as long as practicable; finished to match lockers.
- H. Filler Panels: Fabricated in an unequal leg angle shape; finished to match lockers. Provide slip joint filler angle formed to receive filler panel.
- I. Boxed End Panels: Fabricated with 1-in.- (25-mm-) wide edge dimension, and designed for concealing fasteners and holes at exposed ends of nonrecessed metal lockers; finished to match lockers.
 - 1. Provide one-piece panels for double-row (back-to-back) locker ends.

2.05 STEEL SHEET FINISHES

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Factory finish steel surfaces and accessories except stainless-steel and chrome-plated surfaces.
- C. Surface Preparation: Clean surfaces of dirt, oil, grease, mill scale, rust, and other contaminants that could impair paint bond. Use manufacturer's standard methods.
- D. Powder-Coat Finish: Immediately after cleaning and pretreating, electrostatically apply manufacturer's standard baked-polymer thermosetting powder finish. Comply with resin manufacturer's written instructions for application, baking, and minimum dry film thickness.

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Examine walls, floors, and support bases, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install level, plumb, and true; shim as required, using concealed shims.
 - 1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 in. (910 mm) o.c. Install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion, using concealed fasteners.
 - 2. Anchor single rows of metal lockers to walls near top of lockers and to floor.
 - 3. Anchor back-to-back metal lockers to floor.
- B. Knocked-Down Metal Lockers: Assemble knocked-down metal lockers with standard fasteners, with no exposed fasteners on door faces or face frames.
- C. Equipment and Accessories: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.
 - 1. Attach hooks with at least two fasteners.
 - 2. Attach door locks on doors using security-type fasteners.
 - 3. Identification Plates: Identify metal lockers with identification indicated on Drawings.
 - a. Attach plates to each locker door, near top, centered, with at least two aluminum rivets.
 - b. Attach plates to upper shelf of each open-front metal locker, centered, with least two aluminum rivets.
 - 4. Attach filler panels with concealed fasteners. Locate fillers panels where indicated on Drawings.
 - 5. Attach sloping top units to metal lockers, with closures at exposed ends.
- D. Fixed Pedestal Locker Benches: Provide not less than 2 pedestals for each bench, uniformly spaced not more than 48 in. (1830 mm) apart. Securely fasten tops of pedestals to undersides of bench tops, and anchor bases to floor where shown.
- E. Wall Bench: Provide not less than 2 brackets for each bench, uniformly spaced not more than 48 in. (1830 mm) apart. Securely fasten tops of pedestals to undersides of bench tops, and anchor brackets to wall where shown.

3.03 ADJUSTING, CLEANING, AND PROTECTION

- A. Clean, lubricate, and adjust hardware. Adjust doors and latches to operate easily without binding.
- B. Protect metal lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit metal locker use during construction.
- C. Touch up marred finishes, or replace metal lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by metal locker manufacturer.

END OF SECTION

DIVISION 11
EQUIPMENT

SECTION 11 45 10
KITCHEN APPLIANCES

PART 1 – GENERAL

1.01 SUBMITTALS

A. Shop Drawings:

1. Include location, type, finishes/colors, dimensions and material.
2. Indicate backing anchors, mounting details, trim, and accessories.

B. Product Data:

1. Printed technical specifications, catalog data, and details of product.
2. Recommended installation and maintenance instructions.
3. Evidence of "Energy Star" certification.

C. Submit above in accordance with Section 01 33 00.

1.02 QUALITY ASSURANCE

A. Use single source for kitchen appliances and accessory items.

B. Product shall bear "Energy Star" certification.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle unit in manner to prevent damage.

B. Furnish complete instructions with assembly shipment.

PART 2 – PRODUCTS

2.01 REFRIGERATOR

A. Whirlpool WRT549SZDM or equal.

B. 19 cubic foot top freezer.

C. Manufacturer's standard ice maker

D. Stainless Steel.

E. 30 inch wide Top Freezer.

F. 115 V, 60 Hz.

2.02 RANGE

A. Whirlpool WEEA251H0HZ or equal.

B. 30-in. smooth top, four elements, two high power.

- C. Stainless Steel.
- D. 6.4 cu. ft. slide-in electric range.
- E. Width: 30 inch.
- F. Depth: 28-7/8 in.
- G. Height: 36 in.

2.03 MICROWAVE

- A. Whirlpool Model No. WMH32519H or equal.
- B. Stainless Steel.
- C. Over the Range Microwave.
- D. 1.8 cu. ft. 1000 watts.
- E. 11.4 in. turntable.

2.04 DISHWASHER (DSH-2)

- A. Whirlpool Model No. WDF540PADM or equal.
- B. Stainless steel.
- C. Consumer Report overall score of 77 or better.

2.05 COFFEE MAKER

- A. 12 cup coffee maker, Bunn, Model No. 230001.0000 CW15-APS, Pourover Airpot Coffee Brewer, 120V.

2.06 COUNTERTOP MICROWAVE

- A. Whirlpool Model No. UMC5225GZ
- B. 2.2 cu. ft. capacity.
- C. 1700 watts, 120 V.
- D. Fingerprint resistant stainless steel.

2.07 COMMERCIAL WASHER

- A. Whirlpool Model No. CAE2795FQ.
- B. Commercial top load washer.
- C. 120 V, 60 Hz.
- D. Width: 30 in.

E. Depth: 27.5 in.

F. Height: 49 in.

2,08 COMMERCIAL DRYER

A. Whirlpool Model No. CGM2795FQ

B. Commercial Gas Dryer.

C. 120 V, 60 Hz.

D. Width: 28.8 in.

E. Depth: 40.8 in.

F. Height: 44.65 in.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Do not install scratched, marred or otherwise damaged equipment.

B. Remove and replace damaged equipment at time defects are discovered before acceptance of Work.

3.02 INSTALLATION

A. Install in accordance with manufacturer's written instructions and approved submittals.

3.03 CLEANING

A. Clean enclosure surfaces as recommended by manufacturer and keep clean until final inspection.

3.04 SCHEDULE

A. See Drawings for locations.

END OF SECTION

SECTION 11 52 00
AUDIO VISUAL SYSTEMS

PART 1 – GENERAL

1.01 SUMMARY

- A. Audio visual equipment for Training Room, Conference Room, and miscellaneous audio visual devices.

1.02 ABBREVIATIONS AND DEFINITIONS

- A. AVSS Audio Visual System Supplier.

1.03 SUBMITTALS

A. General:

1. Submit Product Data in sufficient detail to confirm compliance with requirements of this Section.
2. Submit Product Data and Shop Drawings in one complete submittal package.
3. Partial submittals are not acceptable.

B. Product Data:

1. Catalog cuts and product specifications for devices and equipment specified.

C. Shop Drawings:

1. Installation and assembly drawings and specifically prepared technical data for audio visual devices and equipment specified.
2. Comprehensive point to point wiring and schematic diagrams for all wiring components.
3. Electrical panel drawings including panel layout, schematic, and bill of materials cross referenced to panel layout drawings.
4. Submit in accordance with Section 01 33 00.

D. Operation and Maintenance (O&M) Data:

1. Operating instructions and maintenance data for materials, products and equipment for inclusion in O&M Manual.
2. Submit in accordance with Section 01 78 23.

1.04 AUDIO VISUAL SYSTEM SUPPLIER (AVSS)

- A. AVI Systems, Inc.
Tom Burns
630-447-2354
Thomas.burns@avisystems.com

B. No Substitutions Permitted.

C. AVSS shall have on-staff personnel assigned to this Project.

D. Contractor shall utilize an AVSS having the experience and knowledge, as defined herein, to

undertake the work specified in Sections 11 52 00. The AVSS shall be an organization having the following organizational and individual experience, knowledge, and capability:

1. AVSS shall be regularly engaged in the design, installation, and servicing of Audio Visual Systems.
2. AVSS shall demonstrate the ability to produce system documentation in the level of detail required by this specification.
3. AVSS shall have previously executed a minimum of five (5) Audio Visual projects of similar size and complexity to this Project.
4. AVSS shall provide, on-site personnel to commission the functional testing, start-up and training as required by the Contract Documents. The individual shall have authored and commissioned Audio Visual Systems for no fewer than three (3) projects of similar or greater complexity.

PART 2 – PRODUCTS

2.01 GENERAL

- A. Like items of equipment shall be end products of single manufacturer to achieve standardization for maintenance, spare parts, operation, service, and training.
- B. Equipment shall be latest and most modern design that is fully compatible, and will operate with City's network.

2.02 AUDIO VISUAL SYSTEM

- A. Provide audio visual equipment for the Training Room, Conference Room, Break Room and Reception as described and as shown on the Drawings. Audio visual system shall be capable of projecting visual images and audio from presentations adequate for viewing and hearing of the anticipated audience.
- B. Audio System Supplier (AVSS) shall provide all work included under this Specification consisting of but limited to the provision of all labor, equipment, materials, supplies, and performing all operations necessary to complete installation of the Audio Visual System in compliance with Specifications and Drawings under the direction of the Contractor.
- C. The Work shall include, but not be limited to, the following:
 1. Furnish and install Digital Signage Flat Panel Display in Reception. Provide Chief PAC501B In-Wall Enclosure (to be installed by Contractor).
 2. Furnish and install Digital Signage Flat Panel Display in Breakroom Provide Chief PAC501B In-Wall Enclosure (to be installed by Contractor).
 3. Furnish and install Digital Signage Flat Panel Display in Conference Room. Provide Chief PAC501B In-Wall Enclosure (to be installed by Contractor).
 4. Furnish and Install Cable Cubby with HDMI and VGA Connectors at Conference Table in Conference Room.
 5. Furnish and install projector in Training Room.
 6. Furnish and install PTZ Camera in Training Room.
 7. Furnish and install wall mounted AV transmitter with VGA and HDMI connections.
 8. Furnish and install five (5) floor mounted AV transmitter and associated data connection.
 9. Furnish and install two (2) ceiling mounted microphone arrays, including airplane cable hangers.
 10. Furnish and install nine (9) ceiling mounted pendant speakers, including airplane cable hangers.
 11. Furnish and install AV Equipment Rack in IT Room as shown on the Drawings. AV system shall be capable of recording and digitally storing sound and video from the AV System.

12. Furnish wall mounted Wireless Touch Panel and Docking Station.
13. Furnish presentation lectern with microphone, video cable connections, networking connection. Lectern shall be mounted on casters with location for securely setting a laptop computer. Lectern shall include digital projector capable of broadcasting images of paper or object to the projector.
14. Provide five (5) wireless tabletop microphones for panel discussions.
15. Provide two (2) wireless handheld microphones.
16. Provide three (3) video connector adapter rings with commonly available video connections to HDMI.
17. For all equipment listed above and all devices required for a complete and working Audio Visual System, AVSS shall furnish and install low voltage cabling including but not limited to Ethernet, speaker wire, RF cable, and video cable).
18. Furnish and install mounting hardware, power supplies, surge protection, amplifiers, interface modules, specialty cabling, media converters, and other appurtenances as required for a complete operating system.
19. Software, hardware, and programming as required for a complete operating system.

D. Work under other Sections:

1. Conduit, power wiring to receptacles and enclosures shown on the drawings.. Coordinate requirements with Division 26 – Electrical, and Division 40 – Process Integration.
2. Mounting of brackets and/or enclosures for devices. Coordinate requirements with Section 08 71 00.
3. Electrical boxes as shown on the Drawings.

E. Equipment Operation:

1. Presenter shall be capable of connecting a laptop computer to the AV system wirelessly or through wired connection to broadcast sound and video images to the projection screen through the projector. Wired connection shall be available through floor mounted transmitters or the lectern.
2. Presenters and other individuals shall be capable of using microphones to amplify and project their voice through the Training Room.
3. In the Conference Room, individuals shall be capable connecting wirelessly or through wired connection in the conference room table to project video and sound to the flat panel display.
4. City employees shall be capable of projecting pre-designed images or videos to the flat panel displays in the Reception area or the Breakroom.
5. If required in the future, cable television broadcasts shall be capable of being projected on the flat panel display in the Breakroom.

PART 3 – EXECUTION

3.01 GENERAL

- A. All work shall be performed in a neat, workmanlike manner and to comply with acknowledged industry and professional standards and practices.
- B. Audio Visual System Supplier shall coordinate with Owner to confirm Av System provided is compatible with City's current computer network.

3.02 EQUIPMENT LOCATION

- A. Placement of devices shall be as shown on Drawings. Verify locations with Engineer before installation. Owner reserves the right to relocate any or all devices within a close proximity (10 feet) to the originally requested locations. All system components and related wiring shall be located with due regard for termination of induced electromagnetic and electrostatic noise, for the

minimization of wiring length, and to provide reasonable safety for plant personnel.

3.03 QUALITY ASSURANCE

- A. All equipment shall conform to appropriate U.L. Listings and be installed in accordance with National Electric Code (NEC) and local code requirements.
- B. Coordination:
 - 1. AVSS shall attend Monthly Progress Meetings and Weekly Meetings specified in specifications, when requested by Owner, Contractor, System Integrator, or Engineer.

3.04 TRAINING

- A. Upon completion of the system, an authorized representative of the AVSS shall thoroughly instruct the Owner's personnel for a period of not less than four (4) hours in complete and proper operation of the system. Provide written instructions for operating and troubleshooting in neat, organized three ring binders (three binders).

END OF SECTION

DIVISION 12
FURNISHINGS

SECTION 12 45 50
MODULAR STEEL LABORATORY CASEWORK

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Steel casework.
2. Table frames.
3. Work surfaces.
4. Sinks and outlets.
5. Service fittings at the fume hood only.
6. Accessory equipment.

1.02 REFERENCES

- A. OSHA: Occupational Safety and Health Administration
- B. ACGIH: American Conference of Governmental Industrial Hygienists

1.03 CASEWORK DESIGN REQUIREMENTS

- A. Flush construction: Surfaces of doors, drawers, and panel faces shall align with cabinet fronts without overlap of case ends, top or bottom rails. Horizontal and vertical case shell members (panels, top rails and bottoms) shall meet in the same plane without overlap, cracks or crevices.
- B. Slimline styling: Maximum front width of end panels 3/4 inch and maximum front height of top and bottom members 1 inch.
- C. Self supporting units: Completely welded shell assembly without applied panels at ends, backs or bottoms, so that cases can be used interchangeably or as a single, stand-alone unit.
- D. Interior of case units: Easily cleanable, flush interior. Base cabinets, 30 inch and wider, with double swinging doors shall provide full access to complete interior without center vertical post.
- E. Drawers: Sized on a modular basis for interchange to meet varying storage needs, and designed to be easily removable in field without the use of special tools.
- F. Case openings: Rabbeted-like joints all four sides of case opening for hinged doors and two sides for sliding doors in order to provide dust resistant case.
- G. Framed glazed doors: Identical in construction, hardware, and installation to solid panel doors. Design frame glazed doors to be removable for glass replacement.
- H. All wall cabinets and wall shelves to be of a modular casework design.
- I. Provide fillers and scribes as necessary for a complete project.

1.04 CASEWORK PERFORMANCE REQUIREMENTS

- A. Structural performance requirements: Casework components shall withstand the following minimum loads without damage to the component or to the casework operation:

1. Steel base unit load capacity: 500 pounds per lineal foot.
2. Suspended units: 300 pounds.
3. Drawers in a cabinet: 150 pounds.
4. Utility tables (4 legged): 300 pounds.
5. Hanging wall cases: 300 pounds.
6. Load capacity for shelves of base units, wall cases and tall cases: 100 pounds.

B. Metal Finish Performance Requirements:

1. Abrasion resistance: Maximum weight loss of 5.5 milligram per 100 cycle when tested on a Taber Abrasion Tester #E40101 with 1000 gram wheel pressure and Calibrase #CS10 wheel.
2. Hardness: Surface hardness equivalent to 4H or 5H pencil.
3. Humidity resistance: Withstand 1000 hour exposure in saturated humidity at 100°F.
4. Moisture resistance:
 - a. No visible effect to surface finish after boiling water trickled over test panel inclined at 45 degrees for five minutes.
 - b. No visible effect to surface finish following 100 hour continuous application of a water soaked cellulose sponge, maintained in a wet condition throughout the test period.
5. Adhesion: Score finish surface of test panel with razor blade into 100 squares, 1/16 x 1/16 inch, cutting completely through the finish but with minimum penetration of the substrate, and brush away particles with soft brush. Minimum 95 squares shall maintain their finish.
6. Salt spray: Withstand minimum 200 hour salt spray test.

1.05 SUBMITTALS

- A. Shop Drawings: Provide elevations of individual and battery of casework units, cross sections, rough-in and anchor placements, tolerances and clearances. Indicate relation of units to surrounding walls, windows, doors and other building components. Provide 1/4 inch = 1 foot - 0 inch rough-in plan drawings for coordination with trades. Rough-in shall show free area.
- B. Product Data: Submit manufacturer's data for each component and item of laboratory equipment specified. Include component dimensions, configurations, construction details, joint details, and attachments, utility and service requirements and locations.
- C. Samples:
 1. Top Sample.
 2. Finish Sample: 3 inch X 5 inch Painted Steel.
 3. Color Samples: 3 inch X 5 inch samples of standard colors of finish for casework, work surfaces and for other prefinished equipment and accessories.
- D. Submit in accordance with Section 01 33 00.

1.06 QUALITY ASSURANCE

- A. Single source responsibility: Casework, work surfaces, laboratory equipment and accessories shall be manufactured or furnished by a single laboratory furniture company.
- B. Manufacturer's qualifications: Modern plant with proper tools, dies, fixtures and skilled workmen to produced high quality laboratory casework and equipment, and shall meet the following minimum requirements:
 1. Five years or more experience in manufacture of laboratory casework and equipment of type specified.

2. Ten installations of equal or larger size and requirements.
- C. Installer's qualifications: Factory trained and/or certified by the manufacturer.
- D. Cabinet identification: Cabinets are identified on drawings by manufacturer's catalog numbers. Unless otherwise modified on drawings or in specifications, catalog description constitutes specific requirements for each type of cabinet.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Schedule delivery of casework and equipment so that spaces are sufficiently complete that material can be installed immediately following delivery.
- B. Protect finished surfaces from soiling or damage during handling and installation. Keep covered with polyethylene film or other protective coating.
- C. Protect all work surfaces throughout construction period with 1/4 inch corrugated cardboard completely covering the top and securely taped to edges. Mark cardboard in large lettering "No Standing".

1.08 PROJECT CONDITIONS

- A. Do not deliver or install equipment until the following conditions have been met:
 1. Windows and doors are installed and the building is secure and weathertight.
 2. Ceiling, overhead ductwork and lighting are installed.
 3. All painting is completed and floor finish is complete.

PART 2 – PRODUCTS

2.01 MANUFACTURER

- A. Casework and equipment manufacturer: Hamilton Laboratory Solutions
- B. Or equal.

2.02 CASEWORK MATERIALS

- A. Sheet steel: Mild, cold rolled and leveled unfinished steel.
- B. Minimum gauges:
 1. 22 gauge: Solid door interior panels, drawer fronts, scribing strips, filler panels, enclosures, drawer bodies, shelves, security panels and sloping tops.
 2. 20 gauge: Case tops, ends, bottoms, bases, backs, vertical posts, uprights, glazed door members, door exterior panels and access panels.
 3. 16 gauge: Top front rails, top rear gussets, intermediate horizontal rails, table legs and frames, leg rails and stretchers.
 4. 14 gauge: Drawer suspensions, door and case hinge reinforcements and front corner reinforcements.
 5. 11 gauge: Table leg corner brackets and gussets for leveling screws.
- C. Glass for glazed doors: minimum 7/32 inch thick, clear laminated safety glass.

2.03 CASEWORK FABRICATION

A. Base Units and Cases:

1. Conform to the sizes shown on the Drawings.
2. Base units and 25 inches, 31 inches, and 37 inches high wall cases: End panels and back reinforced with internal reinforcing front and rear posts.
3. 49 inches and 84 inches high cases: Formed end panels with front and rear reinforcing post channels; back shall be formed steel panel, recessed 3/4 inch for mounting purposes.
4. Posts: Front post fully closed with full height reinforcing upright. Shelf adjustment holes in front and rear posts shall be perfectly aligned for level setting, adjustable to 1/2 inch on center.
5. Secure intersection of case members with spot and arc welds. Provide gusset reinforcement at front corners.
6. Base unit backs: Provide drawer units without backs and cupboard units with removable backs.
7. Bottoms: Base units and 25 inches, 31 inches, 37 inches and 49 inches high wall cases shall have one piece bottom with front edge formed into front rail, rabbeted as required for swinging doors and drawers and flush design for sliding doors. Holes or capped punch outs for leveling screw access are not acceptable.
8. Top rail for base units: Interlock with end panels, flush with front of unit.
9. Horizontal intermediate rails: Recessed behind doors and drawer fronts; removable for later revision in cabinet configuration.
10. Base for base units: 4 inches high x 3 inches deep with formed steel base and 11 Ga. die formed steel gussets at corners Provide 3/8 inch diameter leveling screw with integral bottom flange of minimum 0.56 square inch area at each corner, accessible through openings in toe space.
11. Tops of wall cases: One piece, with front edge formed into front rail.
12. Backs of wall cases: One piece, with two u-shaped members welded to back designed to fit on adjustable height MAX wall hanger rail, allowing for 1 inch vertical height adjustment and/or cabinet removal without tools.

B. Drawers:

1. Drawer fronts: 3/4 inches thick, double wall construction, prepainted prior to assembly and sound deadened; top front corners welded and ground smooth.
2. Drawer bodies: Bottom and sides formed into one-piece center section with bottom and sides coved and formed top edges. Front and back panels spot welded to center section.
3. Drawer suspension: Heavy duty coved raceways for both case and drawer with nylon tired, ball bearing rollers; self-centering and self-closing when open to within 5 inches of the closed position.
4. Provide drawer with rubber bumpers. Friction centering devices are not acceptable.
5. Provide security panels for drawers with keyed different locks.
6. File drawers: Provide with full extension slides for full access and operation.

C. Doors:

1. Solid panel doors: 3/4 inches thick, double wall, telescoping box steel construction with interior prepainted and sound deadened, all outer corners welded and ground smooth. Reinforce interior of front panel with welded steel hat channels. Hinges with screws to internal 14 gauge reinforcing in case and door. Hinges shall be removable; welding of hinges not acceptable. Doors shall close against rubber bumpers.
2. Frame glazed doors: Outer head to be one piece construction. Inner head to consist of top, bottom and side framing members which are removable for installation or replacement of glass. Provide continuous vinyl glazing retainer to receive glass. In all other respects, framed glazed door construction and quality shall match solid panel doors.
3. Sliding doors - solid or framed glazed: Design for tilt-out removal after removal of bottom guide. Doors shall be hung with nylon tired sleeve bearing rollers in formed steel top hung track and shall close against rubber bumpers.

4. Unframed sliding glass doors: Glass with edges ground set in extruded aluminum shoe with integral pulls, wheel assemblies and top and bottom extruded aluminum track. Provide rubber bumpers at fully opened and closed door position.

D. Shelves:

1. Form front and back edges down and back 3/4 inches. Form ends down 3/4 inches.
2. Reinforce shelves over 36 inches long with welded hat channel reinforcement the full width of shelf.
3. Pull out shelves: Same suspension as specified for drawers.

E. Base molding: 4 inches high, black rubber or vinyl; inside corners mitered and outside corners wrapped.

F. Hardware:

1. Drawer and hinged door pulls: Recessed ABS plastic in Chameleon color.
2. Sliding door pulls: Manufacturer's standard plastic pulls, Chameleon color.
3. Hinges: Institutional type, five knuckle projecting barrel hinges, minimum 2-1/2 inches long, type 302 or 304 stainless steel. Provide two hinges for doors up to 36" high; three hinges for doors over 36 inches high. Drill each leaf for three screw attachment to door and frame.
4. Door catches: Adjustable type, spring actuated nylon roller catches.
5. Elbow catches: Spring type of cadmium plated steel, with strike of suitable design.
6. Locks: National Lock Remove-A-Core 5-disc tumbler, heavy duty cylinder type. Exposed lock noses shall be dull nickel (satin) plated and stamped with identifying numbers.
7. Keying: Locks shall have capacity for 225 primary key changes. Master key one level with the potential of 40 different, non-interchangeable master key groups.
8. Keys: Stamped brass available from manufacturer or local locksmith, and supplied in the following quantities unless otherwise specified:
 - 2 - for each keyed different lock.
 - 3 - for each group keyed alike locks.
 - 2 - for master keys for each system.
9. Label holders: Formed steel with satin chrome finish, 1 inch x 1-1/2 inch, screw installed.
10. Shelf clips: Die formed steel, zinc plated, designed to engage in shelf adjustment holes.
11. File followers: Metal backs engaging in steel bottom channel, with spring positioning lock.

2.04 TABLE FRAMES

- A. Table frames: 4-1/2 inches high "C" channel front and back aprons, end rails and cross rails.
- B. Table drawers: Provide front and back rails; drawer unit, hardware and suspension same as specified for base unit drawers.
- C. Legs: 2 inch x 2 inch steel tube legs with welded leg bracket. Attach legs with two bolts to front and back aprons and weld to end rails. Each leg shall have a recessed leveling screw and a black, coved vinyl or rubber leg shoe, two inches in height.

2.05 METAL FINISH

- A. Preparation: Spray clean metal with a heated cleaner/phosphate solution, pretreat with iron phosphate spray, water rinse, and neutral final seal. Immediately dry in heated ovens, gradually cooled, prior to application of finish.
- B. Application: Electrostatically apply powder coat of selected color and bake in controlled high

temperature oven to assure a smooth, hard satin finish. Surfaces shall have a chemical resistant, high grade laboratory furniture quality finish of the following thicknesses:

1. Exterior and interior surfaces exposed to view: 1.5 mil average and 1.2 mil minimum.
 2. Backs of cabinets and other surfaces not exposed to view: 1.0 mil average.
- C. Finish drawer bodies in matching or harmonizing color and apply corrosion-resistant treatment to selected, concealed interior parts.

2.06 EPOXY WORK SURFACES

- A. Material: Chemical and abrasion resistant, durable top of one inch thick cast material of epoxy resins and inert products, cast flat, with a uniform low-sheen black surface.
- B. Backsplash curb: Same material as top, 4 inches high, butt jointed and cemented to top. Provide where indicated on drawings. Include end curb where top abuts end wall.
- C. Pegboards:
1. Epoxy resin board fabricated of 1 inch thick black epoxy resin with white polypropylene pegs in 5 inches, 6½ inches, and 8 inch lengths and 5 inches deep full width stainless steel drip trough with outlet. Base of pegs to be two-prong style for mechanical attachment. Do not bond pegs to board. Pegs to protrude at 45° angle. Pegboard to have finished face and edges.

2.06 LABORATORY COUNTERTOP AND CURB SURFACES

- A. Material: Imperial stone top of natural quarried stone 1-1/4 in. thick, free of veins, stratifications or laminations. Butt jointed joints cemented together with rounded top and corner edges.
- B. Minimum Physical Characteristics:
1. Density: 140 lbs/cu. ft.
 2. Modulus of Rupture: 3,600 psi.
 3. Brinell Hardness: 84 (100 mm ball, 500 kg load).
- C. Finish top and side surfaces with 7 coats and underside surface with 3 coats of jet black, high baked finish resistant to acids, alkalis, salts, and solvents.

2.07 SINKS, DRAINS AND TRAPS

- A. Epoxy resin sinks: Integrally molded from modified thermosetting black epoxy resin, specially compounded and oven cured. Cove inside corners and pitch bottom to threaded drain outlet.
- B. Lab faucets shall be provided with ASSE 1035 backflow preventers.
- C. Sink supports:
1. Cabinet sinks: Support sinks on 11 gauge, adjustable, 1 inch x 2 inch x 1 inch channel with reagent resistant finish. Provide two channels across width of cabinet, attached to 3/8 inch diameter threaded hanger rods.
 2. Caulk joint between top and sink with non-hardening mastic.

- D. Epoxy resin cupsinks: Integrally molded from modified thermosetting black epoxy resin, specially compounded and oven cured. Cove inside corners and pitch bottom to threaded drain outlet.

2.08 FUME HOODS

A. General requirements:

1. Fume hoods is to be Fisher Hamilton SafeAire constant volume bypass type, prepiped and prewired.
2. Fume hoods shall function as ventilated, enclosed work spaces, designed to capture, confine, and exhaust fumes, vapors, and particulate matter produced or generated within the enclosure.
3. Fume hoods shall provide safe operation when properly installed and connected to an exhaust system that provides the proper exhaust air volume to permit the fume hood to operate at the specified face velocity.
4. Fume hoods shall be provided with a prewired electronic safety monitor (54L04050). This system shall monitor the face velocity if face velocity drops below 70 feet per minute. The monitor shall have audible and visual alarm signals, solid state construction, thermistor-based sensing system.
5. Fume hoods shall be designed and furnished to meet ADA requirements.

B. Fume hood liner material:

1. Fume hood product numbers which include the suffix letter "P" shall have all interior liner surfaces, including both baffle surfaces, fabricated of poly-resin.

C. Construction and design:

1. Remote baffle adjustment complies with OSHA recommendations.
2. Vertical sash stop to provide capture efficiencies 50 times safer than ACGIH guidelines.
3. Front mounted remote control fixtures.
4. Metal free interior – hood interior shall have no metal brackets, angles, or screwheads.
5. Rectangular exhaust collar – reducing static pressure to conserve energy and decrease noise levels of exhauster air.
6. Safety monitor – factory calibrated electronic safety monitor activates alarm under low flow, high flow, and blockage conditions.
7. Fume hoods shall be prepiped and prewired per State codes. Proper exterior vacuum breaker included.
8. Provide Owner with safety video tape for OSHA compliance.
9. Cold water outlets shall be fitted with an ASSE 1035 backflow prevention device.

D. Performance:

1. Fume hood shall have a maximum pressure drop 0.15 in wc or lower with an airflow rate of 100 fpm face velocity.

2.09 LABORATORY EQUIPMENT

A. Laboratory Glassware Washer

1. Miele Professional Model No. G 7883.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Casework installation:

1. Set casework components plumb, square, and straight with no distortion and securely anchored to building structure. Shim as required using concealed shims.
2. Bolt continuous cabinets together with joints flush, tight and uniform, and with alignment of adjacent units within 1/16 inch tolerance.
3. Secure wall cabinets to solid supporting material, not to plaster, lath or gypsum board.
4. Abut top edge surfaces in one true plane. Provide flush joints not to exceed 1/8 inch between top units.

B. Work surface installation:

1. Where required due to field conditions, scribe to abutting surfaces.
2. Only factory prepared field joints, located per approved shop drawings, shall be permitted. Secure joints in field, where practicable, in the same manner as in factory, with dowels, splines, adhesive or fasteners recommended by manufacturer.
3. Secure work surfaces to casework and equipment components with material and procedures recommended by the manufacturer.

C. Sink installation: Sinks which were not factory installed shall be set in chemical resistant sealing compound and secured and supported per manufacturer's recommendations.

D. Accessory installation: Install accessories and fittings in accordance with manufacturer's recommendations. Turn screws to seat flat; do not drive.

E. Laboratory Equipment Installation: Install laboratory glassware washer in accordance with manufacturer's recommendations.

3.02 ADJUSTING

A. Repair or remove and replace defective work, as directed by Engineer upon completion of installation.

B. Adjust doors, drawers, hardware, fixtures and other moving or operating parts to function smoothly.

3.03 CLEANING

A. Clean shop finished casework, touch up as required.

B. Clean counter tops with diluted dishwashing liquid and water leaving tops free of all grease and streaks. Use no wax or oils.

3.04 PROTECTION OF FINISHED WORK

A. Provide all necessary protective measures to prevent exposure of casework and equipment from exposure to other construction activity.

B. Advise contractor of procedures and precautions for protection of material, installed laboratory casework and fixtures from damage by work of other trades.

3.05 LABORATORY FURNITURE SCHEDULE

A. Laboratory furniture product numbers on Drawings are by Hamilton Laboratory Solutions.

END OF SECTION

SECTION 12 48 10
ENTRANCE MATS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Set-in frames to receive recessed mats, grilles or flooring units.
2. Recessed mats or flooring units.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's specifications and installation instructions for each type entrance mat. Include methods of installation for each type substrate.
- B. Shop Drawings: Submit for entrance mats. Include full scale sections of typical installations. Show details of patterns or designs, anchors, and accessories.
1. Coordinate Shop Drawing submittal with concrete Shop Drawings showing oversized recess for delayed installation of mat frames.
- C. Samples: Submit samples for each type and color exposed entrance mat, frames, and accessories required. Provide 12 in. sq samples of mat materials and 12 in. lengths of frame members.
- D. Submit manufacturer's printed instructions for cleaning, drying, maintaining, and rehandling removable entrance mat units.
- E. Submit in accordance with Section 01 33 00.

1.03 QUALITY ASSURANCE

- A. Manufacturer: Except as otherwise indicated, provide entrance mats and accessories by single manufacturer for entire project.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Matsinc. (www.matsinc.com)
- B. Or equal.

2.02 MATERIALS AND FABRICATION

- A. General:
1. Provide colors/patterns/profiles of materials including metals and metal finishes, as indicated on Drawings or by this Specification or, where not indicated, as selected by ARCHITECT from manufacturer's standard colors/patterns/profiles.

2. Shop fabricate units of entrance mat work to greatest extent possible in sizes as indicated. Where not otherwise indicated, provide single unit for each mat installation, but do not exceed manufacturer's maximum size recommendation for units intended for removal and cleaning. Where joints in mats are necessary, space symmetrically and away from normal traffic lanes. Miter corner joints in framing elements, with hairline joints, or provide prefabricated corner units without joints. Where possible, verify sizes by field measurement prior to shop fabrication.
3. Sustainable Design Requirements:
 - a. Provide materials with 100% pre-consumer recycled vinyl for mats and 55 percent recycled aluminum billet for frames.

2.03 ENTRANCE MAT FRAMES

- A. Provide manufacturer's standard design of size and style to mate with insert type and adjacent finish floor or wall construction, for permanent recessed installation in subfloor; complete with corner pins or reinforcing and installation anchorages.
- B. Provide frames of extruded aluminum with 49% pre-consumer and 6% post-consumer material. Coat surface of frame which will contact cementitious material with zinc chromate paint or manufacturer's standard protective coating.
- C. Provide frame members in single lengths or, where frame dimensions exceed maximum available lengths, provide minimum number of pieces possible, with hairline joints equally spaced and pieces spliced together by means of straight connecting pins.

2.04 GRILLES/MATS

- A. Matsinc Soft Grid:
 1. Materials: 100% pre-consumer black recycled vinyl.
 2. Style: Embossed anti-slip surface.
 3. Thickness: 3/8 in.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Install recessed frames and entrance mats to comply with manufacturer's instructions at locations indicated and with top frames and mats in proper relationship to one another and to adjoining finished flooring. Set mat tops at proper height for most effective cleaning action; coordinate top of mat surfaces with doors that swing across mats to provide underdoor clearance.
- B. Install mats, foot grilles, and other finish flooring units near time of Substantial Completion.

3.02 PROTECTION

- A. Upon completion of frame installations and concrete work, provide temporary filler of plywood or fiberboard in mat recesses and cover frames with plywood protective flooring. Maintain protection until construction traffic has ended and Project is near time of Substantial Completion.

END OF SECTION

SECTION 12 49 40
SHADES

PART 1 – GENERAL

1.01 SUMMARY

A. Section includes:

1. Roll shades, motorized.
2. Combination Top-Down/Bottom-Up shades, manual and motorized.

1.02 SUBMITTALS

A. Product Data:

1. Submit for each type of shade specified. Include printed data on physical characteristics.

B. Shop Drawings:

1. Show location and extent of shades.
2. Show installation details at and relationship to adjoining work.
3. Include elevations indicating shade units.
4. Indicate locations of shade controls.
5. Motorized Systems: Provide shade assembly and mounting details, including wiring diagrams.

C. Samples for initial selection purposes in manufacturer's standard sizes showing full range of colors, textures, and patterns available for each type of shade indicated.

D. Samples for Verification Purposes: One 18 in. square sample of shade material for each color, texture, and pattern of shade required.

E. Submit in accordance with Section 01 33 00.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Engage experienced Installer who has specialized in installing shades similar to those required for this Project.

B. Flame-resistant materials shall pass or exceed one or more of following tests:

1. National Fire Protection Association (NFPA) 7019 small scale for horizontal applications).
2. Department of Transportation Motor Vehicle Safety Standard 302 Flammability of Interior Materials.
3. California Administrative Code Title 19.
4. Federal Standard 191 Method 5903 9used by Port Authority of New York and New Jersey for drapery, curtain, and upholstery material.
5. Boston Fire Department Teat BFD IX-1.
6. New York State Uniform Fire Prevention and Building Code.

C. Single-Source Responsibility: Obtain shades from 1 source of single manufacturer.

1.04 PROJECT/SITE CONDITIONS

- A. Field Measurements: Check openings by field measurements before fabrication. Show recorded measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delay in Work.
 - 1. Where field measurements cannot be made without delaying Work, guarantee opening dimensions and proceed with fabricating shades without field measurements. Coordinate wall and ceiling construction to ensure that actual opening dimensions correspond to guaranteed dimensions.

1.05 MAINTENANCE

- A. Provide cleaning and maintenance instructions using practices and products that are zero VOC and comply with LEED Existing Building requirements.

1.06 WARRANTY

- A. Fabrics warranted for 5 years.

PART 2 – PRODUCTS

2.01 MATERIALS AND FABRICATION

- A. Components: Noncorrosive, self-lubricating materials.
- B. Shade Units: Fill opening with not more than ¼ in. clearance at jambs and 3/8 in. clearance at sill.
 - 1. Fabricate end-to-end installations with terminations at mullions or other defined vertical separations.
- C. Electric Motors (where specified): UL approved, low-voltage motor with thermal overload switch. Each motor unit sized and provided by shade fabricator for installation indicated. Manufacturers motorization packaged complete with 120 VAC, 1-phase and switches for complete installation. Provide with four master switches which control shades in Administration Building in Conference Room north wall, Conference Room east wall, Conference Room clerestory (south wall) and remainder of clerestory.
- D. Installation Fasteners: Not less than 2 fasteners per bracket, fabricated from metal noncorrosive to shade hardware and adjoining construction and to support shades under conditions of normal use.

2.02 SHADES

- A. Shade Designation: Blackout.
 - 1. Locations: Administration Building, Conference/Training Room 104.
 - 2. Manufacturer's Name: Hunter Douglas contract or equal.
 - a. Product Name: Roller Shades FR.
 - b. Color: Color to be selected by Owner from manufacturer's full range of colors produced for shades specified.
 - c. Openness Factor: Blackout.
 - 3. Mounting: Wall.
 - 4. Direction of Roll: Reverse.
 - 5. Operation: Top down. Motor with wall switch.

- a. Static operating mode to stop and hold shade at any position.
 - 6. Fascia: To match shade material.
 - 7. Side and Sill Closure Channels: Between shade side and window jambs and between hem bar and window sill.
 - a. Finish: Anodized aluminum.
- B. Shade Designation: Solar Control.**
1. Location and Operation (Administration Building 900):
 - a. Plant Operations Superintendent Office 131, south and east window, manual.
 - b. Clerestory Break Room 105 and (north and west window) Break Room 105. Electric operated.
 - c. Offices 129, and 130, south windows, manual.
 - d. Conference Room, east window, manual.
 2. Location and Operation (Process Control Building 120):
 - a. Chemist Office Room 105, Work Station Room 106, Control Room 102 and Laboratory Room 103 windows, manual.
 3. Manufacturer's Name: Hunter Douglas or equal.
 - a. Product Name: Combination Top-Down/Bottom-Up.
 - b. Color: As selected by OWNER from manufacturer's full range of colors produced for shades specified.
 4. Mounting: Jamb mounted.
 5. Operation: Top-down operation. Manual or motor with wall switch as noted.
 - a. Static operating mode to stop and hold shade at any position.
 6. Shade Treatment: Double-cellular honeycomb.

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Examine openings where shades will be installed prior to beginning installation. Verify that critical dimensions are correct and surface conditions acceptable.
 1. Complete finishing operations, including painting, before beginning installation.
- B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install shades level and plumb, mounted not less than 1 in. from face of exterior glass.
- B. Install metal parts isolated from concrete or mortar to prevent corrosion.
- C. Install mounting brackets with at least 2 fasteners per bracket.

3.03 CLEANING

- A. After completing installation, clean shade surfaces according to manufacturer's instructions.
- B. Remove surplus materials, packaging, rubbish and debris resulting from installation. Leave areas where installation occurred neat, clean, and ready for use.

END OF SECTION

SECTION 12 51 00
OFFICE FURNITURE

PART 1 – GENERAL

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Desks.
2. Chairs.
3. Stools.
4. Wall Cases.
5. Bookcases.
6. Tables.
7. Files
8. Work Stations.

B. Materials and equipment in this Section shall be provided by a single vendor or supplier.

1.02 SUBMITTALS

A. Product Data:

1. For each product specified, manufacturer's technical data, colored illustrations, indicating materials, hardware, finishes, and assembly instructions.
2. Mark items by model number including options. Key in model numbers to Shop Drawings and illustrations.

B. Shop Drawings:

1. Floor plan drawing illustrating location of furniture and accessories being provided. Each item shall be shown using same furniture reference numbers.

C. Samples:

1. Actual samples of fabric, plastic laminate, vinyl, plastics as specified for equipment provided.
2. Color chips of available enamel finishes.

D. LEED Documentation:

1. Evidence of use of recycled materials.
2. Evidence of use of low emitting (VOC) paints and coatings.
3. Evidence of regional manufacturing.

E. Submit in accordance with Section 01 33 00.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Deliver to Project site in original factory wrappings and containers, clearly labeled with identification of manufacturer, brand name, and lot number.

- B. Store materials in original undamaged packages and containers inside well ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity. Lay flat and block off ground to prevent sagging or warping.
- C. Comply with manufacturer's instructions and recommendations for special storage and handling requirements.
- D. Do not deliver furniture until painting, wet work, and grinding operations have been completed.

1.04 WARRANTY

- A. Warrant against defects in design, materials, and workmanship for 10 yrs from Substantial Completion, except as noted below:
 - 1. Operating components, electrical components, and functional mechanisms: 5 yrs.
 - 2. Wood seating products, high wear parts such as casters, fabrics, and other covering materials, wood veneers: 3 yrs.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Unless otherwise noted, manufacturers furniture products identified in this specification establish quality and type desired only.
- B. Vendor Supplier:
 - a. Eamons Business Interiors, Inc, Milwaukee, WI
 - b. Or approved equal.

2.02 DESKS, BRIDGES, CREDENZAS, AND RETURNS

- A. Executive Desk Type A:
 - 1. Manufacturers:
 - a. HON
 - b. Or approved equal.
 - 2. Top and Chassis: 1 3/16 in. bookmatched veneer or High Pressure Laminate (HPL).
 - 3. Finish: American Walnut, Medium Cherry or Medium Oak.
 - 4. Veneer chassis fastened by screws, glue and hardwood cleats.
 - 5. Pedestals: 3/4 or full.
 - 6. 3/4 in. full modesty panel.
 - 7. Drawers: Hardwood sides, backs, and drawer bottoms. Dovetail construction.
 - 8. Drawer Suspension: File drawers have full extension, other drawers have 3/4 extension with ball bearing rollers.
 - 9. Locking: Standard lock in pedestals with black removable cores.
- B. Storage Credenza:
 - 1. Manufacturers:
 - a. HON
 - b. Or equal.

2. Top and Chassis: 1 3/16 in. bookmatched veneer or High Pressure Laminate (HPL).
3. Finish: American Walnut, Medium Cherry or Medium Oak.
4. Veneer chassis fastened by screws, glue and hardwood cleats.
5. Pedestals: 3/4 or full.
6. Dimensions: 30 in. or 36 in deep x 72 in. long.
7. Drawers: Hardwood sides, backs, and drawer bottoms. Dovetail construction.
8. Drawer Suspension: File drawers have full extension, other drawers have 3/4 extension with ball bearing rollers.
9. Locking: Standard lock in pedestals with black removable cores.

C. Bridge:

1. Manufacturers:
 - a. HON
 - b. Or approved equal.
2. Top and Chassis: 1 3/16 in. bookmatched veneer or High Pressure Laminate (HPL).
3. Finish: American Walnut, Medium Cherry or Medium Oak.
4. Veneer chassis fastened by screws, glue and hardwood cleats.
5. Dimensions: 24 in. deep x 42 in. or 48 in. long.

D. Secretarial Desk Type B:

1. Manufacturers:
 - a. National Office Furniture (NOF), Series Waterfall.
 - b. Or approved equal.
2. Top: 1 1/16 in. thick High Pressure Laminate (HPL).
3. End Panels: 1 in. thick.
4. Finish: American Walnut, Medium Grey, or Medium Oak.
5. Veneer chassis fastened by screws, glue and hardwood cleats.
6. Pedestals: 3/4.
7. 3/4 in. thick, modesty panel, U Bridge has full panel.
8. Drawers: Laminate sides, backs, and drawer bottoms. Tongue and groove construction.
9. Drawer Suspension: File drawers have full extension, other drawers have 3/4 extension with ball bearing rollers.
10. Locking: Standard lock in pedestals with black removable cores.

E. Operational Return:

1. Manufacturers:
 - a. HON
 - b. Or approved equal.
2. Top: 1 1/16 in. thick High Pressure Laminate (HPL).
3. End Panels: 1 in. thick.
4. Finish: American Walnut, Medium Grey, or Medium Oak.
5. Veneer chassis fastened by screws, glue and hardwood cleats.
6. Pedestals: 3/4, left or right return.
7. Dimensions: 24 in. deep x 45 in. wide.
8. Drawers: Laminate sides, backs, and drawer bottoms. Tongue and groove construction.

9. Drawer Suspension: File drawers have full extension, other drawers have 3/4 extension with ball bearing rollers.
10. Locking: Standard lock in pedestals with black removable cores.

F. Desks (Work Stations):

1. Manufacturers:
 - a. HON
 - b. Or approved equal.
2. Material: Frame 16 ga. steel; top plastic laminate.
3. Pedestal: 24 in. hanging pedestal box/file.
4. Cabinet: Open or enclosed, see attached drawing.
5. Lights: Task light.
6. Privacy Screens:
7. Finish: Baked enamel on steel surfaces..

2.03 CHAIRS

A. Desk Chair Type A:

1. Manufacturers:
 - a. HON
 - b. Or approved equal.
2. Seats and Backrests:
 - a. Molded foam and upholstery glued to 7/16 in. thick plywood. Molded plastic liner covers bottom.
 - b. Upholstered back.
3. Upholstery: Fabric, Group 4A, 4B.
4. Recessed Arms: No arms, urethane fixed, or adjustable.
5. Pneumatic height adjustment.
6. Base: Metal, 5 leg, w/carpet casters, glides or hard floor casters.
7. Color: Selected by ARCHITECT from manufacturers standard colors.

B. Desk Chair Type B:

1. Manufacturers:
 - a. HON
 - b. Or approved equal.
2. Seats and Backrests:
 - a. Molded foam and upholstery glued to 1/2 in. thick plywood. Molded plastic liner covers bottom
 - b. Poly plastic or upholstered back.
3. Upholstery: Group 4A, 4B.
4. Recessed Arms: Urethane fixed or adjustable.
5. Pneumatic height adjustment, adjustable back height..
6. Base: Metal, 5 leg w/carpet casters, glides or hard floor casters.

7. Color: Selected by ARCHITECT from manufacturers standard colors.

C. Guest Chair:

1. Manufacturers:
 - a. HON
 - b. Or approved equal.
2. Upholstery: Group 4A, 4B.
3. Fully upholstered or poly back panel.
4. Arms: No arms or urethane fixed.
5. Base: 1 1/8 in round metal tubing, sled base.
6. Color: Selected by ARCHITECT from manufacturers standard colors.

D. Stacking Chairs:

1. Manufacturers:
 - a. HON
 - b. Or approved equal.
2. Material: Unupholstered thermoplastic shell.
3. Nonganging or ganging.
4. Legs: 1 1/4 in. od seam welded oval tubular steel frame.
5. Arms: Armless or plastic capped arms.
6. Color: Color of shell and legs selected by ARCHITECT from manufacturer's standard colors.

2.04 STOOLS

A. Stools (lab upholstered):

1. Manufacturers:
 - a. HON
 - b. Or approved equal
2. Seats and Backrests:
 - a. Molded foam and upholstery glued to 1/2 in. thick plywood. Molded plastic liner covers bottom.
 - b. Poly plastic or upholstered back.
3. Upholstery: Group 4A, 4B.
4. Recessed Arms: Fixed or adjustable height, tubular steel frame w/urethane armrest or no arms.
5. Adjustments: Pneumatic seat height adjustment, back height.
6. Base: Metal, 5 leg w/carpet casters, glides or hard floor casters, and foot ring,.
7. Color: Selected by ARCHITECT from manufacturers standard colors.

2.05 BOOKCASES AND HUTCHES

A. Hutch (Wood):

1. Manufacturer:

- a. HON.
 - b. Or approved equal.
 - 2. Top and Chassis: 1 3/16 in. bookmatched veneer or High Pressure Laminate (HPL).
 - 3. Finish: American Walnut, Medium Cherry or Medium Oak.
 - 4. Veneer chassis fastened by screws, glue and hardwood cleats.
- B. Bookcase (Wood):
- 1. Manufacturers:
 - a. HON
 - b. Or approved equal.
 - 2. Top and Chassis: 1 3/16 in. bookmatched veneer or High Pressure Laminate (HPL).
 - 3. Finish: American Walnut, Medium Cherry or Medium Oak.
 - 4. Veneer chassis fastened by screws, glue and hardwood cleats.
 - 5. Support 100 lbs evenly distributed weight.
 - 6. Adjustable shelves.
- C. Bookcase (steel):
- 1. Manufacturers:
 - a. HON
 - b. Or approved equal.
 - 2. Material: Shell (18 and 20 ga steel), shelves (22 ga steel).
 - 3. Depth: 12 in. or 15 in.
 - 4. Height: 28 in. (1 shelf), 42 in. (2 shelves), 54 in. (3 shelves), or 66 in. (4 shelves).
 - 5. Width: 36 in.
 - 6. Shelves: Adjustable.
 - 7. Adjustable floor glides.
 - 8. Laminate Top: as indicated in schedule.
 - 9. Color: Selected by ARCHITECT from manufacturers standard colors.

2.06 TABLES

A. Round (Single Leg)

- 1. Manufacturers:
 - a. HON
 - b. Or approved equal
- 2. Top:
 - a. 1 1/4 in. thick, solid core particle board.
 - b. High pressure melamine laminate top surface.
 - c. 1 1/4 in round vinyl bullnose edge.
 - d. Diameter: 30, 36, 42, or 48 in.
- 3. Base:
 - a. 14 ga. 3 in. round steel upright column and 4 16 ga. 1 3/4 in x 7/8 in elliptical foot

- tubes.
- b. Adjustable guides threaded to foot tubes.

4. Color: Selected by ARCHITECT from manufacturers standard colors.

B. Rectangular Table:

1. Manufacturers:

- a. HON
- b. Or approved equal

2. Top:

- a. 1 1/4 in. thick, solid core particle board.
- b. High pressure melamine laminate top surface.
- c. 1 1/4 in round vinyl bullnose edge.
- d. Size: as shown on schedule.

3. TT Base:

- a. 2 14 ga. 1 3/4 in. round steel upright columns and 16 ga. 1 3/4 in x 7/8 in elliptical foot tubes.
- b. Adjustable guides threaded to foot tubes.

4. Color: Selected by ARCHITECT from manufacturers standard colors.

C. Folding (metal):

1. Manufacturers:

- a. HON
- b. Or approved equal.

2. Top: 3/4 in. particle board core with plastic laminate surface with 18 ga. steel apron.

3. Edge: Extruded vinyl bullnose.

4. Folding Legs: 18 ga. welded tubular steel.

5. Color: Color of top, edge and legs to selected by ARCHITECT from manufacturers standard colors.

2.07 FILES

A. Lateral Files (Wood):

1. Manufacturers:

- a. HON
- b. Or approved equal.

2. Two drawers.

3. Size: 21 in. x 36 in.

4. Top and End Panels: 1 3/16 in. bookmatched veneer or High Pressure Laminate (HPL).

5. Finish: American Walnut, Medium Cherry or Medium Oak.

6. Veneer chassis fastened by screws, glue and hardwood cleats.

7. Drawers: Hardwood sides, backs, and drawer bottoms. Dovetail construction.

8. Drawer Suspension: File drawers have full extension, other drawers have 3/4 extension

- with ball bearing rollers.
9. Locking: Standard lock in pedestals with black removable cores.

B. Lateral Files (Wood):

1. Manufacturers:
 - a. HON
 - b. Or approved equal.
2. Two drawers.
3. Size: 20 in. x 36 in.
4. Top: 1 1/16 in. thick High Pressure Laminate (HPL).
5. End Panels: 1 in. thick.
6. Finish: American Walnut, Medium Grey, or Medium Oak.
7. Veneer chassis fastened by screws, glue and hardwood cleats.
8. Drawers: Laminate sides, backs, and drawer bottoms. Tongue and groove construction.
9. Drawer Suspension: File drawers have full extension, other drawers have 3/4 extension with ball bearing rollers.
10. Locking: Standard lock in pedestals with black removable cores.

C. Lateral File (Steel):

1. Manufacturers:
 - a. HON
 - b. Or approved equal
2. Construction:
 - a. Shell: 20 ga steel.
 - b. Drawers: 22 ga steel with 2 heavy duty, three section, ball bearing suspensions.
3. Width: 30, 36 or 42 in.
4. Depth: 18 in.
5. Height: 27 in. (2 drawer), 38 in. (3 drawer), 49 in. (4 drawer), or 64 in. (4 drawer and 1 receding door).
5. Locks: Keyed locks.
6. Color: Baked enamel finish, color selected by ARCHITECT from manufacturers standard.

D. Vertical File (Steel):

1. Manufacturers:
 - a. HON
 - b. Or approved equal
2. Construction:
 - a. Shell: 20 ga steel.
 - b. Drawers: 22 ga steel with 2 heavy duty, 3 section, ball bearing suspensions.
3. Width: 15 or 18 in.
4. Depth: 28 in.
5. Height: 27 in. (2 drawer), 38 in. (3 drawer), 49 in. (4 drawer), or 60 in. (5 drawer).

- 6. Locks: Keyed locks.
- 7. Color: Baked enamel finish, color selected by ARCHITECT from manufacturers standard.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install after other finishing operations, including painting is complete.
- B. Wall Mounted Accessory Units: Install accessories complying with manufacturer's printed instruction, using fasteners as recommended by manufacturer as appropriate to substrate.
- C. Free Standing Accessory units: Install free standing units in indicated locations or where designated by ARCHITECT.
- D. Keying: Meet with OWNER to coordinate keying requirements.
- E. Locks: Provide factory installed lock plugs for onsite custom keying.

3.02 ADJUST AND CLEAN

- A. Adjust accessory items for proper operation.
- B. Clean and polish exposed surfaces, using materials and methods recommended by manufacturer.

3.03 PROTECTION

- A. Protect accessories against damage during remainder of construction period, complying with manufacturer's directions.

3.04 FURNITURE SCHEDULE

Room	Quantity	Description	Manufacturer/Series	Remarks
				To be provided through Addendum

Room	Quantity	Description	Manufacturer/Series	Remarks

END OF SECTION

DIVISION 14
CONVEYING EQUIPMENT

SECTION 14 65 00
HOISTING EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Portable davit crane and bases.

1.02 REFERENCES

A. ANSI: American National Standards Institute

B. AISC: American Institute of Steel Construction

1.03 SUBMITTALS

A. Product Data:

1. Manufacturer's literature, installation drawings, and equipment details.

B. Operation and Maintenance (O&M) Data:

- C. Submit in accordance with Section 01 33 00 and 01 78 50.

1.04 QUALITY ASSURANCE

- A. Proportion parts of mechanisms for stresses that occur during continuous operation, during fabrication, and during installation.

1.05 IEPA LOAN REQUIRED DOCUMENTATION – AMERICAN IRON & STEEL

- A. Pursuant to the IEPA loan being used to finance the project, the Contractor and his/her suppliers shall comply with Section 436 of federal H.R. 3547, which are requirements regarding the use of American iron and steel products. These requirements apply to and are binding to the manufacturer of the products specified in the Section.

- B. The manufacturer shall provide with the shop drawing submittal one (1) signed and dated original of the fully completed Certification Letter (a sample copy of which is provided on page A-00 30-80-3 of this manual). Said form shall demonstrate compliance with Section 436 of federal H.R. 3547.

PART 2 - PRODUCTS

2.01 TRANSPORTABLE DAVIT CRANE AND ACCESSORIES

A. Manufacturers:

1. Thern, Inc., Model Commander 2000 5PT20 w/ M3 winch.
2. Or equal.

- B. Provide two 1000 lbs. capacity manual transportable davit crane.

- C. Provide thirty six floor mounted pedestal supports. Use stainless steel anchor bolts.
- D. Provide weep holes for floor mounted pedestal supports.
- E. Crane shall be fully operable from support bases at locations shown on Drawings.
- F. Hand winch to be provided with spur gear and equipped with disc brake.
- G. Hand winch shall have removable handle for operation by electric driver. Winch handle shall be suitable for cranking operation from either side.
- H. Mast and boom to be stainless steel.
- I. Minimum 3 telescoping boom lengths; at least one length minimum of 24 inches from support base center, and another minimum 80 inches from support base center.
- J. Crane(s) and base(s) shall be stainless steel construction.
- K. Winch(s) shall be stainless steel construction.
- L. Wire rope and hook shall be stainless steel.
- M. Crane lift shall extend to 25 feet below the floor level.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install davit crane as shown on Drawings, approved submittals, and in accordance with manufacturer's written recommendations.

END OF SECTION

DIVISION 21
FIRE SUPPRESSION

SECTION 21 10 00
WATER-BASED FIRE-SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Fire protection service piping from new water service to fire protection riser to serve the Building 125 Chemical Room.
2. Fire protection service piping from new water service to fire protection riser to serve the Building 900.
3. Fire protection riser piping to distribution systems, including alarm valves, flow switches, and tamper switches.
4. Fire protection distribution piping from risers to sprinkler heads, including access to valves in enclosed ceilings and walls.

1.02 SYSTEM DESCRIPTION

A. Design Requirements:

1. Design Criteria:

a. Fire Protection System 1:

- 1) Occupancy Classification: Ordinary Hazard, Group 1.
- 2) System Type: Wet pipe system.
- 3) Area of Sprinkler Protection: 1,165 sq ft.
- 4) Area of Sprinkler Operation: 1,500 sq ft. or size of area served.
- 5) Density of Water Application: 0.15 gpm/sq ft minimum.
- 6) Area per Sprinkler: 130 sq ft.
- 7) Allowance for Inside Hose: None.
- 8) Allowance for Combined Inside and Outside Hose: 250 gpm

b. Fire Protection System 2:

- 1) Occupancy Classification: Light Hazard, Group 1.
- 2) System Type: Wet pipe system.
- 3) Area of Sprinkler Protection: 8844 sq ft.
- 4) Area of Sprinkler Operation: 1,500 sq ft. or size of area served.
- 5) Density of Water Application: 0.10 gpm/sq ft minimum.
- 6) Area per Sprinkler: 130 sq ft.
- 7) Allowance for Inside Hose: None.
- 8) Allowance for Combined Inside and Outside Hose: 100 gpm

2. Water Supply Information:

- 1) Contractor shall obtain fire test data prior to system design. For purposes of bidding, Contractor shall assume 60-psig static pressure and 40-psig residual at 1,000gpm.

1.03 SUBMITTALS

A. Submittal Information.

1. Product Data: Submit manufacturer's data for fire protection systems, materials, and products.
2. Shop Drawings: Submit scaled layout drawings approved by local Fire Marshall and Owner's insurance carrier for fire protection pipe and fittings including, but not necessarily limited to, pipe and tube sizes, locations, elevations and slopes of horizontal runs, wall and floor penetrations, and connections. Show interface and spatial relationship between piping and proximate equipment. Submit hydraulic calculations.
3. Fire Protection System supplier responsible for submittals as required to Local and State agencies for review of Fire Protection System and all fees associated with such reviews. No system submittal will be reviewed or approved without prior State and/or Local approval. Material only submittals will be reviewed prior to agency review, but installation shall not begin prior to full approval.

B. Miscellaneous:

1. Certificate of Installation: Submit certificate upon completion of fire protection piping work which indicates work has been tested in accordance with NFPA Nos. 13, 14, and 20, and that system is operational, complete, and has no defects.

C. Submit in accordance with Section 01 33 00.

1.04 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of fire protection piping systems products, of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 yrs.

B. Regulatory Requirements:

1. Factory Mutual (FM) Labels: Provide sprinkler products bearing FM approval labels.
2. Underwriter's Laboratory (UL) Labels: Provide fire sprinkler piping products which have been approved and labeled by Underwriters Laboratories.
3. Local Fire Department/Marshall Regulations: Comply with governing regulations pertaining to fire sprinkler piping.
4. Insurance Compliance: Comply with regulations and requirements of Owner'S insurance carrier. Where discrepancies exist between requirements of insurance carrier and local fire marshall, more stringent requirements governs.

1.05 MAINTENANCE

A. Extra Materials:

1. For each style and temperature range required, furnish additional sprinkler heads, amounting to 1 unit for every 100 installed units, but not less than 6 units of each.
2. Furnish replacement heads with tools necessary for removal and replacement of heads in red colored, lockable carrying case.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Manufacturer's equipment used as basis of design for this project is name indicated in specification for particular type of equipment or application contained in Contract Documents. If no manufacturer is listed, basis of design is industry standard indicated.

2.02 PIPING MATERIALS AND PRODUCTS

- A. Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities indicated. Where not indicated, provide proper selection determined by Contractor to comply with installation requirements.
- B. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in fire protection piping systems.
- C. Where more than one type of materials or products are indicated, selection is Contractor's option.

2.03 BASIC IDENTIFICATION

- A. Comply with following:
 - 1. Plastic Pipe Markers:
 - a. Snap-On Type: Manufacturer's standard preprinted, semi-rigid snap-on, color coded pipe markers complying with ANSI A13.1.
 - 2. Valve Tags:
 - a. 19 ga polished brass valve tags with stamp engraved piping system abbreviation in 1/4 in. high letters, sequenced valve numbers 1/2 in. high, and 5/32 in. hole for fastener.
 - b. 1 1/2 in. dia tags except as otherwise indicated.

2.04 BASIC PIPE, TUBE, AND FITTINGS

- A. All piping materials shall be UL listed for the application.
- B. Interior piping located in Building 125:
 - 1. Stainless Steel Pipe:
 - a. Threaded:
 - i. Pipe Weight: ASTM A312/A312M Schedule 40.
 - ii. Fittings: ASTM A403/A403M, Class 125, stainless steel.
- C. Interior piping located in Building 900:
 - 1. Black Steel Pipe:
 - a. Threaded:
 - i. Pipe Weight: ASTM A53/A53M Schedule 40.
 - ii. Fittings: Class 125, cast iron threaded.
 - b. Mechanical Fittings:
 - i. Pipe Weight: ASTM A135/A135M Schedule 10.
 - ii. Fittings: Class 125, mechanical grooved pipe couplings and fittings; cut-groove type.

2.05 PIPING SPECIALTIES

- A. Pipe Escutcheons:
 - 1. Manufacturers:

- a. Chicago Specialty Manufacturing Company.
 - b. Producers Specialty Manufacturing Corporation.
 - c. Sanitary-Dash Manufacturing Company.
 - d. Or equal.
2. Provide pipe escutcheons with inside diameter closely fitting pipe outside dia, or outside of pipe insulation where pipe is insulated. Selected outside diameter of escutcheon to cover pipe penetration hole in floors, walls or ceilings and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas. Prime paint finish for unoccupied areas.
 3. Pipe Escutcheons: Provide cast brass or sheet brass escutcheons, solid or split hinged.
- B. Dielectric Unions:
1. Manufacturers:
 - a. B&K Industries, Inc.
 - b. Capital Manufacturing Company, Division of Harsco Corporation.
 - c. Eclipse, Inc.
 - d. Epco Sales, Inc.
 - e. Perfection Corporation.
 - f. Rockford Eclipse Division.
 - g. Or equal.
 2. Standard products recommended by manufacturer for use in service indicated which effectively isolate ferrous from nonferrous piping (electrical conductance), prevent galvanic action, and stop corrosion.
- C. Mechanical Sleeve Seals:
1. Manufacturers:
 - a. Thunderline Corporation.
 - b. Or equal.
 2. Modular mechanical type consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve.
 3. Connect with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.
- D. Fire Barrier Penetration Seals:
1. Manufacturers:
 - a. Electro Products Division/3M.
 - b. Nelson; Unit of General Signal.
 - c. Or equal
 2. Cracks, Voids, or Holes up to 4 in. Dia: Use putty or caulking, 1-piece intumescent elastomer, noncorrosive to metal, compatible with synthetic cable jackets, and capable of expanding 10 times when exposed to flame or heat, UL listed.
 3. Openings 4 in. or Greater: Use sealing system capable of passing 3 hr fire test in accordance with ASTM E814, consisting of wall wrap of liner, partitions, and end caps capable of expanding when exposed to temperatures of 250°F to 350°F (121°C to 177°C), UL listed.

2.06 FABRICATED PIPING SPECIALTIES

- A. Drip Pans: Fabricate from corrosion-resistant sheet metal with watertight joints and edges turned up 2 1/2 in. Reinforce top, either by structural angles or by rolling top over 1/4 in. steel rod. Provide hole, gasket, and flange at low point for watertight joint and 1 in. drain line connection.
- B. Pipe Sleeves: Provide one of following.
 - 1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint.
 - a. 3 in. and Smaller: 20 ga.
 - b. 4 in. to 6 in.: 16 ga.
 - c. Over 6 in.: 14 ga.
 - 2. Steel Pipe: Schedule 40 galvanized steel pipe; remove burrs.
 - 3. Iron Pipe: Fabricate from cast iron or ductile iron pipe; remove burrs.
 - 4. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe; remove burrs.
- C. Sleeve Seals: Provide sleeve seals for sleeves located in foundation walls below grade or in exterior walls, of one of following.
 - 1. Lead and Oakum: Caulked between sleeve and pipe.
 - 2. Mechanical Sleeve Seals: Installed between sleeve and pipe.

2.07 BASIC SUPPORTS, ANCHORS, AND SEALS

- A. Provide supports, anchors, and seals complying with NFPA No. 13 and in accordance with following.
 - 1. Pipe supports shall be of galvanized steel construction.
 - 2. Adjustable steel clevises, adjustable steel band hangers, and adjustable band hangers for horizontal piping hangers and supports.
 - 3. Two-bolt riser clamps for vertical piping supports.
 - 4. Steel turnbuckles and malleable iron sockets for hanger rod attachments.
 - 5. Concrete inserts, top beam C-clamps, side beam or channel clamps, and center beam clamps for building attachments.

2.08 VALVES

- A. Comply with NFPA No. 13 and in accordance with following.
 - 1. Gate valves:
 - a. Coated iron body.
 - b. Bolted bonnet.
 - c. Solid wedge
 - d. OS&Y.
 - e. 175-psi non-shock working pressure.
 - f. FM approved.
 - g. Approved for usage in potable water applications, meets NSF 61.
 - h. Provide each isolation gate valve with tamper switch.
 - 2. Backflow Preventer (Chemical Rooms):
 - a. Manufacturers:

- (i) Watts No. 774DCDA.
 - (ii) Or equal.
 - b. Double check detector assembly for fire protection systems.
 - c. Double check valve body shall be stainless steel.
 - d. Epoxy coated cast iron gate valves on both sides of the check valve body.
 - e. Check valves internals shall be of thermoplastic construction with stainless steel hinge pins, cam arm and cam bearing.
 - f. Bypass assembly shall include meter, small diameter double check assembly with test cocks and isolation valves.
3. Backflow Preventer (Mechanical Rooms):
- a. Manufacturers:
 - (i) Watts No. 709DCDA.
 - (ii) Or equal.
 - b. Double check detector assembly for fire protection systems.
 - c. Epoxy coated cast iron check valves.
 - d. Epoxy coated cast iron gate valves on both sides of the check valve body.
 - e. Bypass assembly shall include meter, small diameter double check assembly with test cocks and isolation valves.

2.09 BASIC METERS AND GAUGES

- A. Provide meters and gauges complying with NFPA No. 13, 3-17 Water Flow Detecting Devices, NFPA No. 13, 3-16 Sprinklers, and in accordance with following.
 - 1. Pressure Gauges: 0 to 250 psi range.

2.10 FIRE PROTECTION SPECIALTIES

- A. Manufacturers:
 - 1. Allen (W.D.) Manufacturing Division, J.W. Moon, Inc.
 - 2. Automatic Sprinkler Corporation of America.
 - 3. Chemetron Corporation.
 - 4. Elkhart Brass Manufacturing Company.
 - 5. Grinnell Fire Protection Systems Company, Inc.
 - 6. Viking Corporation.
 - 7. Western Fire Equipment Company.
 - 8. Or equal.
- B. UL listed and in accordance with following list. Provide sizes and types which mate and match piping and equipment connections.
 - 1. Water Flow Indicators: Vane type water flow detectors.
 - 2. Water Motor Gongs: 10-in. weatherproof, red enameled finish, water motor gongs.
 - 3. Supervisory Switches: Products recommended by manufacturer for use in service indicated.
 - 4. Fire Department Connection: Wall connection with satin chrome finish, and plate and caps shall be engraved AUTOMATIC SPRINKLER FIRE DEPARTMENT CONNECTION. Furnish with Fire Departments standard hose thread. Coordinate final sizes and thread with Local Fire Marshal.

5. Automatic Sprinklers: Automatic sprinklers of type indicated on Drawings, and in accordance with following. Provide fusible links for 165°F (74°C) unless otherwise indicated.
 - a. Upright.
 - b. Pendent.
 - c. Vertical sidewall.
 - d. Conventional; 40% discharge upward, 60% downward.
 - e. Flush pendent.
 - f. Horizontal sidewall.
 - a. Finish: All heads shall be of brass or stainless steel construction.
6. Sprinkler Cabinet and Wrench: Steel, baked red enameled sprinkler box with capacity to store 10 sprinklers and wrench sized to sprinklers.

PART 3 – EXECUTION

3.01 INSTALLATION OF BASIC IDENTIFICATION

- A. Install pipe markers on each fire protection system including arrows showing normal direction of flow.
- B. Install fire protection signs on piping in accordance with NFPA Nos. 13, 14, and 20 requirements, and in accordance with requirement of authority having jurisdiction and Owner's insurance carrier. Where conflicting requirements exist, install in accordance with most stringent requirements.
- C. Install sign on each riser indicating static and residual pressure, flow in gpm, and area served.
- D. Locate pipe markers and color bands as follows wherever piping exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums), and exterior nonconcealed locations.
- E. Valve Identification:
 1. Provide valve tag on every valve, cock, and control device in each piping system.
 2. Exclude check valves, valves within factory fabricated equipment units.
 3. List each tagged valve in valve schedule for each piping system.

3.02 INSTALLATION OF PIPE, TUBE, AND FITTINGS

- A. Install pipe, tube, and fittings in accordance with NFPA No. 13.
- B. Fire Sprinkler Piping Systems:
 1. Comply with requirements of NFPA No. 13 for installation of fire sprinkler piping materials. Install fire sprinkler piping products where indicated in accordance with manufacturer's written instructions, and in accordance with recognized industry practices, to ensure fire sprinkler piping complies with requirements and serves intended purposes.
 2. Coordinate with other work, including plumbing piping, as necessary to interface components of fire sprinkler piping properly with other work.
 3. Install sectional valves in inlet piping at bottom of each riser and in loops as indicated.
 4. Mount supervisory switches on each sectional valve.
 5. Install air vents at high points of sprinkler piping.
 6. Install drain piping at low points of fire sprinkler piping.
 7. Install manual shutoff at each audible alarm station.
 8. Wire all tamper and alarm switches to nearest Fire Alarm Panel.

3.03 INSTALLATION OF PIPING SPECIALTIES

- A. Pipe Escutcheon: Install pipe escutcheons on each pipe penetration through floors, walls, partitions, and ceilings where penetration is exposed to view and on exterior of building. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole and is flush with adjoining surface.
- B. Dielectric Unions: Install at each piping joint between ferrous and nonferrous piping. Comply with manufacturer's installation instructions.
- C. Mechanical Sleeve Seals: Loosely assemble rubber links around pipe with bolts and pressure plates located under each bolt head and nut. Push into sleeve and center. Lighten bolts until links have expanded to form watertight seal.
- D. Fire Barrier Penetration Seals: Fill entire opening with sealing compound. Adhere to manufacturer's installation instructions.
- E. Pipe Sleeves:
 - 1. Install types indicated where piping passes through walls, floors, ceilings, and roofs.
 - 2. Do not install sleeves through structural members of work, except as detailed on Drawings or as reviewed by Engineer.
 - 3. Install sleeves accurately centered on pipe runs.
 - 4. Size sleeves so that piping and insulation (if any) will have free movement in sleeve, including allowance for thermal expansion but not less than pipe sizes larger than piping run. Where insulation includes vapor-barrier jacket, provide sleeve with sufficient clearance for installation.
 - 5. Install length of sleeve equal to thickness of construction penetrated, and finish flush to surface except floor sleeves. Extend floor sleeves 1/4 in. above level floor finish, and 3/4 in. above floor finish sloped to drain.
 - 6. Provide temporary support of sleeves during placement of concrete and other work around sleeves and provide temporary closure to prevent concrete and other materials from entering sleeves.
 - 7. Install sheet metal sleeves at interior partitions and ceilings other than suspended ceilings.
 - 8. Install iron pipe sleeves at exterior penetrations; both above and below grade.
 - 9. Install steel pipe or plastic pipe sleeves except as otherwise indicated.

3.04 INSTALLATION OF SUPPORTS, ANCHORS, AND SEALS

- A. Install in accordance with NFPA No. 13.

3.05 INSTALLATION OF VALVES

- A. Install in accordance with NFPA No. 13.

3.06 INSTALLATION OF METERS AND GAUGES

- A. Install in accordance with NFPA No. 13.

3.07 INSTALLATION OF FIRE PROTECTION SPECIALTIES

- A. Install in accordance with NFPA Nos. 13.

3.08 ADJUSTING

- A. Sprinkler Piping Flushing: Prior to connecting sprinkler risers for flushing, flush water feed mains, lead-in connections, and control portions of sprinkler piping. After fire sprinkler piping installation has been completed and before piping is placed in service, flush entire sprinkler system, as required to remove foreign substances, under pressure as specified in NFPA No. 13. Continue flushing until water clear, and check to ensure debris has not clogged sprinklers.

3.09 FIELD QUALITY CONTROL

- A. Hydrostatic Testing: After flushing system, test fire sprinkler piping hydrostatically, for period of 2 hrs, at not less than 200 psi or at 50 psi in excess of maximum static pressure when maximum static pressure is in excess of 150 psi. Check system for leakage of joints. Measure hydrostatic pressure at low point of each system or zone being tested.
 - 1. Repair or replace piping system required to eliminate leakage in accordance with NFPA standards for no visible leakage and retest as specified to demonstrate compliance.

END OF SECTION

DIVISION 22

PLUMBING

SECTION 22 00 05
PLUMBING SYSTEMS

PART 1 – GENERAL

1.01 SUMMARY

A. This section includes plumbing equipment, fixtures, insulation and piping systems, including:

1. Domestic Water Piping System:

- a. Domestic cold water piping (W1, W2 and W3).
- b. Domestic hot water piping (HW, HWRE, TW).
- c. Exterior water piping.

2. Soil and Waste Piping Systems:

- a. Above ground soil, waste and vent piping in buildings including traps and connections to fixtures and drains.
- b. Underground soil waste and vent piping terminating at connection to sanitary sewers 10 feet outside inner face of foundation wall.

3. Sump Pump and associated discharge piping.

4. Storm Water Piping Systems:

- a. Conductor piping from roof drains and deck drains to storm building drain.
- b. Storm building drain piping from conductor piping and area drains to storm sewers 10 feet outside inner face of foundation wall.

5. Laboratory Piping

- a. Vacuum and air piping (VAC, AIR).
- b. Autoclave steam vent piping (SV).
- c. Deionized water (DI).
- d. Acid waste and vent piping for drainage of lab sink and fixtures (AW and AV).

1.02 DEFINITIONS, ABBREVIATIONS AND ACRONYMS

A. Acronyms:

- 1. ABS: Acrylonitrile Butadiene Styrene
- 2. CPVC: Chlorinated Polyvinyl Chloride
- 3. CWP: Cold Working Pressure
- 4. DR: Dimension Ratio
- 5. DWV: Drain Waste Vent
- 6. EPDM: Ethylene Propylene Diene Monomer
- 7. HDPE: High Density Polyethylene
- 8. IDR: Inside Dimension Ratio
- 9. IPS: Iron Pipe Size
- 10. NPT: National Pipe Thread
- 11. O.S.&Y.: Outside Stem and Yoke
- 12. PE: Polyethylene
- 13. PEX: Crosslinked Polyethylene
- 14. PLC: Programmable Logic Controller, refer to Division 13 for interface requirements
- 15. PTFE: Polyetrafluoroethylene (Teflon®)

- 16. PVC: Polyvinyl Chloride
- 17. TEFC: Totally Enclosed Fan Cooled
- 18. TFE: Tetrafluoroethylene

B. Unit Abbreviations:

- 1. °F: Degrees Fahrenheit
- 2. Btu/Hr: British Thermal Units per Hour
- 3. CFM: Cubic Feet per Minute
- 4. GPH: Gallons per Hour
- 5. GPM: Gallons per Minute
- 6. HP: Horsepower
- 7. kW: Kilowatts
- 8. PSI: Pounds per Square Inch
- 9. RPM: Revolutions per Minute

1.03 REFERENCES

A. Code References:

- 1. ADA: Americans with Disabilities Act

B. Standard References:

- 1. ANSI: American National Standards Institute
- 2. ASME: American Society of Mechanical Engineers
- 3. ASSE: American Society of Sanitary Engineering
- 4. ASTM: American Society for Testing and Materials
- 5. AWWA: American Water Works Association
- 6. CISPI: Cast Iron Soil Pipe Institute
- 7. CDA: Copper Development Association Incorporated
- 8. CSA: Canadian Standards Association
- 9. MSS: Manufacturers Standardization Society
- 10. PDI: Plumbing and Drainage Institute
- 11. UL: Underwriters Laboratories Incorporated

1.04 SUBMITTALS

A. General:

- 1. Submit Product Data in sufficient detail to confirm compliance with requirements of this Section. Submit Product Data and Shop Drawings in one complete submittal package. Partial submittals are unacceptable.

B. Product Data - Submit manufacturer's technical data for all fixtures, drain, valves and equipment. Include in submittal, specifications, capacity ratings, pump curves showing scheduled operating point clearly identified, dimensions, weights, materials, accessories furnished, and installation instructions.

C. Shop Drawings - Submit assembly-type shop drawings showing unit dimensions, construction details, rough-in elevations, methods of assembly of components, and field connection details.

D. Wiring Diagrams - Submit manufacturer's electrical requirements for power supply wiring to equipment. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be

field-installed.

- E. Maintenance Data - Submit maintenance data and parts list for piece of scheduled equipment, accessory, and control. Include this data and product data in maintenance manual in accordance with requirements of Division 1.
- F. Submit in accordance with Section 01 33 00.
- G. Operation and Maintenance (O&M) Data:
 - 1. Operating instructions and maintenance data for materials and products for inclusion in O&M Manual.
 - 2. Manufacturer's written instructions for periodic tests of equipment in service.
 - 3. Submit in accordance with Section 01 78 23.
- H. Submit in accordance with Section 01 33 00.

1.05 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Provide plumbing equipment, fixtures, insulation and piping from firms regularly engaged in manufacture of same types and sizes of equipment required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Plumbing Code Compliance: Comply with all applicable portions of building codes pertaining to plumbing materials, construction and installation of products.
 - 1. Illinois Department of Public Health:
 - a. Part 890: Illinois Plumbing Code.
 - 2. Joliet, Illinois Code of Ordinances
 - a. Plumbing Code Amendments Chapter 8 Article VI, Sec. 8-325
 - 3. All local plumbing codes.
- C. PDI Compliance: Comply with applicable PDI standards pertaining to products and installation of soil waste piping systems.
- D. Manufacturer Qualifications: Firms experienced in manufacturing equipment of types and capacities indicated that have record of successful in-service performance.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver equipment and system components to their final locations in protective wrappings, containers, and other protection that will exclude dirt and moisture and prevent damage from construction operations. Remove protection only after equipment is made safe from such hazards.
- B. Store equipment in clean, dry location.

1.07 IEPA LOAN REQUIRED DOCUMENTATION – AMERICAN IRON AND STEEL

- A. Pursuant to the IEPA loan being used to finance the project, the CONTRACTOR and his/her suppliers shall comply with Section 436 of federal H.R. 3547, which are requirements regarding the use of American iron and steel products. These requirements apply to and are binding to the

manufacturer of the products specified in this Section.

- B. The manufacturer shall provide with the shop drawing submittal one (1) signed and dated original of the AIS Certification Letter (a blank copy of which is provided on page A-00 30 80-3 of this manual). Said letter shall demonstrate compliance with Section 436 of federal H.R. 3547.

PART 2 – PRODUCTS

2.01 GENERAL

- A. Where more than one type is indicated, selection is Contractor's option or compliance with governing regulations
- B. Size system drain piping as shown or, if not shown, as required to properly drain piping systems, including valves and equipment.
- C. Manufacturer's equipment used as basis of design for project is name indicated in Specifications for particular type of equipment or application contained in these contract documents. If no manufacturer listed, basis of design is industry standard indicated.

2.02 DOMESTIC WATER PIPING SYSTEMS

- A. Size 3 inch or smaller, buried:
 - 1. Copper Tube:
 - a. ASTM B88, Type K.
 - b. Fittings: Brass flared connections.
 - c. Valves: Class 150 Bronze.
 - d. ANSI/NSF 61 certified, bearing NSF-61 mark.
- B. Size 3 inch or smaller potable water (W1, TW), in Building 125 Chemical Room:
 - a. CPVC Pipe:
 - 1) ASTM D2846 CPVC pipe, schedule 80.
 - 2) Fittings: ASTM F439, socket weld joints.
 - 3) All plastic pipe and fittings serving potable water systems shall be third party certified to comply with NSF 14.
- C. Size 3 inch or smaller potable water (W1, HW, HWRE, TW), interior, process spaces:
 - a. Stainless Steel Pipe:
 - 1) ASME B36.19M, Schedule 40, seamless stainless steel, type 304L pipe.
 - 2) Fittings: MSS SP-114, Class 150 threaded fittings.
 - 3) Fittings: MSS SP-114, Class 150 socket-weld fittings.
- D. Size 3 inch or smaller, non-potable water (W2 or W3), interior:
 - a. Stainless Steel Pipe:
 - 1) ASME B36.19M, Schedule 40, seamless stainless steel, type 304L pipe.
 - 2) Fittings: MSS SP-114, Class 150 threaded fittings.
 - 3) Fittings: MSS SP-114, Class 150 socket-weld fittings.

E. Size 3 inch or smaller, non-potable water (W3), in Building 125 Chemical Room:

a. Polyvinyl Chloride (PVC) Pipe:

- 1) Pipe Weight: Schedule 80, ASTM D1785.
- 2) Fittings: ASTM D2467, socket weld joints.
- 3) Joints: Solvent cement joints in accordance with ASTM D2855.

F. Size 3-inch or smaller, interior, administrative areas (W1, HW, TW, HWRE):

1. Copper Tube:

- a. ASTM B88, Type L.
- b. ANSI/NSF 61 certified, bearing NSF-61 mark.
- c. Fittings: ANSI/ASME B16.22 wrought copper solder joint
- d. ASTM B3 lead free solder.

G. Size 3 inch or smaller, exterior, non-potable water (W2 or W3):

1. Stainless Steel Pipe:

- a. ASME B36.19M, Schedule 40, seamless stainless steel, type 304L pipe.
- b. Fittings: MSS SP-114, Class 150 threaded fittings.
- c. Fittings: MSS SP-114, Class 150 socket-weld fittings.

H. Size 4 inch or larger, buried or interior:

1. Cement-Lined Ductile Iron:

- a. Furnish and install in accordance with Section 33 11 16 and Section 40 05 19.

2.03 SOIL, VENT AND STORM SYSTEM PIPING

A. Sizes 10 inch or smaller, below ground, within 5'-0" of building footprint:

1. Cast Iron:

- a. ASTM A74, hub and spigot soil pipe and fittings.
- b. Pipe Class: Service Weight.
- c. Joints: Compression gasket or lead and oakum.

B. Sizes 10 inch or smaller, below ground, greater than 5'-0" away from building footprint:

- a. See 33 31 13

C. Sized 10 inch or smaller, above ground:

1. Unless specifically noted, material is Contractors choice between cast iron and PVC.

- a. Soil and vent piping serving Building 125, Chemical room shall be PVC.

2. Cast Iron:

- a. CISPI 301 hubless soil pipe and fittings.
- b. Pipe Class: Service weight.

3. Polyvinyl Chloride (PVC) Pipe:
 - a. Pipe Weight: Type DWV, ASTM D2665.
 - b. Fittings: PVC Plastic, Type DWV, socket type.
 - c. Joints: Solvent cement joints in accordance with ASTM D2855.

2.04 SUMP PUMP PIPING

A. Size 3 inch or smaller, above grade:

1. Polyvinyl Chloride (PVC) Pipe:
 - a. Pipe Weight: Schedule 40, ASTM D1785.
 - b. Fittings: PVC Plastic, Schedule 40, socket type, ASTM 2466.
 - c. Joints: Solvent cement joints in accordance with ASTM D2855.

2.05 LABORATORY PIPING SYSTEMS

A. Air (AIR), Vacuum (VA), Steam vent (SV):

1. Copper Tube:
 - a. ASTM B88, Type L.
 - b. Fittings: Wrought copper with brazed-joint ends conforming to ANSI B16.22.

B. Deionized water (DI)

1. Crosslinked Polyethylene (PEX) for concealed tubing :
 - a. Pipe Weight: ASTM F876, ASTM F877.
 - b. Fittings: ASTM F1807

C. Acid waste and vent piping, above and below grade: (AW, AV)

1. Spears LabWaste, or equal.
2. Flame spread of less than 25 and smoke development of less than 50.
3. CPVC Type IV, ASTM Cell Classification 23447 per ASTM D1784.
4. Piping externally marked to indicate chemical waste service.
5. Fitting to ASTM D331 dimensions.
6. Solvent welded end connections with solvent NSF certified for corrosive waste end use.

D. Natural gas (NG)

1. In accordance with specification 23 11 23

2.06 FLEXIBLE METAL HOSE

A. Manufacturer:

1. Unaflex.
2. Or Equal.

B. Internal flexible core of corrugated-type 321 stainless steel tubing.

C. 304 stainless steel external wire braid reinforcement.

- D. For pipe sizes 2-1/2 inch and larger provide stainless steel flanged connection.
- E. For pipe sizes 2 inch and smaller, provide stainless steel male NPT nipples.

2.07 VALVES

A. General:

- 1. Valves installed in insulated piping systems shall be furnished with extended stem as required to allow operation of valve without damage to or interference with insulation system.
- 2. All valves used on potable water systems (W1, HW, HWRE, TW) shall be of lead free construction suitable for potable water use, complying with NSF/ANSI 61.

B. Iron Body Gate Valves

- 1. Manufacturers:
 - a. Nibco, Figure F-619-RWS.
 - b. Or Equal.
- 2. Class 125 ductile iron body gate valve.
- 3. NSF/ANSI 61 Compliant, Lead free
- 4. Bolted Bonnet.
- 5. Non-rising stem.
- 6. Solid wedge.
- 7. Bronze mounted.
- 8. Flanged ends.
- 9. Rated for 300-psi to 400 deg F.

C. Ball Valves 3 inch and smaller for stainless steel water service:

- 1. Manufacturers:
 - a. Apollo, Figure 76-100.
 - b. Or Equal.
- 2. Comply with MSS-SP-110.
- 3. Conventional port, two-piece stainless steel body for threaded valves.
- 4. Conventional port, three-piece stainless steel body for socket weld valves.
- 5. Stainless steel ball and stem.
- 6. Reinforced TFE Seats.
- 7. 1,000 psi CWP.

D. Ball Valves 3 inch and smaller for PVC water and sump pump discharge service:

- 1. Manufacturers:
 - a. Spears Manufacturing.
 - b. Nibco.
 - c. Hayward Industrial Products, Inc.
 - d. Or equal.
- 2. Provide sizes as indicated on Drawings.

3. PVC construction, ASTM D1784.
 4. Valve shall be true union type.
 5. Provide with socket weld joints.
 - a. Full-port.
 6. PTFE ball seats.
 7. O-rings shall be EPDM.
 8. All valve unions and nuts shall have Buttress threads.
 9. Rated for 150-psi at 73 deg F.
 10. Unless indicated otherwise, provide with double-stop polypropylene handle operator.
- E. Ball Valves 3 inch and smaller for CPVC water service:
1. Manufacturers:
 - a. Spears.
 - b. Nibco.
 - c. Or equal.
 2. Provide sizes as indicated on Drawings.
 1. CPVC construction, ASTM D1784.
 2. Full-port.
 3. Valve shall be true union type.
 4. Provide with socket weld joints.
 5. PTFE ball seats.
 6. O-rings shall be EPDM.
 7. All valve unions and nuts shall have Buttress threads.
 8. Rated for 150-psi at 73 deg F.
 9. Unless indicated otherwise, provide with double-stop polypropylene handle operator.
- F. Ball Valves 3 inch and smaller for copper water service:
1. Manufacturers:
 - a. Nibco, Figure T-580-LF.
 - b. Or Equal.
 2. ½-inch to 3-inch for water service on copper piping systems.
 3. Comply with MSS-SP-110.
 4. Two-piece bronze body.
 5. Full port for sizes 1-in and smaller.
 6. Conventional port for sizes greater than 1-inch.
 7. Silicon bronze stem.
 8. Brass ball.
 9. Reinforced TFE Seats.
 10. 600 WOG rating.
 11. Lead free.
 12. NSF/ANSI 61 and NSF/ANSI 372 Compliant.
- G. Globe Valves 3 inch and smaller for copper water service:
1. Manufacturers:
 - a. Apollo, 120S LF.

- b. Or Equal.
 - 2. ½-inch to 3-inch for water service on copper piping systems.
 - 3. Comply with MSS-SP-80.
 - 4. Bronze body.
 - 5. Solder connection
 - 6. Brass ball.
 - 7. Class 125 valve.
 - 8. Lead free.
 - 9. NSF/ANSI 61 and NSF/ANSI 372 Compliant.
- H. Swing Check Valves used for sump pump discharge:
- 1. Manufacturers
 - a. Spears, Quiet Check Valve.
 - b. Or equal.
 - 2. 2-inch and smaller.
 - 3. PVC construction.
 - 4. Spring controlled rate of close to prevent slamming.
 - 5. True union socket connection.
 - 6. Pressure rating 150 psi when open and 75 psi when closed at 73F.
- I. Swing Check Valves for copper water service:
- 1. Manufacturers:
 - a. Apollo, 161S-LF.
 - b. Or Equal.
 - 2. Comply with MSS-SP-139.
 - 3. Bronze body.
 - 4. Solder connection
 - 5. Renewable bronze seat disc.
 - 6. 200 psi working pressure.
 - 7. NSF/ANSI 372 Compliant.
- J. Wall Hydrants: (WH)
- 1. Manufacturers:
 - a. Woodford, Model 65.
 - b. Or equal.
 - 2. Approved under ASSE Standard 1019-B.
 - 3. 3/4 inch male hose thread connection.
 - 4. Vacuum Breaker.
 - 5. Freeze-proof.
 - 6. Wall clamp.
 - 7. Brass body with chrome plated face plate.
 - 8. Removable key handle

K. Backflow Preventer:

1. Manufacturers:
 - a. Watts No. 909LF.
 - b. Or equal.
2. Reduced pressure principle designed to meet the requirements of ASSE 1013
3. Sizes 2-1/2 inch and larger: Epoxy coated cast iron body.
4. Sizes 2 inch and smaller: Bronze body construction.
5. Lead free construction suitable for potable water use, complying with NSF/ANSI 61.
6. Provide with integral body unions or flanged ends.
7. Provide with strainer.
8. Provide with integral air gap assembly.

L. Emergency Wash Station Tempering Valve: (TMV-1)

1. Manufacturers:
 - a. Lawler Manufacturing Co, Model 911.
 - b. Or equal.
2. Emergency shower mixing valve with two independent control mechanisms which split flow in half and blend split flow to desired temperature at discharge. Thermometer at two inlets and discharge. Anti-scald protection to disrupt hot water if loss of cold water. Designed to comply with ANSI Z358.1. Rated for 125-psi inlet pressure and 180°F inlet temperature.
3. Bronze body construction.
4. Integral inlet check and isolation valves.
5. Capacity: 60 gpm at 30 psig. Capable of maintaining setpoint temperature even if hot or cold water temperature changes 30°F, or a supply pressure reduction of 50%.

M. Emergency Eyewash Tempering Valve: (TMV-2)

1. Manufacturers:
 - a. Lawler Manufacturing Co, Model 911E/F.
 - b. Or equal.
2. Emergency eyewash mixing valve with two independent control mechanisms which split flow in half and blend split flow to desired temperature at discharge. Anti-scald protection to disrupt hot water if loss of cold water. Designed to comply with ANSI Z358.1. Rated for 125 psi inlet pressure and 180°F inlet temperature.
3. Bronze body construction.
4. Capacity: 5 gpm at 20 psig. Capable of maintaining setpoint temperature even if hot or cold water temperature changes 30°F, or a supply pressure reduction of 50%.

N. Strainers:

1. Manufacturers:
 - a. Watts, Series 88S.
 - b. Or Equal.
2. Wye pattern style with threaded drain cap.
3. Stainless steel body construction, ASTM A351 grade CF8M.
4. Class 600.

5. Threaded ends.
 - a. 304 stainless steel screen. Provide 40 mesh or size indicated on Drawings.

2.08 FIXTURES

A. Countertop Sink: (CS-1)

1. Manufacturers:
 - a. Kohler, Model Toccata (K-4015-4).
 - b. Or Equal.
2. 19 gauge 304 stainless steel.
3. Self-rimming two compartment.
4. 33 inch by 22 inch with 6 inch basin depth.
5. Three faucet holes and handspray hole.
6. Countertop mounted.
7. Faucet:
 - a. Kohler, Model Forte K-10433-CP, or equal.
 - b. 3-hole kitchen sink faucet with 10-1/8-inch spout.
 - c. Single lever handle faucet with 1.5 gpm aerator.
 - d. Chrome plated finish.
 - e. ADA compliant
 - f. Provide with color matched handspray unit with escutcheon.
 - g. Pull out faucet spray.
8. Accessories:
 - a. Two Chrome plated brass sink strainer with removable basket strainer with open/close stopper, tailpiece, and 1-1/2 inch connections.
 - b. 1-1/2 inch by 1-1/2 inch cast brass adjustable P-trap with polished chrome finish.
 - c. Two 3/8 inch NPT polished chrome finished angle supply with stop

B. DI Faucet:

1. Manufacturers:
 - a. Chicago Faucets, Model 869-BPVC.
 - b. Or Equal.
2. Deck mounted DI water faucet.
3. Gooseneck style with serrated outlet suitable for hose connection.
4. PVC construction

C. Emergency Eyewash and Showers: (EWS-1)

1. Manufacturers
 - a. Guardian, Model G1993.
 - b. Haws Drinking Faucet Co.
 - c. Or Equal.
2. Corrosion resistant, schedule 80 PVC construction.
3. Yellow 10 inch diameter ABS plastic shower head with 20 gpm restrictor orifice.

4. 1 inch PVC coated, brass body stay open shower valve with stainless steel actuating arm and pull rod.
5. 11.5 inch diameter yellow ABS plastic eye/face wash bowl.
6. ½ inch PVC coated, brass body stay open eyewash valve.
7. Twin face wash heads with flip-top dust cover, internal flow control, and water filter.
8. Provide with flow switch with contact closure wired to Plant PLC to alarm on flow to shower or eyewash.

D. Emergency Eyewash and Showers: (EWS-2)

1. Manufacturers:

- a. Guardian, Model GBF1994.
- b. Haws Drinking Faucet Co.
- c. Or Equal.

2. Combination eye/face wash.
3. Schedule 40 brushed stainless steel construction.
4. 10 inch diameter stainless steel shower head with 20-gpm restrictor orifice.
5. 1 inch 316 stainless steel stay open shower valve with stainless steel actuating arm and pull rod.
6. 11.5 inch diameter stainless steel eye/face wash bowl.
7. ½ inch 316 stainless steel stay open eye/face wash valve.
8. Four face wash heads with flip-top dust cover, internal flow control, and water filter.

E. Emergency Eye/Face Wash: (EEW-1)

1. Manufacturers:

- a. Guardian, Model G1704.
- b. Haws Drinking Faucet Co.
- c. Or Equal.

2. Pedestal mounted, combination eye/face wash.
3. Schedule 40 galvanized steel pipe and fittings with polyethylene pipe covers.
4. 11-1/8 inch diameter stainless steel eye/face wash bowl.
5. ½ inch chrome plated brass stay open eye/face wash valve.
6. Furnish with ANSI-compliant identification sign.
7. Four face wash heads with flip-top dust cover, internal flow control, and water filter.

F. Faucet (FX-1):

1. Chicago Faucet, Model 911, or equal.
2. ADA compliant wall mounted faucet.
3. Rear inlets.
4. Polished chrome finish.
5. Elevated atmospheric vacuum breaker.
6. Pail hook.
7. Wall brace.
8. Accessories:
 - a. 5 feet long hose and wall mounted hose clamp.

G. Countertop Lavatory (LAV-1):

1. Manufacturers:
 - a. Kohler, Model Intaglio (K-2292).
 - b. Or Equal.
 2. Vitreous china with white enamel finish.
 3. Drop-in bathroom sink.
 4. 17 inch by 14 inch oval with no faucet holes.
 5. ADA compliant.
 6. Faucet:
 - a. Kohler, Sculpted Insight Touchless (Model K-7515-CP).
 - b. Single-Hole 5-5/16 inch spout.
 - c. Motion active faucet with infrared technology.
 - d. Polished chrome finish.
 - e. Temperature control handle and temperature mixer.
 - f. 0.5 gpm aerator.
 - g. 30-year hybrid energy cell.
 7. Automatic Safety Mixing Valve
 - a. Watts LFUSG-B, Or Equal
 - b. Meets ASSE Standard 1070.
 - c. Lead free construction and suitable for use with potable water.
 - d. Built in check valves to prevent water migration.
 - e. Integral 40 mesh stainless steel strainer.
 - f. Tamper resistant locking nut.
 - g. Outgoing temperature range from 80F to 120F. Initially set for 100F.
 - h. Maximum 10 psi pressure drop at a flow rate of 0.5 gpm.
 8. Accessories:
 - a. Cast brass adjustable P-trap with polished chrome finish.
 - b. 3/8 inch NPT polished chrome finished angle supply with stop.
- H. Countertop Lavatory (LAV-2):
1. Manufacturers:
 - a. Kohler, Model Kathryn (K-2297-0).
 2. Vitreous china with white enamel finish.
 3. Under mounted, self rimming type.
 4. 23-7/8 inch by 15-5/8 inch with no faucet holes.
 5. ADA compliant.
 6. Faucet:
 - a. Kohler, Geometric Insight Touchless (Model K-7517-CP).
 - b. Single-Hole 5-5/16 inch spout.
 - c. Motion active faucet with infrared technology.
 - d. Polished chrome finish.
 - e. Temperature control handle and temperature mixer.
 - f. 0.5 gpm aerator.
 - g. 30-year hybrid energy cell.
 7. Automatic Safety Mixing Valve

- a. Watts LFUSG-B, Or Equal
 - b. Meets ASSE Standard 1070.
 - c. Lead free construction and suitable for use with potable water.
 - d. Built in check valves to prevent water migration.
 - e. Integral 40 mesh stainless steel strainer.
 - f. Tamper resistant locking nut.
 - g. Outgoing temperature range from 80F to 120F. Initially set for 100F.
 - h. Maximum 10 psi pressure drop at a flow rate of 0.5 gpm.
8. Accessories:
- a. Cast brass adjustable P-trap with polished chrome finish.
 - b. 3/8 inch NPT polished chrome finished angle supply with stop.
- I. Countertop Lavatory (LAV-3):
1. Manufacturers:
- a. Kohler, Model Brenham (K-1999-SS1).
 - b. Or Equal.
- 2. Vitreous china with white enamel finish.
 - 3. Wall-mount bathroom lavatory with shroud.
 - 4. 14 inch by 12 inch oval with one faucet hole.
 - 5. Wall hanger.
 - 6. Overflow drain.
 - 7. ADA compliant.
 - 8. Faucet:
 - a. Kohler, Sculpted Insight Touchless (Model K-7515-CP).
 - b. Single-Hole 5-5/16 inch spout.
 - c. Motion active faucet with infrared technology.
 - d. Polished chrome finish.
 - e. Temperature control handle and temperature mixer.
 - f. 0.5 gpm aerator.
 - g. 30-year hybrid energy cell.
9. Automatic Safety Mixing Valve
- a. Watts LFUSG-B, Or Equal
 - b. Meets ASSE Standard 1070.
 - c. Lead free construction and suitable for use with potable water.
 - d. Built in check valves to prevent water migration.
 - e. Integral 40 mesh stainless steel strainer.
 - f. Tamper resistant locking nut.
 - g. Outgoing temperature range from 80F to 120F. Initially set for 100F.
 - h. Maximum 10 psi pressure drop at a flow rate of 0.5 gpm.
10. Accessories:
- a. Cast brass adjustable P-trap with polished chrome finish.
 - b. 3/8 inch NPT polished chrome finished angle supply with stop.
 - c. Piping shroud (K-1998-SS)
- J. Mop Sink: (MS-1)

1. Manufacturers:
 - a. Florestone, Model 96-32x32
 - b. Or equal.
2. 32 inch x 32 inch with neo angled drop front.
3. 4-in depth at drop front and 10 inch overall depth.
4. Steel wire reinforced terrazzo construction with tan and white marble chips cast in white Portland cement.
5. Integrally cast 3 inch brass drain.
6. Integrally cast stainless steel protective cap on drop front.
7. Faucet:
 - a. Chicago Faucet, Model 835, or equal.
 - b. Wall mounted service sink faucet.
 - c. Top inlets.
 - d. Polished chrome finish.
 - e. Vacuum breaker spout.
 - f. Pail hook.
 - g. Wall brace.
8. Accessories:
 - a. 3 inch stainless steel strainer.
 - b. Hose vacuum breaker.
 - c. 5 feet long hose and wall mounted hose clamp.

K. Handicapped Shower (SHR-1)

1. Shower Base:
 - a. Manufacturers:
 - 1) American Standard, Townsend.
 - b. ADA solid surface shower base
 - c. 38-inch by 38-inch outer dimensions.
 - d. Integral 3 sided 1-inch tilting/water retention flange.
 - e. Fungi and bacterial resistant
 - f. Meets flame and smoke spread of 0/25.
 - g. Removable brushed stainless steel trench drain cover.
 - h. 2-inch drain pipe connection.
2. Shower Valve and Spray Head:
 - a. Manufacturers:
 - 1) Symmons C-96-300-B30-V-X.
 - 2) Or equal.
 - b. Pressure balanced mixing valve meeting the requirements of ASSE 1016.
 - c. Single lever handle temperature adjustment with adjustable stop screws to limit handle turn.
 - d. ADA compliant.
 - e. Wall/handheld 2.5 gpm shower assembly with removable hand held shower head, 5

- feet long flexible metal hose with inline vacuum breaker.
- f. 30 inch slide bar for handheld shower mounting.
- g. Escutcheon plates for hose outlet and slide bar.

L. Service Sink: (SS-1):

1. Manufacturers:
 - a. Kohler, Model Bannon K-6718.
 - b. Or equal.
2. Enamel coated cast iron with stainless steel rim guard.
3. Blank back.
4. Faucet:
 - a. Chicago Faucet, Model 835, or equal.
 - b. Wall mounted service sink faucet.
 - c. Top inlets.
 - d. Polished chrome finish.
 - e. Vacuum breaker spout.
 - f. Pail hook.
 - g. Wall brace.
5. Accessories:
 - a. 3 inch trap with strainer, Kohler K-6673.
 - b. Hose vacuum breaker.
 - c. 5 feet long hose and wall mounted hose clamp.

M. Urinal (UR-1):

1. Manufacturers:
 - a. Kohler, Model Branham K-4920-T.
 - b. American Standard.
 - c. Or equal.
2. Vitreous china, stall type.
3. ¾ inch top spud.
4. ADA compliant.
5. China grate strainer.
6. Automatic Flush valve:
 - a. Kohler, Model K10675-SV.
 - b. Exposed, battery powered, infrared sensor operated.
 - c. 0.5 gallon per flush.
 - d. ADA compliant.
 - e. Courtesy flush with over-ride button.
 - f. Operates on four AA batteries and provided with low battery LED.
 - g. Adjustable infrared sensor range.
 - h. ¾" angle stop and ¾" top spud bowl connection.
 - i. Chrome plated finish.

N. Water Closets: (WC-1)

1. Manufacturers:

- a. Kohler, Model K-4325, Kingston.
 - b. American Standard.
 - c. Or equal.
2. Vitreous china, elongated bowl.
 3. Wall hung, siphon jet type.
 4. 1.6 gallon per flush.
 5. 1-1/2 inch top spud.
 6. ADA compliant.
 7. White finish.
 8. Accessories:
 - a. Flush Valve:
 - 1) Exposed, battery powered, infrared sensor operated.
 - 2) 1.28 gallon per flush.
 - 3) ADA compliant.
 - 4) Courtesy flush with over-ride button.
 - 5) Operates on AA batteries.
 - 6) Adjustable infrared sensor range.
 - 7) 1 inch angle stop and 1-1/2 inch top spud bowl connection.
 - 8) Chrome plated finish.
 - 9) Kohler Tripoint, K-10956-SV.
 - b. Seat and cover:
 - 1) Open front for elongated bowl.
 - 2) White finish.
 - 3) Solid polypropylene plastic.
 - 4) Anti-microbial agent.
 - 5) Self-sustaining check hinge.
 - 6) Kohler K-4670-CA, or equal.
 - c. JR Smith Figure 0440 or 0450 compact floor mount fixture support with vertical waste and vent centers. Or equal.

2.09 EQUIPMENT

A. Gas-Fired Water Heater: (600-GWH-1)

1. Manufacturers:
 - a. Navien, Model NPE-150S.
2. General: Provide gas-fired, tankless, condensing, wall mounted water heater.
3. Heater: Working pressure of 150 psi. Casing material shall be of cold rolled carbon steel. Heat exchanger material shall be of stainless steel.
4. Safety Controls: Equip with flame sensor system, high limit sensors, and overheat prevention device.
5. Acceptable natural gas supply pressure shall be 3.5-inch to 10.5-inch water column.
6. 120,000 Btu/Hr input with 6.8 GPM flow rate at 35°F temperature rise.
7. Capable of reducing input heat to 18,000 Btu/hr.
8. Heater shall be sealed combustion unit designed to be vented with PVC inlet and exhaust vents in a through the roof orientation.
9. Maximum flow to activate water heating of 0.5 gpm.

10. Output temperature setpoint: 98°F.
 11. Minimum heating efficiency of 96%.
 12. Power Supply:
 - a. Main supply: 120V/60Hz/1-phase.
 - b. Maximum power consumption: 200W.
 13. Provide with Manufacturers concentric vent adapter designed to allow a single roof penetration for both intake and exhaust.
 14. Provide with combination intake/exhaust vertical termination kit.
- B. Gas-Fired Water Heater: (900-GWH-1, -2)
1. Manufacturers:
 - a. Navien, Model NPE-240A.
 2. General: Provide gas-fired, tankless, condensing, wall mounted water heater.
 3. Heater: Working pressure of 150 psi. Casing material shall be of cold rolled carbon steel. Heat exchanger material shall be of stainless steel.
 4. Safety Controls: Equip with flame sensor system, high limit sensors, and overheat prevention device.
 5. Acceptable natural gas supply pressure shall be 3.5-inch to 10.5-inch water column.
 6. 199,900 Btu/Hr input with 5.6 GPM flow rate at 67°F temperature rise.
 7. Heater shall be sealed combustion unit designed to be vented with CPVC inlet and exhaust vents in a through the roof orientation.
 8. Maximum flow to activate water heating of 0.1 gpm.
 9. Minimum heating efficiency of 96%.
 10. Outgoing water temperature setpoints between 98F and 140F.
 11. Integral pump and buffer tank designed to provide recirculation of the building hot water piping. Pump shall be acceptable for piping systems up to 300 ft.
 12. Power Supply:
 - a. Main supply: 120V/60Hz/1-phase.
 - b. Maximum power consumption: 350W.
- C. Domestic Water Expansion Tanks
1. Manufacturers:
 - a. State Water Heaters, Thermoflex or Waterguard.
 - b. Or Equal.
 2. Provide expansion tanks with of 5.25 gallon minimum acceptance volume at 60 psi charge pressure, model ETC-10X.
 3. Provide expansion tanks approved for potable water supplies by IAPMO.
 4. Expansion tank shall be constructed of drawn steel with a bonded polymer liner.
 5. Expansion tank shall have Butyl diaphragm separating the air chamber from the water-containing chamber.
 6. Expansion tank shall have a field adjustable pre-charge.
 7. Maximum working pressure of 100 psi.
- D. Sump Pump (600-SP-1, 600-SP-2):
1. Manufacturers:

- a. Weil, Model 1619.
 - b. Metropolitan.
 - c. Or equal.
2. 32 gpm at 15 feet of head, minimum shut-off head of 25-feet of head.
 3. Cast iron construction with stainless steel shaft, handle, guard and lifting cable.
 4. Cast iron impeller.
 5. Upper and lower ball type bearings, permanently lubricated and double sealed.
 6. Ceramic face mechanical seal.
 7. NEMA 6, submersible air filled, hermetically sealed motor with Class F insulation. Motor shall have a cast iron motor shell. 1/2 hp, 1750 rpm, 460V/3-phase.
 8. Provide with properly sized steel sump cover.
 9. Provide stainless steel, NEMA 4X control panel (600-SPCP-1) with:
 - a. Main disconnect and individual circuit breakers in panel.
 - b. Combination motor starters with overloads.
 - c. Control transformer with fused primary and secondary.
 - d. Numbered and wired terminal board for controls.
 - e. Lights to indicate each pump run, each pump fail, high water alarm, control power, and motor overload.
 - f. Provide extra contact closure to send alarm signal to PLC on high water alarm.
 - g. Diaphragm micro level switches for pumps off, lead pump on, lag pump on, and high water alarm. Mercury switches not acceptable.
 - 1) Pumps off: 7" from bottom of sump.
 - 2) Lead on: 14" from bottom of sump.
 - 3) Lag on: 21" from bottom of sump.
 - 4) High water alarm: 28" from bottom of sump. If existing sump less than 28" deep, place 2" below sump rim.

E. Drinking Fountain: (120-EWC-1, 900-EWC-1, 900-EWC-2)

1. Manufacturers:
 - a. Elkay, Model LZSTL8WSLP
 - b. Haws.
 - c. Or Equal.
2. Bi-level, wall mounted water cooler with Push-button operated valve.
3. Touchless motion sensor bottle filling station.
4. Water filter certified to NSF 42 and 53.
5. Laminar flow nozzle.
6. ADA Compliant.
7. Chilling capacity of 8GPH of 50F water with 80F inlet.
8. Stainless steel construction.
9. Light grey granite finish.
10. Power: 120V single phase, 5 full load amps.
11. Anti-microbially treated on plastic components.
12. Dimensions (LxWxH): 36.75-inch, 19-inch, 39.5-inch
13. Supply: 3/8 inch ball or globe valve with in-line filter.

2.10 DRAINAGE AND VENT PRODUCTS

A. Floor Drains: (FD-1)

1. Manufacturers:

- a. Zurn model Z-415 with "Type B" Strainer.
 - b. J.R. Smith.
 - c. Or equal.
 2. Provide sizes as indicated on plans.
 3. Coated cast iron body.
 4. Combination invertible membrane clamp and adjustable collar.
 5. 6 inch diameter polished bronze adjustable strainer with square heel proof openings and secure grate.
 6. Provide with Zurn ZShield, Z1072, barrier trap seal.
 - a. Designed to minimize trap evaporation.
 - b. Rigid ABS structure with silicone gasket
 - c. Complies with ASSE 1072.
- B. Heavy Duty Floor Drains: (FD-2)
1. Manufacturers:
 - a. Zurn model Z-520.
 - b. J.R. Smith.
 - c. Or equal.
 2. Provide sizes as indicated on plans.
 3. Coated cast iron body with seepage pan and adjustable frame.
 4. 9 inch diameter, heavy-duty cast iron deep flange slotted grate.
 5. Provide with Zurn ZShield, Z1072, barrier trap seal.
 - a. Designed to minimize trap evaporation.
 - b. Rigid ABS structure with silicone gasket
 - c. Complies with ASSE 1072.
- C. Floor Cleanouts: (CO)
1. Manufacturers:
 - a. Zurn model Z-1400
 - b. J.R. Smith.
 - c. Or equal.
 2. Adjustable coated cast iron cleanout.
 3. Cleanouts installed in Administrative Buildings shall have a round adjustable scoriated secured polished nickel bronze top. Cleanouts located in all other spaces shall have a round adjustable scoriated secured coated cast iron top.
 4. Gas and watertight ABS tapered thread plug.
- D. Wall Cleanouts:
1. Manufacturers:
 - a. J.R. Smith, Figure 4422.
 - b. Zurn.
 - c. Or equal.
 2. Cast iron spigot ferrule with cast bronze taper thread plug.

3. Stainless steel round cover and screw.

E. Roof Drains: (RD-1)

1. Manufacturers:
 - a. Zurn, Z100.
 - b. J.R. Smith, Figure 1010.
 - c. Or equal.
2. Provide sizes as indicated on plans.
3. Cast iron body with combined flashing clamp and gravel stop.
4. Aluminum dome.
5. Sump receiver.
6. Under deck clamp.
7. Insulation extension

F. Wall Cleanouts:

1. Manufacturers:
 - a. J.R. Smith, Figure 4422.
 - b. Zurn.
 - c. Or equal.
2. Cast iron spigot ferrule with cast bronze taper thread plug.
3. Stainless steel round cover and screw.

2.11 ACCESSORIES

A. Water Hammer Arrestors:

1. Manufacturers:
 - a. Precision Plumbing Products.
 - b. Or Equal.
2. Provide where required by state codes, where indicated on drawings and Installation portion of this Section and as required for complete installation.
3. For CPVC or PVC piping systems:
 - a. CPVC, Schedule 80 construction, conforming to ASTM standard 1784 for materials and F411 for pipe.
 - b. Suitable for normal operating pressures of 35-100 psig and spike pressures to 250-psig.
4. For copper piping systems:
 - a. Barrel-fabricated of type "L" hard drawn copper with copper or brass cap. Brass or polycarbonate piston and EPDM O-rings.
 - b. Suitable for normal operating pressures of 0-200 psig and spike pressures to 400-psig.
5. For stainless steel piping systems:
 - a. 316 stainless steel construction.
 - b. Flanged or threaded end connections as dictated by unit size.

- c. Suitable for normal operating pressures of 35-500 psig and spike pressures up to 2,000 psig.

6. Where no size indicated, provide unit one line size smaller than piping system size served.

2.12 INSULATION

A. Insulate interior W1, W2, W3, HW, HWRE, TW, horizontal STM, SV piping in its entirety. Flexible unicellular pipe insulation shall be allowed only within a plenum space.

1. Fibrous Glass Insulation:

a. Manufacturers:

- 1) Owens-Corning.
- 2) Manville.
- 3) Or equal.

b. 1 inch thick, 3.5 pound per cubic foot density.

c. Ratings not exceeding flame spread of 25 and smoke developed of 50 (Test Method ASTM E84)

d. Provide all service jacket when installed in a plenum space. Otherwise provide PVC jacketing as specified below.

2. Flexible Unicellular Pipe Insulation:

a. Manufacturers:

- 1) Manville.
- 2) Rubatex.
- 3) Or equal.

b. 1 inch thick.

c. ASTM C534, Type I, density 4.5 to 8.5 pound per cubic foot.

d. Maximum ASTM C96 permeability of 0.3 perm-in.

e. Ratings not exceeding flame spread of 25 and smoke developed of 50 (Test Method ASTM E84)

f. Maximum $k = 0.30 \text{ Btu-in./hr-sq. ft-}^\circ\text{F}$, at 75°F to 200°F , with PVC jacket and fittings sealed at joints.

B. PVC Piping Jacket Materials:

- 1. Heavy-duty UV resistant PVC jacketing, ASTM D1784, 30 mil thickness, solid color, Johns Manville Zeston 300 PVC, or equal.
- 2. Color to be as selected by Owner or Engineer.

2.13 PIPING SPECIALTIES

A. Provide piping specialties in accordance with Section 22. Provide piping specialties from manufacturers regularly engaged in manufacture of piping specialties of type and sizes required for not less than 3 years.

B. Pipe Escutcheons: Provide pipe escutcheons with inside diameter closely fitting pipe outside diameter and outside diameter to completely cover pipe penetration and pipe sleeve extensions. Furnish pipe escutcheons with nickel or chrome finish.

- C. Pipe Sleeves and Wall Collars: Provide pipe sleeves and wall collars of one of the following:
 - 1. Sheet Metal: Round tube with snap lock joint, welded spiral seams or welded longitudinal joint. Fabricate from galvanized steel of the following gauges, 20 gauge for smaller than 4 inch, 16 gauge up to 6 inch, 14 gauge for all pipe sizes greater than 6 inch
 - 2. Plastic Pipe: Provide sleeves fabricated of schedule 80 PVC pipe.
 - 3. Iron Pipe: Provide ductile iron or cast iron pipe with integrally cast intermediate collar in exterior, water supporting and water retaining walls and slabs.
 - 4. Steel Pipe: Provide seals fabricated of schedule 40 carbon steel pipe with welded center flange. Sleeve shall be hot-dipped galvanized when used for water stoppage.
- D. Mechanical Sleeve Seals: Provide modular type sleeve seals consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates designed to cause rubber sealing elements to expand when tightened. Seal shall withstand 40 feet hydrostatic head of water.
- E. Sleeve Seals: Provide sleeve seals for sleeves located in exterior walls or slab on grade floors with either elastomeric joint sealant or mechanical sleeve seals as described above.

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions under which piping and equipment is to be installed. Do not proceed with installation until unsatisfactory conditions are corrected.

3.02 GENERAL

- A. All work to conform to state and local plumbing and backflow prevention codes.
- B. Install fixtures and equipment in accordance with manufacturer's installation instructions.
- C. Trench, backfill and compact in accordance with Section 31 23 33.
- D. Install pipe hangers, supports and anchors in accordance with local plumbing code and Section 40 05 07.
- E. Provide pipe identification in accordance with Section 40 05 97.
- F. Install wall pipes, sleeves and seals in accordance with Section 40 05 09.
- G. Install valves in accordance with Section 40 05 53.

3.03 PIPING INSTALLATION

- A. General:
 - 1. Pressfit piping systems shall be installed in accordance with manufacturer's installation instructions including use of manufacturer's recommended crimping device.
 - 2. Install pipe, tube and fittings in accordance with recognized industry practices, local plumbing code and ANSI B31.9 - Building Service Piping.
 - 3. Piping installations shall achieve permanently leakproof piping systems capable of performing each indicated service without piping failure.
 - 4. Install each pipe run with minimum joints and couplings.
 - 5. Provide unions at each valve and equipment connection.
 - 6. Reduce sizes, where indicated, by use of reducing fittings.

7. Align piping accurately at connections, within 1/16 inch misalignment tolerance.
8. Where equipment connections differ from pipe sizes indicated on Drawings, route piping full size as indicated on drawings to unit including isolation valve and provide reducer as required at point of connection.
9. Non-metallic piping systems buried outside of the foundation of a structure shall be installed with tracer wire in accordance with Section 33 05 05.

B. Pipe Locations:

1. Locate piping runs, except otherwise indicated, vertically and horizontally (pitched to drain), and avoid diagonal runs wherever possible.
2. Orient horizontal runs parallel with walls, building column lines and other piping.
3. Locate runs, as shown or described by diagrams, plans, details and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct usable space or block access for servicing building and equipment.
4. Hold piping close to walls, overhead construction, columns and other structural and permanent enclosure elements of building; limit clearance to 1/2 inch where furring is shown for enclosure for concealment of piping, but allow for insulation thickness, if any.
5. Where possible, locate insulated piping for 1.0 inch clearance outside insulation.
6. Wherever possible in finished and occupied spaces, conceal piping from view by locating in column enclosures, hollow wall construction or above suspended ceilings; do not encase horizontal runs in solid partitions, except as indicated.
7. Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures unless unavoidable or indicated to do so.
8. Install drip pan under piping that must be run through electrical spaces.

C. Piping System Joints:

1. Thread pipe in accordance with ANSI B2.1; cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.
2. Solder copper tube-and-fitting joints where indicated, in accordance with recognized industry practice. Cut tube ends squarely, ream to full inside diameter, and clean outside of tube ends and inside of tube fittings. Apply solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens.
3. Weld pipe joints in accordance with ANSI B31.
4. Hubless Cast-Iron Joints - Comply with CISPI 310.
5. Plastic Pipe/Tube Joints - Comply with manufacturer's instructions and recommendations, and with applicable industry standards, ANSI/ASTM D 2235, and ANSI/ASTM F 402.

D. Exterior Water Piping:

1. Install exterior water service piping system in compliance with local governing regulations.
2. Water Service Piping: Extend water service piping of size and in location indicated to water service entrance at building. Provide sleeve in foundation wall for water service entry, make entry watertight. Provide gate valve at water service entry inside building; strainer, pressure gauge, test tee with valve.
3. Copper Tube: Install in accordance with recommended procedures of CDA.
4. Ductile Iron Pipe: Install in accordance with AWWA C600 and Section 40 05 19.

E. Expansion Compensation:

1. Install piping including mains, branches and runouts with sufficient offsets to allow for free expansion and contraction, sufficient to prevent leaks and overstressing of piping system.

F. Water Hammer Arrestors:

1. Install in upright position in locations and of sizes in accordance with PDI-WH-201 and elsewhere as indicated and as noted below:
 - a. Provide $\frac{3}{4}$ inch unit on top of riser serving each hose outlet, hose reel, or high pressure wash system supply connection.
 - b. Provide $\frac{1}{2}$ inch unit at each branch connection serving washing machines or dishwashers.
 - c. Provide $\frac{1}{2}$ inch unit on top of riser serving each lavatory (LAV), wash fountain (WF), or urinal (UR).
 - d. Provide $\frac{3}{4}$ inch unit on top of riser serving each water closet (WC).
 - e. Provide line sized unit upstream of each solenoid valve.

G. Installation of Soil, Storm and Vent Piping and Products:

1. Install soil and vent products in accordance with manufacturer's written installation instructions and local plumbing code.
2. General: Install underground building drains as indicated and in accordance with local plumbing code. Lay underground building drains beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Clean interior of piping of dirt and other superfluous material as Work progresses. Maintain swab or drag in line and pull past each joint as completed. Place plugs in ends of uncompleted piping at end of day or whenever Work stops.
3. Install horizontal piping on constant grade, avoiding pockets. Minimum grade of 1/8 inch per foot for mains and 1/4 inch per foot for branches.
4. Install cleanouts where indicated on drawings. In addition to where shown, provide cleanouts at every 90 degree bend in soil and storm piping at maximum of 50 foot intervals for 3 inch and smaller soil piping and 100 foot intervals for 4 inch and larger soil piping.
5. Test soil and vent piping in accordance with requirement of local plumbing code.
6. Catch basin outlet pipe shall be installed with an elbow down within the basin, extending a minimum of 6 inch below the invert of the outlet pipe.
7. Floor Drains:
 - a. General: Install floor drains in accordance with manufacturer's written instructions and in locations indicated.
 - b. Coordinate with soil and waste piping as necessary to interface floor drains with drainage piping systems.
 - c. Install floor drains at low points of surface areas to be drained or as indicated. Set tops of drains flush with finished floor.
 - d. Install drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 - e. Position drains so accessible and easy to maintain.
8. Roof Drains:
 - a. General: Install drains in accordance with manufacturer's written instructions and locations indicated.
 - b. Coordinate with roofing necessary to interface roof drains with roofing work.
 - c. Under deck clamp for roof drains shall cover entire roof penetration and fit tightly to drain pipe or body such that the roof penetration is not visible from below.
 - d. Coordinate with storm water piping necessary to interface drains with drainage piping systems.

- e. Install drains at low points of surface areas to be drained or as indicated.
- f. Install drain flashing collar or flange so no leakage occurs between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
- g. Position drains so they are accessible and easy to maintain.

3.04 WATER SERVICE

- A. Contractor shall apply for permit and schedule to tap the existing street water main. Inspection and tapping fees will be waived.
- B. Water service connection shall be coordinated with Local Water Utility and installed in accordance with Utility's instructions.
- C. The Utility shall furnish the water meter to the Contractor at no cost. Install water meter in accordance with manufacturer's and utility's instructions.
- D. Schedule any interruption of the existing water service with the Owner.
- E. Contractor shall provide ball valve on each side of meter, drain connection between shut-off valves.

3.05 FIXTURES

A. General:

- 1. Install in accordance with manufacturer's written installation instructions and with local plumbing codes.
- 2. Install plumbing fixtures of types indicated where shown and at indicated heights, in accordance with fixture manufacturer's written instructions, roughing-in drawings, and recognized industry practices. Ensure plumbing fixtures comply with requirements and serve intended purposes. Comply with applicable requirements of Plumbing Code pertaining to installation of plumbing fixtures.
- 3. Verify locations and coordinate with architectural designs and other devices and equipment, as approved by Engineer before roughing-in connections.
- 4. Examine floors, substrates, and conditions under which fixture work to be accomplished.
- 5. Correct incorrect locations of piping and other unsatisfactory conditions for installation of plumbing fixtures.
- 6. Do not proceed with Work until unsatisfactory conditions corrected
- 7. Operation of fixtures shall be tested for proper operation and adjusted for field connections and service use, as required.
- 8. Fasten plumbing fixtures securely to indicated supports or building structure level and plumb. Secure plumbing supplies behind or within wall construction to be rigid and not subject to pull or push movement.
- 9. Protect installed fixtures from damage during remainder of construction period.
- 10. Do not use new fixtures during construction unless approved in writing by Owner.
- 11. Upon completion of installation and after units are water pressurized, test fixtures to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at site, then retest to demonstrate compliance, or remove and replace with new units and proceed with retesting.
- 12. Inspect each installed unit for damage to finish. If feasible, restore and match finish to original at site, or remove fixture and replace with new unit. Feasibility and match to be judged by Engineer. Remove cracked or dented units and replace with new units
- 13. Clean plumbing fixtures, trim, and strainers of dirt and debris upon completion of installation.
- 14. Insulate all LAV exposed drain components.

3.06 EQUIPMENT

A. General:

1. Install in accordance with manufacturer's written installation instructions and with local plumbing codes.
2. Verify locations and coordinate with architectural designs and other devices and equipment, as approved by Engineer before roughing-in connections.
3. Operation of fixtures shall be tested for proper operation and adjusted for field connections and service use, as required.

B. Water Heaters:

1. General:

- a. Install in accordance with manufacturer's written installation instructions and local plumbing code.
- b. Support: Set units on concrete pads, orient so controls and devices needing service and maintenance have adequate access. Level and plumb unit.
- c. Pipe discharge from relief valve to 6 inch above floor.
- d. Piping: Connect hot and cold water piping to units with shutoff valves and unions. Connect recirculating water line to unit with shutoff valve, check valve, and union.

2. Gas-Fired Water Heaters:

- a. Install gas piping in accordance with Section 23 11 23.
- b. Gas Supply: Connect to gas line with drip leg, tee, gas cock, and union; full size of unit inlet connection. Locate piping to not interfere with service of unit.
- c. Install vent piping in accordance with manufacturer's written installation instructions and local codes.
- d. Install PVC vent and intake air piping through roof in sizes recommended by Manufacturer.
- e. Startup: Startup, test, and adjust gas-fired water heaters in accordance with manufacturer's startup instructions, and Utility Company's requirements. Check and calibrate controls, adjust burner for maximum efficiency

C. Sump Pumps:

1. Install in accordance with manufacturer's written installation instructions and local plumbing code.
2. Provide union, check valve and isolation valve on sump pump discharge piping.
3. Provide offsets and transitions as required to connect to existing discharge piping.
4. Set float switches at Manufacturer recommended elevation for pump off. Set Pump On float at 18 inch above bottom of sump, Lag Pump On at 24 inch above bottom of sump, and High Water Alarm shall be set to 6 inch below top of sump. Wire switches to control panel.
5. After piping complete, startup shall be by Plumber.

3.07 VALVES

A. Install valves in accordance with manufacturer's written installation instructions and local plumbing code.

B. Sectional Valves - Install on each branch and riser, close to main, where branch or riser serves 2 or more plumbing fixtures or equipment connections, and elsewhere as indicated.

- C. Shutoff Valves - Install on inlet of each piece of plumbing equipment, and on inlet of each plumbing fixture, and elsewhere as indicated.
- D. Drain Valves - Install on each plumbing equipment item located to completely drain equipment for service or repair. Install at base of each riser, at base of each riser or drop in piping system, and elsewhere where indicated or required to completely drain domestic water piping system.
- E. Pressure Reducing Valves – Install per Manufacturer’s written installation instructions. Adjust pressure settings as indicated. Provide pressure gauge upstream and downstream of valve. Provide reducers as required to transition from line size indicated on Drawings to valve size selected by manufacture.
- F. Pressure Reducing and Pressure Sustaining Valves – Install per manufacturers written installation instructions. Adjust pressure settings as indicated.
- G. Backflow Preventers:
 - 1. Maintain minimum clearances for servicing and testing.
 - 2. Provide indirect waste piping with air gap installation from relief opening to above hub drain or floor drain.
 - 3. Provide initial registration, testing and report filing required by local plumbing code. List the name and address of the building that the backflow preventer installations occur in.
- H. Pressure Reducing and Relief Valves – Install per Manufacturer’s written installation instructions. Install pressure gauges upstream and downstream of reducing valves. Adjust pressure settings as indicated.

3.08 PIPE INSULATION

- A. Insulate all W1, W2, W3, HW, HWRE, TW and SV piping systems in their entirety.
- B. Install pipe insulation in accordance with manufacturer's written installation instructions.
- C. Insulation shall not be installed until testing and acceptance of piping systems has been completed.
- D. Install insulation for each continuous run of piping with full-length units, do not use scraps or cut pieces abutting each other.
- E. Install insulation on domestic hot, cold and horizontal storm water piping.
- F. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation, install factory molded or precut on job fabricated units.

3.09 CLEANING AND STERILIZATION

- A. Clean and sterilize domestic water piping systems as required by health authorities having jurisdiction and in accordance with Section 33 13 00 and local plumbing code.
- B. All water lines 3 inch and larger shall be disinfected, samples from two consecutive days must be taken to an approved lab, and the lab analysis reports must be submitted to the Development Services Department showing that the samples have passed the tests for two consecutive days per ANSI/AWWA C651-92, the AWWA Standard for Disinfecting Water Mains.
- C. Plate count must be less than 10 spc/ml.

3.10 TESTING PIPING SYSTEMS

A. Test piping system in accordance with Section 40 80 10 and local plumbing code.

3.11 FIELD QUALITY CONTROL

A. Manufacturer's Field Services:

1. Supplier's or manufacturer's representative for equipment specified herein shall be present at jobsite or classroom designated by Owner for workdays indicated, travel time excluded, for assistance during plant construction, plant startup, and training of Owner's personnel for plant operation. Include:
 - a. 1 workday for Installation Services.
 - b. 1/2 workday for Instructional Services.
 - c. 1/2 workday for Post Startup Services
2. Supplier or manufacturer shall direct services to system and equipment operation, maintenance, troubleshooting, and equipment and system-related areas other than wastewater treatment process. See Section 01 61 00.
3. In addition to the services specified above, provide manufacturer's services as required to successfully complete systems demonstration as specified in Section 01 79 10.

END OF SECTION

SECTION 22 12 23.13
WATER STORAGE PRESSURE TANKS

PART 1 – GENERAL

1.01 SUMMARY

- A. This section includes Diaphragm Tank (600-T-0221) and Diaphragm Tank (600-T-0231).

1.02 SYSTEM DESCRIPTION

- A. ASME: American Society of Mechanical Engineers

1.03 SYSTEM DESCRIPTION

- A. Water storage pressure tank replaceable bladder type pre-charged hydro-pneumatic tank for commercial system. The tank should be able to deliver water under pressure between pump cycles to provide sufficient flow to meet demands. The water is contained in a butyl bladder.
- B. Performance Requirements:
 - 1. Maximum Design Temperatures: 240 °F
 - 2. Maximum Design Pressure: 125 PSI
 - 3. Factory PreCharge 30 PSI

1.04 SUBMITTALS

- A. Product Data - Submit manufacturer's technical data for all the equipment in this section. Include in submittal, specifications, capacity ratings showing scheduled operating point clearly identified, dimensions, weights, materials, accessories furnished, and installation instructions.
- B. Shop Drawings - Submit assembly-type shop drawings showing unit dimensions, construction details, rough-in elevations, methods of assembly of components, and field connection details.
- C. Maintenance Data - Submit maintenance data and parts list for piece of scheduled equipment, accessory, and control. Include this data and product data in maintenance manual in accordance with requirements of Division 1.
- A. Submit above in accordance with Section 01 33 00.

1.05 QUALITY ASSURANCE

- A. Manufacturer's Qualifications:
 - 1. Installer experienced in performing work of this section who has specialized in installation of work similar to that required for this project.
 - 2. Manufacturer certified under ISO 9001
- B. Regulatory Requirements: Provide domestic water storage pressure tank that complies with the following requirements:
 - 1. SECTION VIII OF THE ASME BOILER AND PRESSURE VESSEL

1.06 DELIVERY, STORAGE

- A. Deliver Materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- B. Store materials protected from exposure to harmful weather conditions.

1.07 Project Conditions:

- A. Installation Location: Confirm pressure and temperature specifications
- B. Check water quality to confirm proper system has been specified.

1.08 Warranty

- A. Submit for Owner's acceptance, manufacturer's standard warranty document. Manufacturer's warranty is in addition to, and not limitation of, other rights Owner may have under Contract Documents.
- B. Warranty: Commencing on Date of Installation.
 - 1. Carbon Steel Tank: 10 years; tank will not rust, corrode, leak, burst or in any other manner fail to perform its proper function.
 - 2. Bladder: 3 years, bladder will not leak, burst or in any other manner fail to perform its proper function
 - 3. Other system components; 1 year; free from defects in materials and workmanship.

PART 2 – PRODUCTS

2.01 GENERAL

- A. Where more than one type is indicated, selection is Contractor's option or compliance with governing regulations
- B. Manufacturer's equipment used as basis of design for project is name indicated in Specifications for particular type of equipment or application contained in these contract documents. If no manufacturer listed, basis of design is industry standard indicated.

2.02 COMMERCIAL WATER STORAGE PRESSURE TANK

A. Manufacturer's:

- 1. Wessels
- 2. Or Equal

B. Construction:

- 1. Shell: Carbon Steel
- 2. Bladder: Heavy Duty Replaceable Butyl (FDA Approved)
- 3. Finish: Red Oxide
- 4. System Connection: Epoxy Lined

C. Furnish and install Diaphragm Tank (600-T-0221) as shown on plans:

- 1. One 53 gallon acceptance volume, 24" diameter x 43" high pre-charged steel hydro-pneumatic tank (600-T-0221) with replaceable heavy duty butyl rubber bladder. Tank shall have a 1-1/2" NPT epoxy lined system connection and a 0.302"-32NC charging valve connection to facilitate the on-site charging of the tank to meet system requirements.

2. Each tank shall be fitted with lifting rings and a floor mounting skirt for vertical installation. Tank must be constructed in accordance with section VII of the ASME boiler and pressure vessel and stamped 125 psi working pressure.
- D. Furnish and install Diaphragm Tank (600-T-0231) as shown on plans:
1. One 35 gallon acceptance volume, 20" diameter x 37" high pre-charged steel hydro-pneumatic tank (600-T-0231) with replaceable heavy duty butyl rubber bladder. Tank shall have a 1" NPT epoxy lined system connection and a 0.302"-32NC charging valve connection to facilitate the on-site charging of the tank to meet system requirements.
 2. Each tank shall be fitted with lifting rings and a floor mounting skirt for vertical installation. Tank must be constructed in accordance with section VII of the ASME boiler and pressure vessel and stamped 125 psi working pressure.

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions under which piping and equipment is to be installed. Do not proceed with installation until unsatisfactory conditions are corrected.

3.02 GENERAL

- A. Install fixtures and equipment in accordance with manufacturer's installation instructions.
- B. Provide pipe identification.

3.03 EXAMINATION

- A. Site Verification of Conditions; Verify installation and operating conditions, including any previously installed equipment, are acceptable for product installation in accordance with manufacturer's instruction.

3.04 INSTALLATION

- A. Install water storage pressure tank in accordance with Manufacturer's instruction.
- B. Position tank in their final location and as shown on plan.
- C. Charge tank to pressure indicate by Engineer.

END SECTION

SECTION 22 12 23.16
Break Tank

PART 1 – GENERAL

1.01 SUMMARY

- A. This section includes Break Tank (600-T-0211).

1.02 SYSTEM DESCRIPTION

- A. Furnish and install a pre-fabricated 100 gallon atmospheric break tank to maintain constant water delivery pressure
- B. Break tank shall be installed on a common 304 stainless steel base frame.
- C. Break tank shall be piped as per Detail M901.

1.03 SUBMITTALS

- A. Product Data - Submit manufacturer's technical data for all the equipment in this section. Include in submittal, specifications, capacity ratings showing scheduled operating point clearly identified, dimensions, weights, materials, accessories furnished, and installation instructions.
- B. Shop Drawings - Submit assembly-type shop drawings showing unit dimensions, construction details, rough-in elevations, methods of assembly of components, and field connection details.
- C. Maintenance Data - Submit maintenance data and parts list for piece of scheduled equipment, accessory, and control. Include this data and product data in maintenance manual in accordance with requirements of Division 1.
- D. Submit above in accordance with Section 01 33 00.

1.04 QUALITY ASSURANCE

- A. Manufacturer's Qualifications:
 - 1. Installer experienced in performing work of this section who has specialized in installation of work similar to that required for this project.

1.05 DELIVERY, STORAGE

- A. Deliver Materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- B. Store materials protected from exposure to harmful weather conditions.

1.06 Project Conditions:

- A. Installation Location: Confirm pressure and temperature specifications
- B. Check water quality to confirm proper system has been specified.

1.07 Warranty

- C. Submit for Owner's acceptance, manufacturer's standard warranty document. Manufacturer's warranty is in addition to, and not limitation of, other rights Owner may have under Contract Documents.

PART 2 – PRODUCTS

2.01 BREAK TANK (600-T-0211)

- A. Furnish and install Break Tank as shown on plans.
- B. Tank shall be minimum 100-gal volume based on bottom of tank to bottom of overflow connection. Maximum tank width of 2'-0".
- C. Tanks shall be of fiber reinforced plastic (FRP) construction.
- A. Tanks shall have a cover with opening for inlet funnel.
- B. Tank shall be provided with the following nozzles:
 - 1. 4-in overflow located with 6-in of the top of the tank.
 - 2. 2-1/2-in suction connection located within 2-in of the bottom of the tank.
 - 3. 3/4-in drain connection located within 2-in of the bottom of the tank.
- C. Provide float valve for system filling, installed and supported from the top of the tank. Valve shall be 1-1/2" V735 as per Section 40 05 53.

2.02 Stainless Steel Stand

- A. 2-feet tall.
- B. 304 stainless steel base frame.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Install water break tank in accordance with Manufacturer's instruction.
- B. Position tank in its final location and as shown on plan.

END SECTION

SECTION 22 33 36
BOOSTER PUMP SYSTEMS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. W2 Booster Pump 1 (600-P-0221)
 - a. Pressure indicators (600-PI-0221S and -0221D).
 - b. Pressure switch (600-PSL-0221).
 - c. Pressure transmitter (600-PIT-0221).
 - d. W2 Booster Pump 1 LCP (600-LCP-0221).
2. W2 Booster Pump 2 (600-P-0222)
 - a. Pressure indicators (600-PI-0222S and -0222D).
 - b. Pressure switch (600-PSL-0222).
 - c. Pressure transmitter (600-PIT-0222).
 - d. W2 Booster Pump 2 LCP (600-LCP-0222).
3. W3 Booster Pump 1 (600-P-0231)
 - a. Pressure indicators (600-PI-0231S and -0231D).
 - b. Pressure switch (600-PSL-0231).
 - c. Pressure transmitter (600-PIT-0231).
 - d. W3 Booster Pump 1 LCP (600-LCP-0231).
4. W3 Booster Pump 2 (600-P-0232)
 - a. Pressure indicators (600-PI-0232S and -0232D).
 - b. Pressure switch (600-PSL-0232).
 - c. Pressure transmitter (600-PIT-0232).
 - d. W3 Booster Pump 2 LCP (600-LCP-0232).

1.02 SYSTEM DESCRIPTION

- A. Provide a pre-fabricated and tested variable speed packaged pumping system suitable for use with potable water and wastewater treatment plant final effluent to maintain constant water delivery pressure.
- B. The packaged pump system shall be a standard product of a single pump manufacturer. The entire pump system including pumps and pump logic controller, shall be designed and built by the same manufacturer.
- C. The complete packaged water booster pump system shall be certified and listed by UL (Category QCZJ – Packaged Pumping Systems) for conformance to U.S. Standards.
- D. W2 Systems shall be capable of boosting the delivery pressure of from approximately 0 psi to 60 psi at a flow rate of 55 gpm.
- E. W3 Systems shall be capable of boosting the delivery pressure of from approximately 40 psi to 100 psi at a flow rate of 60 gpm.

1.03 SUBMITTALS

A. General:

1. Submit Product Data in sufficient detail to confirm compliance with requirements of this Section. Submit Product Data and Shop Drawings in one complete submittal package. Partial submittals are unacceptable.

B. Product Data:

1. Catalog cuts and product specifications for submersible centrifugal equipment specified.
2. Motor data. Submit in accordance with Section 26 05 84.
3. Coating systems. Submit in accordance with Section 09 96 00.

C. Shop Drawings:

1. Installation and assembly drawings and specifically prepared technical data for equipment.
2. Wiring Diagrams: Show power and control connections and distinguish between factory-installed and field-installed wiring.

D. Test Results:

1. Certified reports of manufacturers' factory production and final tests indicating compliance of equipment with referenced standards.
2. Certified reports of field tests and observations.

E. Submit in accordance with Section 01 33 00.

F. Operation and Maintenance (O&M) Data:

1. Operating instructions and maintenance data for materials and products for inclusion in O&M Manual.
2. Manufacturer's written instructions for periodic tests of equipment in service.
3. Submit in accordance with Section 01 78 23.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Firms experienced in manufacturing equipment of types and capacities indicated that have record of successful in-service performance.

1. Emergency Service: System manufacturer or manufacturer representative maintains service center capable of providing training, parts, and emergency maintenance and repairs at Project site with 48 hours maximum response time.

B. Single-Source Responsibility: Obtain components from single manufacturer with responsibility for entire system. Unit shall be representative product built from components that have proven compatibility and reliability and are coordinated to operate as unit as evidenced by records of prototype testing.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment and system components to their final locations in protective wrappings, containers, and other protection that will exclude dirt and moisture and prevent damage from construction operations. Remove protection only after equipment is made safe from such hazards.

- B. Store equipment in clean, dry location.
- C. Manufacturer shall define the requirements to properly protect the equipment and parts shipped to the job site.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Grundfos
- B. Contractor's Request for Substitution must meet specifications in full with the following exceptions:
 - 1. Booster Pump Systems are design around "A" Manufacturer. Changes to Work shall be performed at no additional cost to project.
 - 2. NEMA Type 1 ABB External VFD shall be considered in lieu of integral VFD specified.
 - 3. Allen Bradley Micrologix 1400 PLC, Delta HIM and Metra Tech III Pro Controller shall be considered in lieu of integral pump system controller specified.
 - 4. Substitution may include a packaged system with Break Tanks per Section 22 12 23.16, Water Storage Pressure Tank per Section 22 12 23.13 and piping / valves shown on Drawings 009-N-2, 600-M-1 and 600-M-2. Substitution package shall meet specifications in full except as noted in this section.
 - 5. Upon project completion, any packaged system shall be removable through doorways and stairwells shown on drawings.

2.02 W2 BOOSTER PUMP 1 (600-P-0221), W2 BOOSTER PUMP 2 (600-P-0222), W3 BOOSTER PUMP 1 (600-P-0231), W3 BOOSTER PUMP 2 (600-P-0232)

- A. The pumps shall be of the in-line vertical multi-stage design.
- B. The head-capacity curve shall have a steady rise in head from maximum to minimum flow within the preferred operating region. The shut-off head shall be a minimum of 20% higher than the head at the best efficiency point.
- C. Pumps:
 - 1. The pump impellers shall be secured directly to the pump shaft by means of a splined shaft arrangement.
 - 2. The suction/discharge base shall have ANSI Class 250 flange or internal pipe thread (NPT) connections as determined by the pump station manufacturer.
 - 3. Pump Construction.
 - a. Suction/discharge base, pump head, motor stool: Cast iron (Class 30)
 - b. Impellers, diffuser chambers, outer sleeve: 304 Stainless Steel
 - c. Shaft 316 or 431 Stainless Steel
 - d. Impeller wear rings: 304 Stainless Steel
 - e. Shaft journals and chamber bearings: Silicon Carbide
 - f. O-rings: EPDM
 - g. Shaft couplings shall be made of cast iron or sintered steel.
 - h. Optional materials for the suction/discharge base and pump head shall be cast 316 stainless steel (ASTM CF-8M) resulting in all wetted parts of stainless steel.
 - 4. The shaft seal shall be a balanced o-ring cartridge type with the following features:
 - a. Collar, Drivers, Spring: 316 Stainless Steel

- b. Shaft Sleeve, Gland Plate: 316 Stainless Steel
 - c. Stationary Ring: Silicon Carbide (Graphite Imbedded)
 - d. Rotating Ring: Silicon Carbide (Graphite Imbedded)
 - e. O-rings: EPDM
5. Shaft seal replacement shall be possible without removal of any pump components other than the coupling guard, shaft coupling and motor.

2.03 INTEGRATED VARIABLE FREQUENCY DRIVE MOTOR

- A. Each motor shall be of the Integrated Variable Frequency Drive design consisting of a motor and a Variable Frequency Drive (VFD) with a built-in pump system controller. The complete VFD/motor assembly shall be built and tested as one unit by the same manufacturer.
- B. The VFD/motor shall have an IP55 (TEFC) enclosure rating as a complete assembly. The motor shall have a standard NEMA C-Face, Class F insulation with a Class B temperature rise.
- C. The VFD shall be of the PWM (Pulse Width Modulation) design using up to date IGBT (Insulated Gate Bipolar Transistor) technology.
- D. The VFD shall convert incoming fixed frequency single-phase AC power into a variable frequency and voltage for controlling the speed of the motor. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump control and to eliminate the need for motor de-rating.
- E. The VFD shall have, as a standard component, an RFI filter (Radio Frequency Interference) to minimize electrical noise disturbances between the power electronics and the power supply. The VFD/motor shall meet all requirements of the EMC directive concerning residential and light industry equipment (EN 61800-3).
- F. The VFD shall have a minimum of two skip frequency bands which can be field adjustable.
- G. The VFD shall have internal solid-state overload protection designed to trip within the range of 125-150% of rated current.
- H. The VFD/motor shall include protection against input transients, loss of AC line phase, over-voltage, under-voltage, VFD over-temperature, and motor over-temperature. The motor over-temperature protection shall consist of three series connected PTC thermistors, one for each motor phase.
- I. The VFD/motor shall provide full nameplate output capacity (horsepower and speed) within a balanced voltage range of 414 to 528 volts.
- J. Automatic De-Rate Function: The VFD/motor shall reduce speed during periods of overload allowing for reduced capacity pump operation without complete shut-down of the system. Detection of overload shall be based on continuous monitoring of current, voltage and temperature within the VFD/motor assembly.
- K. The VFD/motor shall have, as a minimum, the following input/output capabilities:
 - 1. Discharge Pressure: 4-20mA
 - 2. Digital remote on/off
 - 3. Fault Signal Relay (NC or NO)
 - 4. Fieldbus communication port (RS485)

- L. Motor drive end bearings shall be adequately sized so that the minimum L10 bearing life is 17,500 hours at the minimum allowable continuous flow rate for the pump at full rated speed.

2.04 MOTORS

- A. W2 Pumps – max 7.5 hp, 460 v, 3-ph, 60 Hz.
- B. W3 Pumps - max 3.5 hp, 460 v, 3-ph, 60 Hz.
- C. Motor shall be inverter duty rated.
- D. Provide adequate space within the motor stool so that shaft seal replacement is possible without motor removal.

2.05 PUMP SYSTEM CONTROLLER AND USER INTERFACE - W2 BOOSTER Pump 1 LCP (600-LCP-0221), W2 BOOSTER Pump 2 LCP (600-LCP-0222), W3 BOOSTER Pump 1 LCP (600-LCP-0231), W3 BOOSTER Pump 2 LCP (600-LCP-0232)

- A. The pump system controller (Proportional-Integral) shall be a standard component of the integrated variable frequency drive motor developed and supported by the pump manufacturer.
- B. The pump system controller shall have an easy to use interface mounted on the VFD/motor enclosure. Pump system start/stop and set-point adjustment shall be possible through the use of two push buttons located on the drive enclosure.
- C. The VFD/motor shall be capable of receiving a remote analog set-point (4-20mA) as well as a remote on/off (digital) signal.
- D. Pump status and alarm state shall be indicated via two LED lights located on the VFD/motor enclosure.
- E. Pump system controller shall be powered via a single 460V, 3 phase, 60 Hz power connection.
- F. Advanced programming and troubleshooting shall be possible via an infra-red hand held programmer or a field connected personal computer. Pump system programming (field adjustable) shall include as a minimum the following:
 - 1. System Pressure set-point, psig
 - 2. System start pressure, psig
 - 3. System Stop pressure, psig
 - 4. Minimum Pump Speed, %
 - 5. Pressure Transducer supply/range
 - 6. Maximum Pump Speed, %
 - 7. System Time (Proportional Gain)
 - 8. Integral Action Time
- G. The infra-red programmer shall be capable of displaying the following status readings:
 - 1. Pump Status (on, off, min., max.)
 - 2. System Set-point, psig
 - 3. Actual system pressure, psig
 - 4. Remote set-point, %
 - 5. Pump speed, rpm
 - 6. VFD/Motor input power, kW

7. VFD/Motor total cumulative kWh
 8. VFD/Motor total operating hours
- H. The infra-red programmer shall also be capable of displaying the following alarms, with the last five alarms stored in memory:
1. Loss of sensor signal
 2. Loss of external set-point signal
 3. Under-voltage & Over-voltage
 4. Motor overload (blocked pump)
 5. Motor over-temperature
 6. Drive over-temperature
 7. Drive Over-current

2.06 SEQUENCE OF OPERATION

- A. The system controller shall receive an analog signal [4-20mA] from the factory installed pressure transducer on the discharge manifold, indicating the actual system pressure. When a flow demand is detected (system pressure drops below the start pressure) the VFD/motor shall start and increase speed until the actual system pressure matches the system set-point. As flow demand changes (increases or decreases), the speed of the pump shall be adjusted to maintain the system set-point pressure.
- B. During a no flow shut-down condition (periods of zero demand) a bladder type diaphragm tank is required. The tank shall be piped to the discharge manifold or system piping downstream of the pump. When zero flow is detected by the system controller, the pump shall be switched off. When the system pressure drops to the start pressure, (flow begins after shut-down), the pump shall be switched on, increasing speed to maintain the system set-point pressure. Zero flow conditions shall be detected by the system controller/factory installed pressure transmitter without the use of additional flow switches or motor current sensing devices.

2.07 SYSTEM CONSTRUCTION

- A. The system shall have a maximum working pressure of 232 psig at a temperature of 176°F.
- B. A pressure transducer (600-PIT-0221, 600-PIT-0222, 600-PIT-0231, 600-PIT-0232) shall be factory installed on the discharge manifold. Pressure transducers shall be made of 316 stainless steel. Transducer accuracy shall be +/- 1.0% full scale with hysteresis and repeatability of no greater than 0.1% full scale. The output signal shall be 4-20 mA with a supply voltage range of 9-32 VDC.
- C. A bourdon tube pressure gauge, 2.5 inch diameter, shall be placed on the suction and discharge manifolds (600-PI-0221S and -0221D, 600-PI-0222S and -0222D, 600-PI-0231S and -0231D, 600-PI-0232S and -0232D). The gauge shall be liquid filled and have copper alloy internal parts in a stainless steel case. Gauge accuracy shall be 2/1/2 %. The gauge shall be capable of a pressure of 30% above it's maximum span without requiring recalibration.
- D. A factory installed pressure switch (600-PSL-0221, 600-PSL-0222, 600-PSL-0231, 600-PSL-0232) shall be installed on the suction manifold for water shortage protection. All wetted parts shall be of stainless steel. The pump shut-down pressure shall be 0.5 psig with a reset pressure of 1 psig for W2 pumps. The pump shut-down pressure for W3 pumps shall be 3 psig with a reset pressure of 5 psig for W2 pumps. Pressure switch shall be adjustable.
- E. The system shall include a factory installed service disconnect switch mounted interlocked with a lockable NEMA 4 enclosure.

2.08 COATINGS

- A. Manufacturer is responsible for surface preparation, priming, and finish coating of equipment prior to shipment.
- B. Provide coatings in accordance with Section 09 96 00.
- C. Stainless steel, bronze, and nonmetallic surfaces shall not be coated.
- D. Coat machined or bearing surfaces and holes with protective grease.

2.09 TESTING

- A. The entire pump system shall be factory performance tested as a complete unit prior to shipment. Job-site programming shall be entered into the controller prior to shipment (details of installation requirements shall be communicated to the pump system manufacturer). A verified performance test report shall be made available from the system manufacturer.
- B. The system shall undergo a hydrostatic test of 250 psig for a minimum of 15 minutes prior to shipment.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Install in accordance with Manufacturer's written instructions and approved submittals.

3.02 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services:
 - 1. Representative for equipment specified herein shall be present at the job site or classroom designed by OWNER for minimum workdays specified below, travel time excluded, for assistance during construction, startup, and post-startup. Include minimum of:
 - a. 1 workdays for Installation Services.
 - b. 1 workdays for Instructional Services.
 - c. 1 workdays for Post-Startup Services.
 - 2. Supplier or manufacturer shall direct services to system and equipment operation, maintenance, troubleshooting, and equipment and system-related areas other than wastewater treatment process. See Section 01 61 00.
 - 3. In addition to the services specified above, provide manufacturer's services as required to successfully complete systems demonstration as specified in Section 01 79 10.

END OF SECTION

DIVISION 23

HEATING, VENTILATING, AND AIR CONDITIONING

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. Drawings and General Requirements of contract including General and Supplementary Conditions and Division 1 specification sections apply to work of this Section.
- B. Extent of testing, adjusting, and balancing work is indicated by requirements of this section, and also by drawings and schedules, and is defined to include, but is not necessarily limited to:
 - 1. Air distribution systems and associated equipment.
 - 2. Heating water supply and return systems.
- C. The work consists of setting speed and volume (flow) adjusting facilities provided for systems, recording data, conducting tests, preparing and submitting reports, and recommending modifications to work as required by contract documents.
- D. Component types of testing, adjusting, and balancing specified in this section includes the following as applied to mechanical equipment:
 - 1. Air handling units.
 - 2. Makeup air units.
 - 3. Roof top units.
 - 4. Fan coils.
 - 5. Fans.
 - 6. Odorous Air Control Fan, 610-EF-0801
 - 7. Ductwork systems.
 - 8. Hot water heating systems and associated pumps, including all pumps specified in Section 23 21 23.

1.02 QUALITY ASSURANCE

- A. A firm certified by National Environmental Balancing Bureau (NEBB) or Associated Air Balance Council (AABC) in those testing and balancing disciplines similar to those required for this project.
- B. Comply with American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) recommendations pertaining to measurements, instruments and testing, adjusting and balancing, except as otherwise indicated and NEBB "Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems".

1.03 SUBMITTALS

- A. Submit certified test reports signed by Test and Balance (TAB) Supervisor who performed TAB work.
- B. Reports shall be on NEBB forms unless other forms have been approved by the Engineer prior to the start of testing.

- C. Include identification and types of instruments used and their most recent calibration date with submission of final test report.
- D. Include copies of certified test reports in maintenance manuals.

1.04 JOB CONDITIONS

- A. Do not proceed with testing, adjusting, and balancing work until work has been completed and is operable. Ensure that there is no work still to be completed.
- B. Do not proceed until work scheduled for testing, adjusting, and balancing is clean and free from debris, dirt and discarded building materials.

PART 2 - PRODUCTS

2.01 PATCHING MATERIALS

- A. Except as otherwise indicated, use same products as used by original Installer for patching holes in insulation, ductwork and housings which have been cut or drilled for test purposes, including access for test instruments, attaching jigs, and similar purposes.
- B. At Tester's option, plastic plugs with retainers may be used to patch drilled holes in ductwork and housings.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine installed work and conditions under which testing is to be done to ensure that work has been completed, cleaned and is operable. Do not proceed with TAB work until unsatisfactory conditions have been corrected in manner acceptable to Tester.

3.02 TEST AND ADJUSTMENT

- A. Test, adjust and balance environmental systems and components, as indicated, in accordance with procedures outlined in applicable standards.
- B. Prepare report of test results, including instrumentation calibration reports, in format recommended by applicable standards.
- C. Air side system balancing shall include but not be limited to the following procedures:
 - 1. Test and adjust fan RPM to design requirements. For fans operating with pressure controlled VFDs, fan speed shall first be set to lowest output that allows design flow to most remote terminal served. Measured minimum required supply air pressure shall be identified to the Temperature Controls Contractor for establishing setpoint in the FMS.
 - 2. Test and record motor full load amperage.
 - 3. Check all fans for correct rotation.
 - 4. Test and record system static pressures, suction, discharge and external at all air handling equipment.
 - 5. Test and adjust system for design outside air and recirculated air quantities.
 - 6. Adjust and record all main supply and return air ducts and zones to proper design CFM.
 - 7. Test and adjust each diffuser, grille and register to within 10% of design requirements. Record data and location. Use manufacturer's rating and calculations.
 - 8. Adjust all grilles to minimize drafts in all areas.
 - 9. Test and record all air temperatures - supply, return, mixed, and outside air.

- D. Water side system balancing shall include but not be limited to the following procedures:
1. Adjust water systems to provide required or design quantities.
 2. For pumps operating with pressure controlled VFDs, pump speed shall first be set to lowest output that allows design flow to most remote terminal served. Measured minimum required supply water pressure shall be identified to the Temperature Controls Contractor for establishing setpoint in the FMS.
 3. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance; where flow metering devices are not installed, base flow balance on temperature difference across heat transfer elements in the system.
 4. Adjust systems to provide indicated pressure drops and flows through heat transfer elements prior to thermal testing; perform balancing by measurement of temperature differential in conjunction with air balancing.
 5. Balance system with automatic control valves fully open to heat transfer elements.
 6. Adjust water distribution systems by means of balancing cocks/valves, valves, and fittings. The system balancer shall not use service or shut-off valves for balancing unless indexed for balance point.
 7. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.
- E. The contractor shall include the cost of new sheaves and belts if it becomes necessary to change the drives during balancing of system.
- F. Patch holes in ductwork and housings, which have been cut or drilled for test purposes, in manner recommended by original Installer.
- G. Mark equipment settings, including damper control positions, fan speed control levers, and similar controls and devices, to show final settings at completion of TAB work. Provide markings with paint or other suitable permanent identification materials.
- H. Balancing contractor shall coordinate damper position settings with temperature control contractor to verify airflows and positions. Include time for this verification. See HVAC controls specification for time included by temperature controls contractor to work with balancing contractor.
- I. Balancing contractor to work with temperature control contractor and HVAC contractor to verify correct operation of entire HVAC system, before submitting report.

END OF SECTION

SECTION 23 07 00
HVAC INSULATION

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. Drawings and General Requirements of contract including General and Supplementary Conditions and Division 1 specification sections apply to work of this Section.
- B. Extent of mechanical insulation specified in this section includes Piping and Ductwork Systems (where indicated).

1.02 QUALITY ASSURANCE

- A. Installation shall meet the requirements Illinois Mechanical and Energy Codes.
- B. Manufacturer - Subject to compliance with requirements, provide products of one of the following:
 - 1. Armstrong World Industries, Inc.
 - 2. Certainteed Corp.
 - 3. Knauf Fiberglass
 - 4. Manville Corp.
 - 5. Owens-Corning Fiberglass Corp.
 - 6. Pittsburg Corning Corp.
 - 7. Rubatex Corp.
- C. Installer - A firm with at least 3 years successful installation experience on projects with mechanical insulation similar to that required for this project.
- D. Flame/Smoke Ratings - Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread rating of 25 or less, and smoke-developed rating of 50 or less, as tested by ANSI/ASTM E 84 (NFPA 255) method.

1.03 SUBMITTALS

- A. Product Data - Submit manufacturer's specifications and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, thickness, and furnished accessories for each mechanical system requiring insulation in accordance with Section 01 33 00.
- B. Maintenance Data - Submit maintenance data and replacement material lists for each type of mechanical insulation in accordance with Section 01 78 23.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or level, affixed showing fire hazard ratings of products.
- B. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged insulation; remove from project site.

PART 2 – PRODUCTS

2.01 FIBERGLASS INSULATION MATERIALS

A. Fiberglass Pipe Insulation:

1. Knauf 1000° Pipe Insulation, Johns Manville Micro-lok, or equal. Preformed insulation designed for nominal pipe sizes indicated on the drawings.
2. Meeting requirements of ASTM C547, ASTM C585, and ASTM C795.
3. Rigid, molded, noncombustible construction.
4. Maximum $k = 0.23$ Btu in./hr sq ft °F at 75°F.
5. Jacketing as specified for intended use.

B. Rigid Fiberglass Equipment Insulation: ASTM C612, high temperature, rigid fibrous glass board, minimum thickness 2 in., and class for service temperature indicated.

1. Load Bearing: ASTM C612, Class 2; FS-HH-I-558B, Form A, Class 2, average density 3.0 pcf, maximum $k = 0.23$ Btu in./hr sq ft °F at 75°F, to 400°F (204°C).

2.02 DUCTWORK INSULATION MATERIALS

A. External Duct Insulation:

1. Rigid Fiberglass Ductwork Insulation: ASTM C612, rigid fibrous glass board. Knauf Insulation Board, or equal.
 - a. Ductwork greater than 7 feet above finished floor or access platform is the contractors option between nonload bearing and load bearing ductwork insulation, all other ductwork insulation shall be load bearing.
 - 1) Nonload Bearing: ASTM C612, Type IA; HH-I-558C, Form A, Class 1, average density 1.5 pcf, maximum $k = 0.24$ Btu in./hr sq ft °F at 75°F. Suitable for operating temperatures to 400°F.
 - 2) Load Bearing: ASTM C612, Type IB; HH-I-558C, Form A, Class 2, average density 6.0 pcf, maximum $k = 0.22$ Btu in./hr sq ft °F at 75°F. Suitable for operating temperatures to 400°F.
 - b. Jacketing: Aluminum Foil Faced Vapor Barrier Material: All service type aluminum foil and fiberglass yarn reinforced kraft paper. FSK type conforming to ASTM C1136 Type II.
 - 1) Maximum water vapor permeability, ASTM E96, 0.02 perms.
2. Flexible Fiberglass Ductwork Insulation: ASTM C553, flexible duct wrap. Knauf Duct Wrap, or equal.
 - a. ASTM C553, Types I, II, III; HH-I-558C, Form B, Class 7, average density 1.0 pcf, maximum $k = 0.27$ Btu in./hr sq ft °F at 75°F. Suitable for operating temperatures to 250°F.
 - b. Jacketing: Aluminum Foil Faced Vapor Barrier Material: All service type aluminum foil and fiberglass yarn reinforced kraft paper. FSK type conforming to ASTM C1136 Type II.
 - 1) Maximum water vapor permeability, ASTM E96, 0.02 perms.

2.03 FLEXIBLE UNICELLULAR INSULATION MATERIALS

- A. Manufacturer:
 - 1. Armacell, AP Armaflex.
 - 2. Or Equal.
- B. Flexible, closed-cell elastomeric insulation.
- C. Provide in sheet form for ductwork systems.
- D. Provide in properly sized preformed shapes for pipe systems. Pipe systems shall be self-seal type.
- E. Meeting the requirements of ASTM C534.
- F. Shall be manufactured without the use of CFC's, HFC's, or HCFC's and shall be formaldehyde free, low VOC's, fiber free, dust free, and resistant to mold and mildew.
- G. Flame spread index less than 25 and smoke-developed index of less than 50 when tested in accordance with ATSM E84.
- H. Maximum thermal conductivity of 0.27-Btu-in./h-ft²-°F at 75°F mean temperature when tested in accordance with ASTM C177 or C518.
- I. Maximum water vapor transmission of 0.08-perm-inches when tested in accordance with ASTM E96, Procedure A.
- J. Exterior ductwork insulation systems, not indicated to receive aluminum jacketing, shall be provided with a multi-ply laminated membrane, ArmaTuff, or Equal. System shall be a 13-ply laminate (6 layers of aluminum foil, 4 layers of polyester film around a scrim reinforcing core) membrane with a 10-yr warranty against UV related breakdown.

2.04 JACKETING MATERIALS

- A. Aluminum Piping Jacket Materials:
 - 1. JRA, 0.016-in. aluminum, ASTM B209, with Pittsburgh seam, butt joint strips, matching fitting covers, stucco embossed finish and weather mastic.
- B. PVC Piping Jacket Materials:
 - 1. Heavy-duty UV resistant PVC jacketing, ASTM D1784, 30 mil thickness, solid color, Johns Manville Zeston 300 PVC, or equal.
 - 2. Color to be as selected by Owner or Engineer.

PART 3 - EXECUTION

3.01 SYSTEM INSULATION

- A. HVAC Ductwork Insulation:
 - 1. Insulate all exterior exposed supply ductwork systems with 2-inch thickness of flexible unicellular insulation material with laminated membrane jacketing.

2. Insulate all exterior exposed odorous air ductwork systems with 2-inch thickness of flexible unicellular insulation material with laminated membrane jacketing.
 3. Insulate all supply, return and outside air ductwork in ceiling cavity with 1-inch thickness of flexible fiberglass ductwork insulation. Insulate the body of all diffusers installed within a ceiling plenum (includes laminar diffusers, slot diffusers, and square diffusers).
- B. Heating Water Supply and Return Piping (HWS and HWR):
1. Insulate all interior piping:
 - a. Insulation: Fiberglass pipe insulation, 1-1/2" thickness for pipe sizes 3-in and smaller and 2-in. thickness for pipe sizes 4-in and larger.
 - b. Insulation for fittings shall be preformed with PVC jacketing.
 - c. Jacketing: PVC.
- C. Dryer Vent:
1. Insulate all interior duct:
 - a. Insulation: Fiberglass pipe insulation, 1" thickness.
 - b. Jacketing: Aluminum
- D. Refrigerant Piping:
1. Insulate all exterior refrigerant piping (RS, RL):
 - a. Insulation: Flexible unicellular pipe insulation, 1/2" thickness.
 - b. Jacketing: Aluminum
 2. Insulate interior refrigerant piping (RS, RL):
 - a. Insulation: Flexible unicellular pipe insulation, 1/2" thickness.
 - b. Jacketing: PVC
- E. Fan Coil Condensate Piping:
1. Insulate interior fan coil drain piping:
 - a. Insulation: Flexible unicellular pipe insulation, 1/2" thickness.
 - b. Jacketing: PVC

3.02 INSTALLATION OF INSULATION

- A. Install insulation products in accordance with manufacturer's written instructions.
- B. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- C. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- D. Maintain integrity of vapor-barrier jackets on insulation, and protect to prevent puncture or other damage.

- E. Cover fittings and similar items in each system with equivalent thickness and composition of insulation as applied to adjoining run. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated.
- F. Extend insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise indicated.
- G. Install protective metal shields and insulated inserts wherever needed to prevent compression of insulation.

3.03 PROTECTION AND REPLACEMENT

- A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.
- B. Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

END OF SECTION

SECTION 23 09 23
DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC

PART 1 – GENERAL

1.01 SUMMARY

- A. Furnish all labor, materials, equipment, and service necessary for a complete and operating control system, utilizing Direct Digital Controls (DDC) and electronic controls as described herein. The systems shall be capable of total integration of the facility infrastructure systems with user access to all system data either locally over a secure Intranet within the building or by secure remote access by a standard Web Browser over the Internet. This shall include HVAC control, energy management, alarm monitoring, and all trending, reporting and maintenance management functions related to normal building operations all as indicated in this specification.
- B. The Building Automation System shall include:
 - 1. Supervisory Server Software.
 - 2. Programmable Controllers.
 - 3. Input/Output Modules as required.
 - 4. Individual BACNet Routers or Building Controller with routing capabilities.
 - 5. Other components required for a complete and working BAS.
- C. All equipment and wiring located in areas designated as Class I, Division 1, Group D Hazardous Classified Location, shall be suitable for this rating and installed in accordance with Division 26.

1.02 DEFINITIONS AND ABBREVIATIONS

A. Definitions:

- | | |
|---|--|
| 1. BACnet Interoperability Building Blocks (BIBB) | A BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBS are combined to build the BACnet functional requirements for a device in a specification. |
| 2. BACnet/IP | An approved BACnet network type which uses an Ethernet carrier and IP addressing. |
| 3. BACnet MS/TP | An approved BACnet network type which uses a Master-Slave Token Passing configuration. MS/TP networks are unique to BACnet and utilize EIA485 twisted pair topology running at 9600 to 76,800 bps |
| 4. BACnet over ARCNET | An approved BACnet network type which uses an ARCNET (attached resource computer network) carrier. ARCNET is an industry standard that can utilize several speeds and wiring standards. The most common configuration used by BACnet controllers is an EIA485 twisted pair topology running at 156,000 bps |
| 5. BACnet/BACnet Standard | BACnet communication requirements as defined by the latest version of ASHRAE/ANSI 135 and approved addenda. |
| 6. Control Systems Server | A computer(s) that maintain(s) the systems configuration and programming database. |

- | | | |
|-----|--|--|
| 7. | Controller | Intelligent stand-alone control device. Controller is a generic reference to building controllers, custom application controllers, and application specific controllers. |
| 8. | Direct Digital Control | Microprocessor-based control including Analog/Digital conversion and program logic. |
| 9. | Gateway | Bi-directional protocol translator connecting control systems that use different communication protocols. |
| 10. | Local Area Network | Computer or control system communications network limited to local building or campus. |
| 11. | Master-Slave/Token Passing | Data link protocol as defined by the BACnet standard. |
| 12. | Point-to-Point | Serial communication as defined in the BACnet standard. |
| 13. | Primary Controlling LAN | High speed, peer-to-peer controller LAN connecting BCs and optionally AACs and ASCs. Refer to System Architecture below. |
| 14. | Protocol Implementation Conformance Statement (PICS) | A written document that identifies the particular options specified by BACnet that are implemented in a device. |
| 15. | Router | A device that connects two or more networks at the network layer. |
| 16. | Smart Actuator (SA) | An actuator which is controlled by a network connection rather than a binary or analog signal. (0-10v, 4-20mA, relay, etc.) |
| 17. | Smart Sensor (SS) | A sensor which provides information to the BAS via network connection rather than a binary or analog signal. (0-10000 ohm, 4-20mA, dry contact, etc.) |
| 18. | Web Services | Web services are a standard method of exchanging data between computer systems using the XML (extensible markup language) and SOAP (simple object access protocol) standards. Web services can be used at any level within a Building Automation System (BAS), but most commonly they are used to transfer data between BAS using different protocols or between a BAS and a non-BAS system such as a tenant billing system or a utility management system |
| 19. | Wiring | Raceway, fittings, wire, boxes and related items. |

1.03 SYSTEM DESCRIPTION

- A. General: The control system shall consist of a high-speed, peer-to-peer network of DDC controllers, a control system web server, and a web-based operator interface.
- B. System software shall be based on a server/thin client architecture, designed around the open standards of web technology. The control system server shall be accessed using a Web browser over the control system network, through local connection and the Building Controller, the owner's local area network, and (at Owner's discretion) over the Internet. Intent of the thin-client architecture is to provide operators complete access to the control system via a Web browser. No special software other than a web browser shall be required to access graphics, point displays, and trends, configure trends, configure points and controllers, or to download programming into the controllers.

- C. System shall use the BACnet protocol for communication to the web server and for communication between control modules. I/O points, schedules, setpoints, trends and alarms specified in Control Sequences shall be BACnet objects.

1.04 SYSTEM PERFORMANCE

- A. Performance Standards. System shall conform to the following minimum standards over network connections. Systems shall be tested using manufacturer's recommended hardware and software for operator workstation or portable operator's terminal (web server and browser for web-based systems).
1. Graphic Display. A graphic with 20 dynamic points shall display with current data within 10 sec.
 2. Graphic Refresh. A graphic with 20 dynamic points shall update with current data within 8 sec. and shall automatically refresh every 15 sec.
 3. Configuration and Tuning Screens. Screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic shall automatically refresh within 6 sec.
 4. Object Command. Devices shall react to command of a binary object within 2 sec. Devices shall begin reacting to command of an analog object within 2 sec.
 5. Alarm Response Time. An object that goes into alarm shall be annunciated at the workstation within 45 sec.
 6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 sec. Select execution times consistent with the mechanical process under control.
 7. Performance. Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.
 8. Multiple Alarm Annunciation. Each workstation on the network shall receive alarms within 5 sec of other workstations.
 9. Reporting Accuracy. System shall report values with minimum end-to-end accuracy listed in Table 1.
 10. Control Stability and Accuracy. Control loops shall maintain measured variable at setpoint within tolerances listed below:

Measured Variable	Reported Accuracy
Space Temperature	±1°F
Ducted Air	±1°F
Outside Air	±2°F
Dew Point	±3°F
Delta-T	±0.25°F
Air Pressure (ducts)	±0.1 in. w.g.
Air Pressure (space)	±0.01 in. w.g.
Electrical	±1% of reading (not including Utility meters)

11. Control Stability and Accuracy. Control loops shall maintain measured variable at setpoint within tolerances listed below:

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	±0.2 in. w.g. ±0.01 in. w.g.	0–6 in. w.g. -0.1 to 0.1 in. w.g.
Airflow	±10% of full scale	
Space Temperature	±2.0°F	

Controlled Variable	Control Accuracy	Range of Medium
Duct Temperature	±3°F	
Humidity	±5% RH	

1.05 SUBMITTALS

A. General:

1. Submit Product Data in sufficient detail to confirm compliance with requirements of this Section. Submit Product Data and Shop Drawings in one complete submittal package. Partial submittals are unacceptable.

- B. Installer Experience: Submit documentation that installer has a minimum of 5-years of experience in installations with the proposed Manufacturer's equipment.

- C. Product Data and Shop Drawings: Contractor shall provide shop drawings or other submittals on hardware, software, and equipment to be installed or provided. No work may begin on any segment of this project until submittals have been approved for conformity with design intent. Provide drawings as AutoCAD 2012 (or newer) compatible files on magnetic or optical disk (file format: .DWG, .DXF, .VSD, or comparable) and three 11" x 17" prints of each drawing. When manufacturer's cutsheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawing shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cutsheets to fulfill submittal requirements. Select and show submittal quantities appropriate to scope of work. Submittal approval does not relieve Contractor of responsibility to supply sufficient quantities to complete work. Submittals shall include:

1. DDC System Hardware:

- a. A complete bill of materials to be used indicating quantity, manufacturer, model number, and relevant technical data of equipment to be used.
- b. Manufacturer's description and technical data such as performance curves, product specifications, and installation and maintenance instructions for items listed below and for relevant items not listed below:
 - 1) Direct digital controllers (controller panels)
 - 2) Transducers and transmitters
 - 3) Sensors (including accuracy data)
 - 4) Actuators
 - 5) Valves
 - 6) Relays and switches
 - 7) Control panels
 - 8) Power supplies
 - 9) Batteries
 - 10) Operator interface equipment
 - 11) Wiring
- c. Wiring diagrams and layouts for each control panel. Show termination numbers.
- d. Schematic diagrams for all field sensors and controllers. Provide floor plans of all sensor locations and control hardware. Riser diagrams showing control network layout, communication protocol, and wire types.

2. Central System Hardware and Software:
 - a. A complete bill of material of equipment used indicating quantity, manufacturer, model number, and relevant technical.
 - b. Manufacturer's description and technical data such as product specifications and installation and maintenance instructions for items listed below and for relevant items furnished under this contract not listed below:
 - 1) Web server
 - 2) Power supplies
 - 3) Battery backups
 - 4) Interface equipment between server and control panels
 - 5) Operator interface software
 - 6) Color graphic software
 - 7) Third-party software
 - c. Schematic diagrams for all control, communication, and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers and functions. Show interface wiring to control system.
 - d. Network riser diagrams of wiring between central control unit and control panels.
3. Controlled Systems:
 - a. Riser diagrams showing control network layout, communication protocol, and wire types.
 - b. A schematic diagram of each controlled system. The schematics shall have all control points labeled with point names shown or listed. The schematics shall graphically show the location of all control elements in the system.
 - c. A schematic wiring diagram of each controlled system. Label control elements and terminals. Where a control element is also shown on control system schematic, use the same name.
 - d. An instrumentation list (Bill of Materials) for each controlled system. List each control system element in a table. Show element name, type of device, manufacturer, model number, and product data sheet number.
 - e. A mounting, wiring, and routing plan-view drawing. The design shall take into account HVAC, electrical, and other systems' design and elevation requirements. The drawing shall show the specific location of all concrete pads and bases and any special wall bracing for panels to accommodate this work.
 - f. A complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system.
 - g. A point list for each control system. List all I/O points and software points. Indicate alarmed and trended points.
4. Quantities of items submitted shall be reviewed but are the responsibility of the Contractor.
5. Description of process, report formats, and checklists to be used for Control System Demonstration and Acceptance.
6. BACnet Protocol Implementation Conformance Statement (PICS) for each submitted type of controller and operator interface.
- D. Project Record Documents. Upon completion of installation, submit three copies of record (as-built) documents of the documents shall be submitted for approval prior to final completion and shall include:

1. Project Record Drawings. As-built versions of submittal shop drawings provided as AutoCAD 2012 (or newer) compatible files on magnetic or optical media (file format: .DWG, .DXF, .VSD, or comparable) and as 11" x 17" prints.
 2. Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements of Control System Demonstration and Acceptance.
 3. Operation and Maintenance (O&M) Manual.
 4. As-built versions of submittal product data.
 5. Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
 6. Operator's manual with procedures for operating control systems: logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.
 7. Programming manual or set of manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
 8. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
 9. Documentation of programs created using custom programming language including setpoints, tuning parameters, and object database. Electronic copies of programs shall meet this requirement if control logic, setpoints, tuning parameters, and objects can be viewed using furnished programming tools.
 10. Graphic files, programs, and database on magnetic or optical media.
 11. List of recommended spare parts with part numbers and suppliers.
 12. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
 13. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation or web server software, and graphics software.
 14. Licenses, guarantees, and warranty documents for equipment and systems.
 15. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
- E. Training Materials: Provide course outline and materials for each class at least six weeks before first class. Training shall be furnished via instructor-led sessions, computer-based training, or web-based training. Engineer will modify course outlines and materials if necessary to meet Owner's needs. Engineer will review and approve course outlines and materials at least three weeks before first class
- F. Submit in accordance with Section 01 33 00.
- G. Operation and Maintenance (O&M) Data:
1. Maintenance Data - Submit maintenance data and spare parts lists for each type of control device. Include this data in maintenance manual. At a minimum include:
 - a. Maintenance instructions and schedule of recommended maintenance for pieces of equipment that require routine maintenance.
 - b. Sequence of Operation.
 - c. Logic diagrams.
 - d. Wiring Diagram.
 - e. Recommended spare parts list.
 2. Operation and Maintenance Manuals:

- a. Preparation and submittal of operation and maintenance data shall be in accordance with Section 01 78 23. Contractor is advised that Section 01 78 23 contains specific information related to the submission of O&M data in an electronic version. The Owner will be compiling both a paper and a computer-based O&M manual, and the vendor will need to provide a CD version of the O&M manual information.

1.06 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of electric, and digital control equipment of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. The Manufacturer of the DDC controllers shall provide documentation supporting compliance with ISO-9001 (Model for Quality Assurance in Design/Development, Production, Installation and Servicing). Product literature provided by the FMCS digital controller manufacturer shall contain the ISO-9001 Certification Mark from the applicable registrar.
- C. Installer:
 1. Provide documentation showing a minimum of 5-years of experience installing submitted Manufacturer's equipment for projects of similar size and scope.
 2. Provide documentation showing Niagara 4 certification and a minimum of 2-years of experience with Niagara 4 Supervisory Server integration.
- D. Electrical Standards: Provide electrical products which have been tested, listed and labeled by Underwriters' Laboratories (UL) and comply with NEMA standards.
- E. NEMA Compliance: Comply with NEMA standards pertaining to components and devices for electric-electronic temperature control systems.
- F. NFPA Compliance: Comply with NFPA No. 90A where applicable to controls and control sequences.
- G. Single-Source Responsibility: Obtain DDC components from single manufacturer with responsibility for entire system.
- H. Regulatory Requirements:
 1. Work, materials, and equipment shall comply with the most restrictive of local, state, and federal authorities' codes and ordinances or these plans and specifications. As a minimum, the installation shall comply with the current editions in effect 30 days prior to the receipt of bids of the following codes:
 - a. National Electric Code (NEC)
 - b. International Building Code (IBC)
 - c. International Mechanical Code (IMC)
 - d. ANSI/ASHRAE Standard 135, BACnet - A Data Communication Protocol for Building Automation and Control Systems

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Provide factory-shipping cartons for each piece of equipment, and control device. Maintain cartons through shipping, storage and handling as required to prevent equipment damage, and to eliminate dirt and moisture from equipment. Store equipment and materials inside and protected from weather.

1.08 JOB CONDITIONS

- A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to insure that the Work will be carried out in an orderly fashion. It shall be this Contractor's responsibility to check the Contract Documents for possible conflicts between his Work and that of other crafts in equipment location, pipe, duct and conduit runs, electrical outlets and fixtures, air diffusers, and structural and architectural features

1.09 OWNERSHIP OF PROPRIETARY MATERIAL

- A. Project-specific software and documentation shall become Owner's property. This includes, but is not limited to:
 - 1. Graphics
 - 2. Record drawings
 - 3. Database
 - 4. Application programming code
 - 5. Documentation

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Provide Direct Digital Control components from the following list of acceptable Manufacturers. Acceptable Manufacturers for field devices and auxiliary control devices shall be as indicated in component specific paragraphs.
 - 1. Johnson Controls, Inc.
 - 2. Or approved equal.

2.02 INSTALLER

- A. Installer shall have an established working relationship with Direct Digital Controls components Manufacturer and be an Authorized Integrator for components offered by Manufacturer with a minimum 5-years of documented experience with Manufacturer.
- B. Installer shall have successfully completed Control System Manufacturer's control system training. Upon request, Installer shall present record of completed training including course outlines.

2.03 COMMUNICATION

- A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135.
- B. Install new wiring and network devices as required to provide a complete and workable control network. All wiring to be installed meeting the requirements of Division 26.
- C. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.

- D. Internetwork operator interface and value passing shall be transparent to internetwork architecture.
 - 1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.
 - 2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute specified control sequences. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.
- E. Building Control Panels and Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated device via the internetwork. The system shall automatically adjust for daylight saving and standard time as applicable.
- F. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring.

2.04 OPERATOR INTERFACE

A. Supervisory Server Software:

1. Software:

- a. Facility Explorer FX Supervisor.
- b. Or approved equal.

2. Shall be Niagara 4 licensed.

3. Shall be installed on Owner's hardware (coordinate server space and partition requirements with work of Division 40) and shall integrate with Owner's existing MS Active Directory.

4. Provide HTML5 programming capabilities.

B. Operator Interface. Web server shall reside on high-speed network with building controllers. Each standard browser connected to server shall be able to access all system information. Interface shall allow for an unlimited number of clients accessing via browsers.

C. Communication. Web server and controllers shall communicate using BACnet protocol. Web server and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ANSI/ASHRAE 135.

D. System Software:

1. System Graphics. The operator interface software shall be graphically based and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using dynamic colors to represent zone temperature relative to zone setpoint.

- a. Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit setpoints and other specified parameters.
- b. Animation. Graphics shall be able to animate by displaying different image files for changed object status.

- c. Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.
 - d. Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X and Adobe Flash).
 - 2. Custom Graphics. Custom graphic files shall be created with the use of a graphics generation package furnished with the system. The graphics generation package shall be a graphically based system that uses the mouse to create and modify graphics that are saved in the same formats as are used for system graphics.
 - 3. Graphics Library. Furnish a complete library of standard HVAC equipment graphics such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. This library also shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. The library shall be furnished in a file format compatible with the graphics generation package program.
- E. System Applications. System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each web browser interface. If furnished as a stand-alone program, software shall be provided to allow installation on standard IBM-compatible PCs with no limit on the number of copies that can be installed under the system license.
- 1. Automatic System Database Configuration. Each web server shall store on its memory a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.
 - 2. Manual Controller Memory Download. Operators shall be able to download memory from the system database to each controller.
 - 3. System Configuration. Software shall be provided, installable on an Owner furnished computer that provides a method of configuring the system. This shall allow for future system changes or additions by users under proper password protection. Operators shall be able to configure the system.
 - 4. On-Line Help. Provide a context-sensitive, on-line help system to assist the operator in operating and editing the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.
 - 5. Security. Each operator shall be required to log on to the system with user name and password in order to view, edit, add, or delete data.
 - a. Operator Access. The user name and password combination shall define accessible viewing, editing, adding, and deleting privileges for that operator. Users with system administrator rights shall be able to create new users and edit the privileges of all existing users. System Administrators shall also be able to vary and deny each operator's privileges based on the geographic location, such as the ability to edit operating parameters in Building A, to view but not edit parameters in Building B, and to not even see equipment in Building C.
 - b. Automatic Log Out. Automatically log out each operator if no keyboard or mouse activity is detected. This auto logoff time shall be user adjustable.
 - c. Encrypted Security Data. Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.
 - 6. System Diagnostics. The system shall automatically monitor the operation of all building management panels and controllers. The failure of any device shall be annunciated to the operator.

7. Alarm Processing. System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as specified. Unless specific external hardwired alarm specified, alarms shall be BACnet alarm objects and shall use BACnet alarm services.
 8. Alarm Messages. Alarm messages shall use the English language descriptor for the object in alarm in such a way that the operator will be able to recognize the source, location, and nature of the alarm without relying on acronyms.
 9. Alarm Reactions. Operator shall be able to configure (by object) what, if any actions are to be taken during an alarm.
 10. Alarm and Event log. Operators shall be able to view all system alarms and changes of state from any location in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledge and delete alarms, and archive closed alarms to the workstation or web server hard disk.
 11. Trend Logs. The operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to memory. Trends shall be BACnet trend objects.
 12. Object and Property Status and Control. Provide a method for the operator to view, and edit if applicable, the status of any object or property in the system. The status shall be available by menu, on graphics, or through custom programs.
 13. Reports and Logs. Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.
 14. Standard Reports. Furnish the following standard system reports:
 - a. Objects. System objects and current values filtered by object type, by status (in alarm, locked, normal), by equipment, by geographic location, or by combination of filter criteria.
 - b. Alarm Summary. Current alarms and closed alarms. System shall retain closed alarms for an adjustable period.
 - c. Logs. System shall log the following to a database or text file and shall retain data for an adjustable period:
 - 1) Alarm History.
 - 2) Trend Data. Operator shall be able to select trends to be logged.
 - 3) Operator Activity. At a minimum, system shall log operator log in and log out, control parameter changes, schedule changes, and alarm acknowledgment and deletion. System shall date and time stamp logged activity.
 15. Custom Reports. Operator shall be able to create custom reports that retrieve data, including archived trend data, from the system, that analyze data using common algebraic calculations, and that present results in tabular or graphical format. Reports shall be launched from the operator interface.
- F. Application Editors. Shall support editing of all system applications. The applications shall be downloaded and executed at one or more of the controller panels.
1. Controller. Provide a full-screen editor for each type of application that shall allow the operator to view and change the configuration, name, control parameters, and set points for all controllers.
 2. Scheduling. An editor for the scheduling application shall be provided at each workstation. Provide a method of selecting the desired schedule and schedule type. Exception schedules and holidays shall be shown clearly on the calendar. The start and stop times for each object shall be adjustable from this interface.

3. Custom Application Programming. Provide the tools to create, edit, debug, and download custom programs. System shall be fully operable while custom programs are edited, compiled, and downloaded. Programming language shall have the following features:
 - a. Language. Language shall be graphically based and shall use function blocks arranged in a logic diagram that clearly shows control logic flow. Function blocks shall directly provide functions listed below, and operators shall be able to create custom or compound function blocks.
 - b. Programming Environment. Tool shall provide a full-screen, cursor-and-mouse-driven programming environment that incorporates word processing features such as cut and paste. Operators shall be able to insert, add, modify, and delete custom programming code, and to copy blocks of code to a file library for reuse in other control programs.
 - c. Independent Program Modules. Operator shall be able to develop independently executing program modules that can disable, enable and exchange data with other program modules.
 - d. Debugging and Simulation. Operator shall be able to step through the program observing intermediate values and results. Operator shall be able to adjust input variables to simulate actual operating conditions. Operator shall be able to adjust each step's time increment to observe operation of delays, integrators, and other time-sensitive control logic. Debugger shall provide error messages for syntax and for execution errors.
 - e. Conditional Statements. Operator shall be able to program conditional logic using compound Boolean (AND, OR, and NOT) and relational (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
 - f. Mathematical Functions. Language shall support floating-point addition, subtraction, multiplication, division, and square root operations, as well as absolute value calculation and programmatic selection of minimum and maximum values from a list of values.
 - g. Variables. Operator shall be able to use variable values in program conditional statements and mathematical functions.
 - 1) Time Variables. Operator shall be able to use predefined variables to represent time of day, day of the week, month of the year, and date. Other predefined variables or simple control logic shall provide elapsed time in seconds, minutes, hours, and days. Operator shall be able to start, stop, and reset elapsed time variables using the program language.
 - 2) System Variables. Operator shall be able to use predefined variables to represent status and results of Controller Software and shall be able to enable, disable, and change setpoints of Controller Software as described in Controller Software section.
- G. Portable Operator's Terminal. Provide all necessary software to configure an IBM-compatible laptop computer for use as a Portable Operator's Terminal. Operator shall be able to connect configured Terminal to the system network or directly to each controller for programming, setting up, and troubleshooting.

2.05 CONTROLLER SOFTWARE

- A. Furnish the following applications for building and energy management. All software applications shall reside and operate in the system controllers. Applications shall be editable through portable operator's terminal, or web browser interface. All software required to access, review, and modify controller programs shall be furnished to the Owner.
- B. Scheduling. Provide the capability to execute control functions according to a user created or edited schedule. Each schedule shall provide the following schedule options as a minimum:
 1. Weekly Schedule. Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).

2. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to a year in advance. Once an exception schedule has executed, the system shall discard and replace the exception schedule with the standard schedule for that day of the week.
 3. Holiday Schedules. Provide the capability for the operator to define up to 24 special or holiday schedules. These schedules will be repeated each year. The operator shall be able to define the length of each holiday period.
- C. System Coordination. Operator shall be able to group related equipment based on function and location and to use these groups for scheduling and other applications.
 - D. Binary Alarms. Each binary object shall have the capability to be configured to alarm based on the operator-specified state. Provide the capability to automatically and manually disable alarming.
 - E. Analog Alarms. Each analog object shall have both high and low alarm limits. The operator shall be able to enable or disable these alarms.
 - F. Alarm Reporting. The operator shall be able to determine the action to be taken in the event of an alarm. An alarm shall be able to start programs, print, be logged in the event log, generate custom messages, and display on graphics.
 - G. Remote Communication. System shall automatically contact web server on receipt of critical alarms. If no network connection is available, system shall use a modem connection.
 - H. Demand Limiting. Software shall be capable of being configured for demand limiting.
 - I. Maintenance Management. The system shall be capable of generating maintenance alarms when equipment exceeds adjustable runtime, equipment starts, or performance limits. Configure and enable maintenance alarms as specified in Control Sequences.
 - J. Sequencing. Application software shall sequence equipment as specified in Control Sequences.
 - K. PID Control. System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs. The calculation interval, PID gains, and other tuning parameters shall be adjustable by a user with the correct security level.
 - L. Staggered Start. System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.
 - M. Energy Calculations:
 1. The system shall accumulate and convert instantaneous power (kW) or flow rates (gpm) to energy usage data.
 2. The system shall calculate a sliding-window average (rolling average). Operator shall be able to adjust window interval to 15 minutes, 30 minutes, or 60 minutes.
 - N. Anti-Short Cycling. All binary output objects shall be protected from short cycling by means of adjustable minimum on-time and off-time settings.
 - O. On and Off Control with Differential. Provide an algorithm that allows a binary output to be cycled based on a controlled variable and a setpoint. The algorithm shall be direct-acting or reverse-acting.

- P. Runtime Totalization. Provide software to totalize runtime for each binary input and output. Operator shall be able to enable runtime alarm based on exceeded adjustable runtime limit. Configure and enable runtime totalization and alarms as specified in Control Sequences.

2.06 CONTROLLERS

- A. General. Provide an adequate number of Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), Smart Actuators (SA), and Smart Sensors (SS) as required to achieve performance specified in System Performance paragraph. Every device in the system which executes control logic and directly controls HVAC equipment must conform to a standard BACnet Device profile as specified in ANSI/ASHRAE 135, BACnet Annex L. Unless otherwise specified, hardwired actuators and sensors may be used in lieu of BACnet Smart Actuators and Smart Sensors. Controllers shall be readily available for purchase and integration by any installer, Owner, or contractor without the need for a distributor agreement to purchase. Programming software shall be made available to Owner. Controllers shall be Johnson Controls FX-PC series controllers, or approved equal.
- B. BACnet:
1. Building Controllers (BCs):
 - a. Each BC shall conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135 and shall be listed as a certified B-BC in the BACnet Testing Laboratories (BTL) Product Listing.
 - b. A fully programmable control module capable of storing trends and schedules, serving as a router to devices on a subnet, and initiating read and write requests to other controllers.
 - c. Capable of serving as a master controller, storing schedules and trends for controllers on a subnet underneath the Building Controller.
 - d. Trend storage capacity shall be adequate to store trend data of all monitored points, taken at a 15-minute sample frequency for a minimum of 3-months. Trend data shall be downloadable from controller memory for external permanent data storage.
 2. Advanced Application Controllers (AACs):
 - a. Each AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135 and shall be listed as a certified B-AAC in the BACnet Testing Laboratories (BTL) Product Listing.
 - b. A fully programmable control module.
 - c. Capable of some of the advanced features found in Building Controllers (storing trends, initiating read and write requests, etc.) but it does not required to serve as a master controller.
 3. Application Specific Controllers (ASCs):
 - a. Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ANSI/ASHRAE 135 and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.
 - b. A pre-programmed control module intended for use in a specific application.
 - c. Configurable, in that the user can choose between pre-programmed options.
 4. BACnet Communication:
 - a. Each BC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing.
 - b. BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.

- c. Each AAC shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
- d. Each ASC shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.

C. Communication:

1. Service Port. Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.
2. Signal Management. BC and ASC operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.
3. Data Sharing. Each BC and AAC shall share data as required with each networked BC and AAC.
4. Stand-Alone Operation. Each system specified in Control Sequences shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network such as outdoor air conditions, supply air or water temperature coming from source equipment, etc.

D. Environment. Controller hardware shall be suitable for anticipated ambient conditions.

1. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
2. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).

E. Keypad. Provide a local keypad and display for each BC and AAC. Operator shall be able to use keypad to view and edit data. Keypad and display shall require password to prevent unauthorized use. If the manufacturer does not normally provide a keypad and display for each BC and AAC, provide the software and any interface cabling needed to use a laptop computer as a Portable Operator's Terminal for the system.

F. Real-Time Clock. Controllers that perform scheduling shall have a real-time clock.

G. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to a field-removable modular terminal strip or to a termination card connected by a ribbon cable. Each BC and AAC shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.

H. Memory:

1. Controller memory shall support operating system, database, and programming requirements.
2. Each BC and AAC shall retain BIOS and application programming for at least 72 hours in the event of power loss.
3. Each BC shall have adequate memory to store trend data of all monitored points, taken at a 15-minute sample frequency for a minimum of 3-months. Trend data shall be downloadable from controller memory for external permanent data storage
4. Each ASC and SA shall use nonvolatile memory and shall retain BIOS and application programming in the event of power loss. System shall automatically download dynamic control parameters following power loss.

- I. Immunity to Power and Noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
- J. Transformer. ASC power supply shall be fused or current limiting and shall be rated at a minimum of 125% of ASC power consumption.

2.07 INPUT AND OUTPUT INTERFACE

- A. General. Hard-wire input and output points to BCs, AACs, ASCs, or SAs.
- B. Protection. All input points and output points shall be protected such that shorting of the point to itself, to another point, or to ground shall cause no damage to the controller. All input and output points shall be protected from voltage up to 24 V of any duration, such that contact with this voltage will cause no controller damage.
- C. Binary Inputs. Binary inputs shall allow the monitoring of ON/OFF signals from remote devices. The binary inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against contact bounce and noise. Binary inputs shall sense dry contact closure without application of power external to the controller.
- D. Pulse Accumulation Inputs. Pulse accumulation inputs shall conform to binary input requirements and shall also accumulate up to 10 pulses per second.
- E. Analog Inputs. Analog inputs shall monitor low-voltage (0–10 Vdc), current (4–20 mA), or resistance (thermistor or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.
- F. Binary Outputs. Binary outputs shall provide for ON/OFF operation or a pulsed low-voltage signal for pulse width modulation control. Binary outputs on Building Controllers shall have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation.
- G. Analog Outputs. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0–10 Vdc or a 4–20 mA signal as required to properly control output devices. Each Building Controller analog output shall have a two-position (auto-manual) switch, a manually adjustable potentiometer, and status lights. Analog outputs shall not drift more than 0.4% of range annually.
- H. Tri-State Outputs. Control three-point floating electronic actuators without feedback with tri-state outputs (two coordinated binary outputs). Tri-State outputs may be used to provide analog output control in zone control and terminal unit control applications such as VAV terminal units, duct-mounted heating coils, and zone dampers.
- I. System Object Capacity. The system size shall be expandable to at least twice the number of input/ output objects required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The operator interfaces installed for this project shall not require any hardware additions or software revisions in order to expand the system

2.08 POWER SUPPLIES AND LINE FILTERING

- A. Power Supplies. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.

1. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand 150% current overload for at least three seconds without trip-out or failure.
 - a. Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.
 - b. Line voltage units shall be UL recognized and CSA listed.

B. Power Line Filtering:

1. Provide internal or external transient voltage and surge suppression for workstations and controllers. Surge protection shall have:
 - a. Dielectric strength of 1000 V minimum
 - b. Response time of 10 nanoseconds or less
 - c. Transverse mode noise attenuation of 65 dB or greater
 - d. Common mode noise attenuation of 150 dB or greater at 40–100 Hz.

2.09 DAMPERS

A. General:

1. No single damper shall be larger in size than 48-in in either dimension. Where a larger damper is required, multiple damper assemblies shall be provided.
2. Where multiple damper assemblies are provided, a common actuator may be used to drive a maximum of four dampers. Provide stainless steel connecting linkage as required. Where an assembly is constructed of more than four dampers, multiple actuators shall be provided.

B. Control Dampers (MCD):

1. Manufacturer:
 - a. Greenheck model VCD-33.
 - b. Or equal.
2. Ultra low leakage damper.
3. 16 gauge galvanized steel frame. Dampers installed in aluminum or stainless steel duct systems or unducted applications in areas specified to use aluminum or stainless steel ducts shall be provided with Hi-Pro polyester coating or be fabricated of 304 stainless steel frame and blades.
4. Airfoil shaped double skin blades completely symmetrical about the axle pivot point.
5. Blade axles in synthetic sleeve bearings.
6. Silicone blade seals.
7. Flexible stainless steel jamb seals.
8. External (out of the airstream) blade to blade linkage.
9. Suitable for pressures to 8-in. w.c. and velocities to 4,000-fpm with maximum AMCA leakage rate of 6 cfm/sq. ft at 4-in w.c.

C. Damper Actuators:

1. Actuators shall be adequately sized for the damper size and air pressures anticipated in the system with a safety factor of two.
2. Actuators shall have ISO9001 quality certification and be UL listed under standard 60730-1 or UL listed under standard 873.

3. Actuators used on dampers shall be designed to directly couple and mount to a stem, shaft or ISO style-mounting pad. Actuator mounting clamps shall be a V-bolt with a toothed V-clamp creating a cold weld, positive grip effect. Single point, bolt, or single screw actuator type fastening techniques or direct-coupled actuators requiring field assembly of the universal clamp is not acceptable.
4. Actuators shall be fully modulating/proportional, pulse width, floating/tristate, or two position as indicated in the sequence of operation and be factory or field selectable. Actuators shall have visual position indicators and shall operate in sequence with other devices if required.
5. Provide actuators with end switches or position feedback as indicated in the sequences of operation.
6. Actuators shall have an operating range of -22° to 122° F.
7. Proportional actuators shall accept a 0-10 VDC or 0-20 mA input signal and provide a 2-10 VDC or 4-20 mA (with a 500 W load resistor) operating range.
8. Actuators shall be capable of operating on 24 or 120 VAC, or 24VDC and Class 2 wiring as dictated by the application. Power consumption shall not exceed 10 VA for AC, including 120VAC actuators, and 8 watts per actuator for DC applications. Power supply requirements are Contractors option.
9. Actuators shall have electronic overload protection or digital rotation sensing circuitry to prevent actuator damage throughout the entire rotation. End switches to deactivate the actuator at the end rotation or magnetic clutches are not acceptable.
10. For power-failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing. Spring return actuators shall be capable of CW or CCW mounting orientation. Spring return models > 60 in-lbs. and non-spring return models > 90 in-lbs. shall be capable of mounting on shafts up to 1.05-in diameter. Spring return actuators with more than 60 in-lb. of torque shall have a metal, manual override crank. Actuators using "on-board" chemical storage systems, capacitors, or other "on-board" non-mechanical forms of fail-safe operation are unacceptable. Upon loss of control signal, a proportional actuator shall fail open or closed as described below. Upon loss of power, a nonspring return actuator shall maintain the last position.
11. Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required. Dampers requiring greater torque or higher close off may be assembled with multiple low torque actuators. Dual mounted actuators using additional anti-rotation strap mechanical linkages, or special factory wiring to function are not acceptable. Actuators in a tandem pair must be "off the shelf," standard actuators ready for field wiring.
12. Damper actuators shall not produce more than 62 dB (A) when furnished with a mechanical fail-safe spring. Non-spring return actuators shall conform to a maximum noise rating of 45 dB(A) with power on or in the running or driving mode.
13. Proportional actuators shall be fully programmable. Control input, position feedback and running time shall be factory or field programmable. Diagnostic feedback shall provide indications of hunting or oscillation, mechanical overload, mechanical travel and mechanical load limit. The actuators shall also provide actuator service data, at minimum, number of hours powered and number of hours in motion.
14. Proportional actuators shall be capable of digital communication, as built.
15. All damper operators shall be oil submerged, geartrain type, inherently positive positioning.
16. The actuators shall be mounted externally of ducts or air handling equipment wherever possible for ease of service and isolated from internal temperatures.
17. Actuator enclosure:
 - a. Unless otherwise indicated, NEMA 2.
 - b. In areas designated as Class 1, Division 1 or 2 hazardous environment, provide explosion proof enclosure.
 - c. All process areas (not Mechanical Rooms, in air handling units (AHU) or Administrative Spaces), NEMA 4X.
18. Fail Position:

- a. Outside Air Louvers/Intakes: Closed with exception of units serving generator rooms.
- b. Generator Room Outside Air and Discharge Air Dampers: Open.
- c. Return Air Dampers: Open.
- d. Duct Mounted Control Dampers: Closed.

2.10 TEMPERATURE SENSORS

- A. Temperature Sensors shall be of the type and have accuracy ratings as indicated and/or required for the application and shall permit accuracy rating of within 1% of the temperature range of their intended use. Sensors must be capable of being calibrated.
- B. Provide sensors such that the DDC shall be able to convert the resistive input signal available from the element into a digital signal for use by the DDC.
- C. All duct sensors shall be electronic resistance type.
- D. Sensors used for mixed air application shall be the averaging type of sufficient length to extend diagonally across the entire duct and have an accuracy of 1%.
- E. Duct sensors shall protrude into the air stream far enough to sense any temperature differences due to stratification, etc.
- F. Outside air sensors shall have a minimum range of -20 °F to 110 °F and an accuracy of within 1 °F in this temperature range. Sensors shall be provided with a water-tight fitting and adequate protection from the effects of solar radiation.
- G. Space temperature sensors located in the Office or Electrical Spaces (as defined on Drawing 001-ENV-1,-2,-3) shall have digital space temperature and setpoint display with external setpoint adjustment and manual Occupied/Unoccupied override. Setpoint adjustment shall be software limited by the operator interface.
- H. Space temperature sensors located in process spaces shall be provided with a NEMA 4X enclosure with corrosion resistant elements. Sensors shall have no setpoint adjustment or display. Space temperature setpoint shall be made via the operator interface.
- I. Space temperature sensors located in areas identified and Class 1, Division 1 or 2 shall be provided with an explosion proof enclosure with corrosion resistant elements. Sensors shall have no setpoint adjustment or display. Space temperature setpoint shall be made via the operator interface.
- J. Water temperature sensors shall be of the bulb type mounted within stainless steel wells filled with a heat conductive compound and in direct contact with the water within the pipe.
- K. All field mounted sensors shall be labeled in accordance with Section 40 05 10 with the name or identification number used in the control program.

2.11 LOW TEMPERATURE PROTECTION THERMOSTATS

- A. Provide low-temperature protection thermostats of manual-reset type with sensing elements 8'-0" or 20'-0" in length.
- B. Provide thermostat designed to operate in response to coldest 1'-0" length of sensing element, regardless of temperature at other parts of element.
- C. Support element properly to cover entire unit width. Provide separate thermostats for each 25 sq. ft. of coil face area or fraction thereof.

2.12 LINE-VOLTAGE/LOW VOLTAGE ON-OFF THERMOSTATS

- A. Bi-metal actuated open contact, or bellows actuated enclosed snap-switch type.
- B. UL-listed at electrical rating comparable with application.
- C. Heat anticipation.

2.13 LINE VOLTAGE THERMOSTATS WITH FAN SWITCH

- A. Provide thermostats as described above with three position manual switch labeled Hand-Off-Auto. Switch shall be integral part of thermostat and be capable of mounting on 2-gang switch box.

2.14 CURRENT SENSORS

- A. Manufacturer:
 - 1. Automation Components Inc, Model A/SCTA.
 - 2. Or Equal.
 - 3.
- B. Split-core type 4-20 mA output current sensor.
- C. +12 o 30 VDC sensor supply voltage.
- D. 4-20 mA, 2-wire loop powered output.
- E. +/- 0.5% accuracy from 0-100% full scale output.
- F. 2,200 VAC isolation voltage and upto 600 VAC sensing voltage.
- G. Minimum 0.75 inch diameter aperture size.
- H. Contactor shall select scale to match equipment served.

2.15 PRESSURE SENSORS

- A. Pressure sensor shall be of commercial grade quality located at the point of measurement and installed in accordance with Manufacturer's recommendations.
- B. Shall be able to convert the 0-5 VDC input signal available from the sensor into a digital signal for use by the DDC.
- C. Ultra precision type with a tolerance at 70°F of no greater than +/- 0.8% of full scale and full scale accuracy of +/-2%.
- D. All field mounted sensors shall be labeled in accordance with Section 40 05 10 with the name or identification number used in the control program.
- E. Water pressure sensors shall have range of 0-50 psig and be suitable for temperatures to 225°F.
- F. Filter differential pressure sensors shall have a range of 0-1 in. w.c. for units with single filters and 0-2 in w.c. for units with prefilters and carbon filters.

2.16 TEMPERATURE CONTROL PANELS (TCP)

- A. Provide control panels with suitable brackets for either wall or floor mounting where indicated and elsewhere as required. Locate panel as indicated and required.
- B. Provide standard NEMA 1 or 12 cabinets of size required to contain temperature controllers; DDC, IDC, and IBC controllers; relays; switches; and similar devices; except limit controllers and other devices excluded in sequence of operations. Where TCP is located outside of an Electrical or Mechanical Room, provide NEMA 4X stainless steel enclosures.
- C. Mount required alarm lights, indicating devices and manual controls on face of panel.

PART 3 – EXECUTION

3.01 GENERAL

- A. All necessary equipment, labor, and materials not specifically indicated or specified, but necessary to complete work, are to be provided as part of the Contract.
- B. Install all control equipment, accessories, wiring, and piping in a neat and workman like manner. All control devices must be installed in accessible locations.
- C. Provide all electrical relays and wiring, line and low voltage, for control systems, devices, and components. All relays and controllers shall be installed in Temperature Control Panels (TCP). All required control power shall be received from TCPs.
- D. Control panels serving equipment served by emergency power shall also be served by emergency power.
- E. Install system and materials in accordance with manufacturer's instructions and roughing-in drawings, and details on drawings. Install electrical work and use electrical products complying with requirements of applicable Division 26 sections of these specifications. Mount controller at convenient locations and heights.
- F. Install "Hand-Off-Auto" selector switches on systems where automatic interlock controls are specified. When switch is in the "Hand" position, allow manual operation of the selected device without the operation of the interlocked motors but allowing unit safety devices to stay in the circuit. When air handling units are in the "Hand" mode, outside air damper shall be open. When fans interlocked with motor operated intake dampers are in the "Hand" mode, associated damper shall open.

3.02 EXAMINATION

- A. The Contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started.
- B. The Contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate or if any discrepancies occur between the plans and the Contractor's work and the plans and the work of others, Contractor shall report discrepancies to the Engineer and shall obtain written instructions for any changes necessary to accommodate Contractor's work with work of others. Any changes in work covered by this Section made necessary by the failure or neglect of the Contractor to report such discrepancies shall be made by and at the expense of, this Contractor.

3.03 PROTECTION

- A. Contractor shall protect all work and material from damage by his/her work or employees and shall be liable for all damage thus caused.
- B. Contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. Contractor shall protect any material that is not immediately installed. Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.04 COORDINATION

A. Site:

- 1. Where the mechanical work will be installed in close proximity to, or will interfere with, work of other trades, Contractor shall assist in working out space conditions to make a satisfactory adjustment. If Contractor installs his/her work before coordinating with other trades, so as to cause any interference with work of other trades, Contractor shall make the necessary changes in his/her work to correct the condition without extra charge.
- 2. Coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.

B. Coordination with controls specified in other sections or divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated by the contractor as follows:

- 1. All communication media and equipment shall be provided as specified in Communication paragraph of this Section.
- 2. Each supplier of a controls product is responsible for the configuration, programming, start up, and testing of that product to meet the Control Sequences.
- 3. Contractor shall coordinate and resolve any incompatibility issues that arise between control products provided under this Section and those provided under other sections or divisions of this specification.
- 4. Contractor is responsible for providing all controls described in the contract documents regardless of where within the contract documents these controls are described.
- 5. Contractor is responsible for the interface of control products provided by multiple suppliers regardless of where this interface is described within the contract documents.

3.05 WORKMANSHIP

- A. Install equipment, piping, and wiring/raceway parallel to building lines (i.e. horizontal, vertical, and parallel to walls) wherever possible.
- B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- C. Install equipment in readily accessible locations as defined by National Electrical Code (NEC).
- D. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
- E. All equipment, installation, and wiring shall comply with industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.06 FIELD QUALITY CONTROL

- A. All work, materials, and equipment shall comply with rules and regulations of applicable local, state, and federal codes.

- B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship.
- C. Contractor shall have work inspection by local and/or state authorities having jurisdiction over the work.

3.07 WIRING

- A. All control and interlock wiring shall comply with national and local electrical codes, and Division 26 of this specification. Where the requirements of this Section differ from Division 26, the requirements of this Section shall take precedence.
- B. All wiring in mechanical, electrical, or service rooms – or where subject to mechanical damage – shall be installed in raceway at levels below 3 m (10ft).
- C. Do not install Class 2 wiring in raceways containing Class 1 wiring. Boxes and panels containing high-voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).
- D. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block.
- E. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
- F. Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, the contractor shall provide step-down transformers.
- G. Use color-coded conductors throughout with conductors of different colors.
- H. Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.
- I. Conceal all raceways except within mechanical, process, electrical, or service rooms. Install raceway to maintain a minimum clearance of 15 cm (6 in.) from high-temperature equipment (e.g. steam pipes or flues).
- J. The contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.

3.08 COMMUNICATION WIRING

- A. Contractor shall adhere to requirements of Division 26 and items listed in the Wiring paragraph of this Section.
- B. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.
- C. Do not install communication wiring in raceways and enclosures containing Class 1 or other Class 2 wiring.
- D. Maximum pulling, tension, and bend radius for the cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.

- E. Contractor shall verify the integrity of the entire network following cable installation. Use appropriate test measures for each particular cable.
- F. All runs of communication wiring shall be unspliced length when that length is commercially available.
- G. All communication wiring shall be labeled to indicate origination and destination data.
- H. All communication wiring shall be labeled to indicate origination and destination data.
- I. Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."
- J. BACnet MS/TP communications wiring shall be installed in accordance with ASHRAE/ANSI Standard 135. This includes but is not limited to:
 1. The network shall use shielded, twisted-pair cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors shall be less than 100 pF per meter (30 pF per foot.)
 2. The maximum length of an MS/TP segment is 1200 meters (4000 ft) with AWG 18 cable. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485.
 3. The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard. Additional nodes may be accommodated by the use of repeaters.
 4. An MS/TP EIA-485 network shall have no T connections.

3.09 SENSOR INSTALLATION

- A. Install sensors in accordance with the Manufacturer's recommendations.
- B. Mount sensors rigidly and adequately for environment within which the sensor operates.
- C. Room temperature sensors shall be installed on concealed junction boxes properly supported by wall framing.
- D. Install all space temperature sensors and thermostats mounted at ADA heights.
- E. Any temperature sensor or thermostat mounted on an exterior wall shall be mounted on a thermally insulated sub-base.
- F. All wires attached to sensors shall be sealed in their raceways or in the wall to stop air transmitted from other areas from affecting sensor readings.
- G. Sensors used in mixing plenums and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.
- H. Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 1-foot of sensing element for each 1-ft² of coil area.
- I. Do not install temperature sensors within the vapor plume of a humidifier. If installing a sensor downstream of a humidifier, install it at least 10-feet downstream.
- J. All pipe-mounted temperature sensors shall be installed in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells.

- K. Install outdoor air temperature sensors on north wall, complete with sun shield.
- L. Differential Air Static Pressure:
 - 1. Supply Duct Static Pressure. Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor (if applicable) or to the location of the duct high-pressure tap and leave open to the plenum.
 - 2. Return Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube. Pipe the low-pressure port to a tee in the low-pressure tap tubing of the corresponding building static pressure sensor.
 - 3. Building Static Pressure. Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe the high-pressure port to a location behind a thermostat cover.
 - 4. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
 - 5. All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without use of ladders or special equipment.
 - 6. All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shut-off valves installed before the tee.
- M. Smoke detectors, freezestats, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the Control Sequences. Unless indicated otherwise, switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status.
- N. Install humidity sensors for duct mounted humidifiers at least 10-feet downstream of the humidifier. Do not install filters between the humidifier and the sensor.

3.10 ACTUATOR INSTALLATION

- A. General. Mount and link control damper actuators according to Manufacturer's instructions.
 - 1. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage.
 - 2. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
 - 3. Provide all mounting hardware and linkages for actuator installation.
- B. Electric/Electronic:
 - 1. Dampers: Actuators shall be direct mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5° travel available for tightening the damper seal. Actuators shall be mounted following Manufacturer's recommendations.
 - 2. Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator Manufacturer's recommendations.

3.11 CONTROL DAMPER INSTALLATION

- A. Damper submittals shall be coordinated for type, quantity, and size to ensure compatibility with sheet metal design.

- B. Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting. Duct openings shall measure ¼ in. larger than damper dimensions and shall be square, straight, and level.
- C. Individual damper sections, as well as entire multiple section assemblies, must be completely square and free from racking, twisting, or bending. Measure diagonally from upper corners to opposite lower corners of each damper section. Both dimensions must be within 0.3 cm (1/8 in.) of each other.
- D. Follow the Manufacturer's instructions for field installation of control dampers. Unless specifically designed for vertical blade application, dampers must be mounted with blade axis horizontal.
- E. Install extended shaft or jackshaft according to Manufacturer's instructions. (Typically, a sticker on the damper face shows recommended extended shaft location. Attach shaft on labeled side of damper to that blade.)
- F. Damper blades, axles, and linkage must operate without binding. Before system operation, cycle damper after installation to ensure proper operation. On multiple section assemblies, all sections must open and close simultaneously.
- G. Provide a visible and accessible indication of damper position on the drive shaft end.
- H. Support ductwork in area of damper when required to prevent sagging due to damper weight.
- I. After installation of low-leakage dampers with seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.

3.12 WARNING LABELS

- A. Permanent warning labels shall be affixed to all equipment that can be automatically started by the control system.
 - 1. Labels shall use white lettering (12-point type or larger) on a red background.
 - 2. Warning labels shall read as follows:

CAUTION

This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing.

- B. Permanent warning labels shall be affixed to all control panels that are connected to multiple power sources utilizing separate disconnects.
 - 1. Labels shall use white lettering (12-point type or larger) on a red background.
 - 2. Warning labels shall read as follows.

CAUTION

This equipment is fed from more than one power source with separate disconnects.
Disconnect all power sources before servicing.

3.13 IDENTIFICATION OF HARDWARE AND WIRING

- A. All equipment labeling shall meet the requirements of Section 40 05 10. All wire, cable and raceway labeling shall meet the requirements of Section 26 05 23.

- B. All wiring and cabling, including that within factory-fabricated panels shall be labeled at each end within 5 cm (2 in.) of termination with control system address or termination number.
- C. All pneumatic tubing shall be labeled at each end within 2-inches of termination with a descriptive identifier.
- D. Permanently label or code each point of field terminal strips to show the instrument or item served.
- E. Identify all other control components with permanent labels. All plug-in components shall be labeled such that label removal of the component does not remove the label.
- F. Identify room sensors related to terminal boxes or valves with nameplates.
- G. Manufacturers' nameplates and UL or CSA labels shall be visible and legible after equipment is installed.
- H. Identifiers shall match record documents.

3.14 CONTROLLERS

- A. Provide a separate controller for each AHU or HVAC system as indicated in Control Sequences. A DDC controller may control more than one system provided that all points associated with the system are assigned to the same DDC controller. Points used for control loop reset, such as outside air or space temperature, are exempt from this requirement.
- B. Building Controllers and Custom Application Controllers shall be selected to provide the required I/O point capacity required to monitor all required hardware points.

3.15 CONTROLS COMMUNICATION PROTOCOL

- A. General. Electronic controls packaged with this equipment shall communicate with the building direct digital control (DDC) system. The DDC system shall communicate with these controls to read the information and change the control setpoints as shown in the Control Sequences and control schematics. The information to be communicated between the DDC system and these controls shall be in the standard object format as defined in ANSI/ASHRAE Standard 135 (BACnet). Controllers shall communicate with other BACnet objects on the internetwork using the Read (Execute) Property service as defined in Standard 135.
- B. Distributed Processing. The controller shall be capable of stand-alone operation and shall continue to provide control functions if the network connection is lost.
- C. I/O Capacity. The controller shall contain sufficient I/ O capacity to control the target system.
- D. The Controller shall have a physical connection for a laptop computer or a portable operator's tool.
- E. Environment. The hardware shall be suitable for the anticipated ambient conditions.
 - 1. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at -40°C to 60°C (-40°F to 140°F).
 - 2. Controllers used in conditioned space shall be mounted in dust-proof enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).
- F. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field removable, modular terminal strips or to a termination card connected by a ribbon cable.

- G. Memory. Controller shall maintain all BIOS and programming information in the event of a power loss for at least 30 days.
- H. Power. Controller shall be able to operate at 90% to 110% of nominal voltage rating.
- I. Transformer. Power supply for Controller must be rated at minimum of 125% of ASC power consumption and shall be fused or current limiting type.

3.16 PROGRAMMING

- A. Provide sufficient internal memory for the specified sequences of operation and trend logging.
- B. Point Naming. Name points as shown on the equipment points list provided with each sequence of operation. Where multiple points with the same name reside in the same controller, each point name may be customized with its associated Program Object number. For example, "Zone Temp 1" for Zone 1, "Zone Temp 2" for Zone 2.
- C. Software Programming:
 - 1. Provide programming for the system and adhere to the specified Control Sequences. All other system programming necessary for the operation of the system, but not specified in this document, also shall be provided by Contractor. Embed into the control program sufficient comment statements to clearly describe each section of the program. Comment statements shall reflect the language used in the Control Sequences. Use the appropriate technique based on the following programming types:
 - a. Text-based:
 - 1) Must provide actions for all possible situations
 - 2) Must be modular and structured
 - 3) Must be commented
 - b. Graphic-based:
 - 1) Must provide actions for all possible situations
 - 2) Must be documented
 - c. Parameter-based:
 - 1) Must provide actions for all possible situations
 - 2) Must be documented.
- D. Operator Interface:
 - 1. Standard Graphics. Provide graphics for all mechanical systems and floor plans of the building. This includes each chilled water system, hot water system, chiller, boiler, air handler, and all terminal equipment. Point information on the graphic displays shall dynamically update. Show on each graphic all input and output points for the system. Also show relevant calculated points such as setpoints.
 - 2. Contractor shall provide all the labor necessary to install, initialize, start up, and troubleshoot all operator interface software and its functions as described in this section. This includes any operating system software, the operator interface database, and any third-party software installation and integration required for successful operation of the operator interface.

3.17 CONTROL SEQUENCES

A. General:

1. All equipment served by the Direct Digital Control (DDC) system shall be provided with a means, through the computer interface, to over-ride the automatic controls of unit to manually start or stop the equipment.
2. All measured values, positions and on/off statuses shall be visible on operator interface.
3. Where multiple items serving the same space require thermostatic control, a single space temperature sensor shall be installed to serve all units, unless indicated otherwise.
4. Individual equipment sequences that follow indicate that a controller shall be furnished for each piece of equipment. Contractor shall be permitted to use a single controller and/or input/output interface points for multiple systems to minimize quantity of controllers required.
5. Provide a digital output interface to Plant PLC to serve as a "Ventilation Failure" at each temperature control panel. If temperature drops 10F below setpoint in space, provide a ventilation failure alarm to the PLC from the respective TCP.
6. Maintenance alarms shall be output to the FMS interface.
7. Occupancy shall be controlled by a user adjustable daily and hourly schedules.

B. Hot Water Baseboard Heater:

1. Units Served:
 - a. 120-HBH-1.
 - b. 120-HBH-2
2. FMS Contractor shall provide DDC controller, space temperature sensor, open-close three-way temperature control valve for each heater, and other components and wiring as required to meet the sequence of operation.
3. FMS shall monitor space temperature. Upon fall in space temperature below setpoint, 70°F, adjustable, temperature control valve shall open. Upon satisfaction of space heating requirements, valve shall close.

C. Hot Water Radiant Heater:

1. Units Served:
 - a. 120-RHP-1.
2. FMS Contractor shall provide DDC controller, space temperature sensor, open-close three-way temperature control valve for each heating panel, and other components and wiring as required to meet the sequence of operation.
3. FMS shall monitor space temperature. Upon fall in space temperature below setpoint, 70°F, adjustable, temperature control valve shall open. Upon satisfaction of space heating requirements, valve shall close.

D. Building 120 Circulating Pumps:

1. Units Served:
 - a. 120-CP-1, -2.
2. FMS shall provide DDC controller, current switch for each pump, and other components and wiring as required to meet the sequence of operation.
3. The current switch shall monitor the run status of each pump.
4. Provide Hand-Off-Auto functionality for each pump.

5. In Hand Mode, 120-CP-X shall energize and run continuously.
6. In the Off Mode, 120-CP-X shall remain off.
7. In the Auto Mode:
 - a. Lead pump shall energize.
 - b. Pumps shall alternate between lead and lag, each running for one week at a time.
 - c. If the lead pump fails to run (as determined by the current switch), the lag pump shall energize. An alarm shall be initiated at the FMS interface.

E. Hot Water Reheat Variable Air Volume Boxes:

1. Units Served:
 - a. 120-VAV-1.
 - b. 120-VAV-2.
 - c. 120-VAV-3.
 - d. 120-VAV-4.
 - e. 120-VAV-5.
 - f. 120-VAV-6.
 - g. 120-VAV-7.
 - h. 120-VAV-8.
2. FMS Contractor shall provide DDC controller, space temperature sensors, three-way modulating temperature control valves, damper actuators, and other components and wiring as required to meet the sequence of operation. Space sensors shall have +/- temperature adjustment with maximum allowable range of adjustment set through the OWS and over-ride button to allow 120-RTU-1 to switch to occupied mode of operation for an adjustable time period upon pressing of any over-ride buttons.
3. FMS shall monitor space temperature, upon rise in space temperature above cooling setpoint (72°F adjustable) damper shall modulate toward full open position.
4. Upon fall in space temperature below heating setpoint (68°F adjustable) damper shall modulate toward minimum open position. If damper is at minimum position and call to heat, temperature control valve shall open and modulate as required to maintain space temperature.
5. When heating on minimum flow rate, if the heating valve is greater than 50% open, increase the airflow of the VAV box to the heating airflow scheduled. When the VAV box is operating at the heating airflow and temperature control valve position is below 20% open, reduce airflow down to minimum airflow rate.
6. Upon fall or rise in space temperature of 5°F above or below setpoint, an alarm shall be initiated at the FMS interface.
7. Upon signal that 120-RTU-1 return air smoke detector in alarm condition, VAV damper shall fully close.

F. Air Handling Unit with Integral Air Cooled Condensing Unit:

1. Units Served:
 - a. 120-RTU-1, 120-EF-1, 120-EF-3
2. Control and operation of mechanical cooling components shall be in accordance with AHU Manufacturers recommendations.
3. FMS Contractor shall provide DDC controller, unit discharge air temperature sensor (for monitoring), return air smoke detector, duct discharge pressure sensor, space differential pressure sensor, filter differential pressure transmitter, space humidity sensor, and other components and wiring as required to meet the sequence of operation. Refer to Section 23 75 16 for item furnished with the unit.

4. FMS system shall control adjustable Occupied/Unoccupied time clock.
 - a. In the Occupied mode: 120-EF-1, 120-EF-3, and 120-RTU-1 supply fan shall energize and run continuously. Outside air damper shall open to minimum position. 120-EF-3 shall modulate to maintain space pressure at -0.02 in wc. FMS shall monitor RTU fan speed and adjust outside air and return air dampers as required to maintain required outside air flow rates regardless of reduced fan speed. FMS shall modulate supply fan speed to maintain duct static pressure setpoint of 0.6-in. w.c. (adjustable). Upon detection of no duct pressure and fan called to run, alarm shall be sent.
 - b. In the Unoccupied mode: 120-RTU-1 supply fan shall energize on call for space heat with outside air damper closed and return air damper open.
 5. Over-ride buttons on each temperature sensor shall cause 120-RTU-1 to operate in occupied mode.
 6. Discharge air temperature shall be set by the FMS based on summation of calls for heat and cooling from space temperature sensors serving VAV boxes 120-VAV-1 through -8 between 55°F and 70°F.
 7. FMS shall monitor space relative humidity via space humidity sensor in the water lab. Upon rise in humidity above setpoint, FMS system shall send a dehumidification enable to the unit along with a cooling coil discharge air temperature setpoint. The RTU shall adjust cooling discharge air temperature to maintain the cooling coil discharge air temperature setpoint. RTU controller shall reset unit discharge air temperature setpoint as required to prevent overcooling of areas served.
 8. RTU controller shall monitor outside air temperature. On call for cooling with outside air temperature above 55°F, adjustable, unit shall stage on compressors, condenser fans and refrigerant solenoids (if applicable) as required to meet discharge air temperature setpoint. On call for cooling when outside air temperature is less than 55°F, RTU shall modulate outside air and return air dampers to maintain setpoint temperature.
 9. Upon drop in discharge air temperature below 39°F, adjustable, supply and exhaust fans shall stop, outside air damper shall close, and alarm shall be sent.
 10. Differential pressure across the filters shall be monitored by the FMS, upon rise in differential above Manufacturer recommended setpoint, alarm shall be sent.
 11. Return air smoke detector shall be installed in the return air ductwork. Upon detection of smoke, supply and exhaust fans shall stop, outside air damper shall close, and ventilation failure alarm shall be sent.
 12. DDC shall monitor fan current draw of EF-1 and EF-3. If called to run, if current draw from the EF is less than anticipated, a loss of ventilation alarm signal shall be sent to Plant PLC. Interface with PLC shall be at 120-TCP-1.
- G. Air Handling Unit with Integral Air Cooled Condensing Unit:
1. Units Served:
 - a. 120-RTU-2, 120-EF-2.
 2. Control and operation of mechanical cooling components shall be in accordance with RTU Manufacturers recommendations.
 3. FMS Contractor shall provide DDC controller, unit discharge air temperature sensor (for monitoring), space temperature sensor, space humidity sensor, filter differential pressure transmitter, current switch for each exhaust fan and other components and wiring as required to meet the sequence of operation. Refer to Section 23 75 16 for item furnished with the unit.
 4. FMS system shall control adjustable Occupied/Unoccupied time clock.
 - a. In the Occupied mode: RTU supply fan and energy recovery exhaust fan shall energize and run continuously and outside air damper shall open to 525-CFM. FMS shall monitor

fan status for EF-2, upon call for fan to run, outside air damper shall modulate to 750 cfm position and energy recovery exhaust fan shall de-energize.

- b. In the Unoccupied mode: 120-RTU-2 supply fan shall energize on call for space heat with outside air damper closed and return air damper open.
5. Over-ride buttons on each temperature sensor shall cause 120-RTU-2 to operate in occupied mode.
 6. Discharge air temperature shall be set by the FMS as required to maintain space temperature setpoint.
 7. FMS shall monitor space relative humidity via space humidity sensor in the Laboratory. Upon rise in humidity above setpoint, FMS system shall send a dehumidification enable to the unit along with a cooling coil discharge air temperature setpoint. The RTU shall adjust cooling coil discharge air temperature to maintain the cooling coil discharge air temperature setpoint. RTU controller shall reset unit discharge air temperature setpoint as required to prevent overcooling of areas served.
 8. RTU shall monitor outside air temperature. On call for cooling with outside air temperature above 55°F, adjustable, RTU shall stage on compressors, condenser fans and refrigerant solenoids (if applicable) as required to meet discharge air temperature setpoint. On call for cooling when outside air temperature is less than 55°F, RTU shall modulate outside air and return air dampers to maintain setpoint temperature.
 9. RTU shall monitor outside air temperature. When beneficial for energy savings, the energy recovery system shall run.
 10. Differential pressure across the filters shall be monitored by the FMS, upon rise in differential above Manufacturer recommended setpoint, maintenance alarm shall be sent.

H. Hot Water Heaters:

1. Units Served:
 - a. 125-HUH-1, -2.
2. FMS Contractor shall provide DDC controller, space temperature sensor, open-close two-way temperature control valve for each heater, and other components and wiring as required to meet the sequence of operation.
3. FMS shall monitor space temperature. Upon fall in space temperature below setpoint, 55°F, adjustable, temperature control valve shall open and HUH fan shall energize. Upon satisfaction of space heating requirements, valve shall close and HUH fan shall de-energize.

I. Make-up Air Unit and Exhaust Fans:

1. Units Served:
 - a. 125-MAU-1, 125-EF-1.
2. FMS Contractor shall provide DDC controller, temperature control panel (NEMA 4X), unit discharge air temperature sensor (for monitoring), filter differential pressure transmitter, outside air temperature sensor, exhaust fan interlocks, current sensors and switches and other components and wiring as required to meet the sequence of operation.
3. On the face of 125-TCP-1 provide On-Off switch for system.
4. In the Off Mode: All fans shall remain off.
5. In the On Mode:
 - a. MAU discharge air damper shall open.
 - b. Upon proof the discharge air damper is open, MAU supply fan shall energize and run continuously.
 - c. Upon proof of MAU supply fan running, EF shall energize and run continuously.

- d. DDC shall send discharge air temperature, initially set to 50F, to the unit controller. Set point temperature shall be adjustable at the FMS interface. The unit controller shall control the makeup air units rate of fire as required to maintain discharge air temperature at setpoint. A room sensor over-ride shall increase the discharge air temperature if space temperature drops below room temperature setpoint, initially set to 50F. Reverse procedure once space temperature is met.
 - e. DDC shall monitor MAU discharge air temperature.
 - f. MAU controller shall monitor outside air temperature, with outside air temperature above an adjustable 60°F setpoint, the burner shall not be allowed to fire.
6. Under all modes of operation:
- a. DDC shall monitor fan current draw of MAU and EF. Regardless of call to run, if current draw from MAU supply fan or EF is less than anticipated, a loss of ventilation alarm signal shall be sent to Plant PLC. Interface with PLC shall be at 125-TCP-1.
 - b. Upon detection that MAU leaving air temperature falls below 35°F (adjustable) fans shall stop, and a maintenance alarm shall be initiated.
 - c. Filter differential pressure shall be monitored, upon rise in differential pressure above adjustable setpoint of 0.4-in w.c. a maintenance alarm shall be initiated.
 - d. Upon activation of break glass system, 125-MAU-1 and 125-EF-1 shall de-energize. A ventilation failure shall be sent to the PLC.
- J. Make-up Air Unit and Exhaust Fans:
- 1. Units Served:
 - a. 600-MAU-1, 610-EF-0801.
 - 2. FMS Contractor shall provide DDC controller, temperature control panel (NEMA 4X), unit discharge air temperature sensor (for monitoring), space temperature sensor, filter differential pressure transmitter, exhaust fan interlocks, current sensors and switches and other components and wiring as required to meet the sequence of operation.
 - 3. On the face of 600-TCP-1 provide Auto-Off switch for system.
 - 4. In the Off Mode: All fans shall remain off.
 - 5. In the Auto Mode:
 - a. MAU supply fan shall energize and run continuously.
 - b. Upon proof of MAU supply fan running, “odorous air fan required” signal shall be sent to the PLC via the TCP.
 - c. MAU controller and FMS shall monitor discharge air temperature.
 - d. With discharge air temperature adjustable setpoint of 60°F, heating controls shall be modulated to maintain discharge air setpoint.
 - e. MAU controller shall modulate rate of fire of burner as required to satisfy discharge air temperature setpoint.
 - f. DDC controller shall monitor space temperature, upon fall in space temperature below adjustable setpoint of 55°F, DDC shall increase discharge air temperature setpoint as required to satisfy space temperature setpoint. Upon rise in space temperature above setpoint, DDC shall reset discharge air temperature setpoint downward toward initial setpoint.
 - g. MAU shall monitor outside air temperature, with outside air temperature above an adjustable 60°F setpoint, burner shall not be allowed to fire.
 - 6. Under all modes of operation:
 - a. DDC shall monitor fan current draw of MAU. Regardless of call to run, if current draw from MAU supply fan is less than anticipated, a loss of ventilation alarm signal shall be

sent to Plant PLC. Interface with PLC shall be at 600-TCP-1.

- b. Upon detection that MAU leaving air temperature falls below 35°F (adjustable) fans shall stop, and a maintenance alarm shall be initiated.
- c. Filter differential pressure shall be monitored, upon rise in differential pressure above adjustable setpoint of 0.4-in w.c. a maintenance alarm shall be initiated.
- d. Return air smoke detector shall be installed in the return air ductwork. Upon detection of smoke, supply and exhaust fans shall stop, outside air damper shall close, and ventilation failure alarm shall be sent.

K. Roof Top Unit and Exhaust Fans:

1. Units Served:

- a. 600-RTU-1, 600-EF-2.

2. Control and operation of mechanical cooling components shall be in accordance with RTU Manufacturers recommendations.

3. FMS Contractor shall provide DDC controller, unit discharge air temperature sensor (for monitoring), space humidity sensor, filter differential pressure transmitter, outside air temperature sensor, return air smoke detector, current switch for each exhaust fan and other components and wiring as required to meet the sequence of operation. Refer to Section 23 75 16 for item furnished with the unit.

4. On the face of 600-TCP-1 provide Auto-Off switch for system.

5. In the Off Mode: All fans shall remain off.

6. In the Auto Mode:

- a. Exhaust fan 600-EF-2 shall energize and run continuously.
- b. Discharge air temperature set point shall be set by the FMS as required to maintain space temperature setpoint.
- c. FMS shall monitor space relative humidity via space humidity sensor in the Laboratory. Upon rise in humidity above setpoint, FMS system shall send a dehumidification enable to the unit along with a cooling coil discharge air temperature setpoint. The RTU shall adjust cooling discharge air temperature to maintain the cooling coil discharge air temperature setpoint. RTU controller shall reset unit discharge air temperature setpoint as required to prevent overcooling of areas served.
- d. RTU shall monitor outside air temperature. On call for cooling with outside air temperature above 55°F, adjustable, RTU shall stage on compressors, condenser fans and refrigerant solenoids (if applicable) as required to meet discharge air temperature setpoint. On call for cooling when outside air temperature is less than 55°F, RTU shall modulate outside air and return air dampers to maintain setpoint temperature.

7. All modes of operation

- a. Differential pressure across the filters shall be monitored by the FMS, upon rise in differential above Manufacturer recommended setpoint, maintenance alarm shall be sent.
- b. Return air smoke detector shall be installed in the return air ductwork. Upon detection of smoke, supply and exhaust fans shall stop, and alarm shall be sent to 600-FACP-1.

L. Building 900 Heating and Cooling:

1. Units Served:

- a. 900-ODU-1, -2, -3, -4
- b. 900-BC-1,-2
- c. 900-FC-1 through 16

2. FMS Contractor shall provide wiring between components, and to central controller (furnished by VRF system manufacturer) interlock wiring, and other components and wiring as required to meet the sequence of operation.
3. DDC interface shall include:
 - a. Monitor:
 - 1) Each unit run status
 - 2) Each unit alarm condition
 - 3) Each unit space temperature
 - 4) Each unit space temperature setpoint
 - 5) Each unit mode: cooling or heating
 - 6) Compressor status
 - b. Control:
 - 1) Each unit energy saving temperature setpoint override (occupancy temperature adjustment). Function shall use BMS time clock for Occupied/Unoccupied should toggle energy saving override.
 - 2) Each unit remote controller prohibit/permit.
 - 3) Each unit temperature setting
 - 4) Note: remote controller prohibit/permit and unit temperature setting would only be lockout control.
4. FMS Contractor shall install manufacturer furnished controllers and space temperature sensors (16).
5. In the Off mode, System shall remain off.
6. In the Auto mode:
 - a. Occupied mode:
 - 1) FC-1 through -16 fan shall energize and run continuously. Heating and cooling shall modulate in response to temperature set point in each space.
 - 2) 900-BC-1,-2 shall control flow through the system as required to provide cooling and heating to spaces.
 - 3) 900-ODU-1,-2,-3,-4 shall energize and modulate in response to fan coil demands.
 - b. Unoccupied mode:
 - 1) FC-1 through -16 fan shall cycle and heating/cooling shall modulate in response to meet space temperature setpoints.
 - 2) 900-BC-1,-2 shall control flow through the system as required to provide cooling and heating to spaces.
 - 3) 900-ODU-1,-2,-3,-4 shall energize and modulate in response to fan coil demands.
 - c. Under any of the following conditions:
 - 1) Alarm condition from system controller

The following shall occur

 - 1) Alarm shall be sent to operator interface.
7. Over-ride buttons on each temperature sensor shall cause each individual fan coil to operate in occupied mode.
8. Outdoor units shall alternate between lead and lag weekly.

M. Building 900 Outside Air Ventilation:

1. Units Served:
 - a. 900-AHU-1, 900-EF-1, 900-MCD-1, 900-MCD-3.
2. Control and operation of mechanical cooling components shall be in accordance with AHU Manufacturers recommendations.
3. FMS Contractor shall provide DDC controller, CO2 sensor, unit discharge air temperature sensor (for monitoring), duct discharge pressure sensor, filter differential pressure transmitter, outside air temperature sensor, and other components and wiring as required to meet the sequence of operation. Refer to Section 23 74 33 for item furnished with the unit.
4. FMS system shall control adjustable Occupied/Unoccupied time clock.
 - a. Occupied mode:
 - 1) 900-AHU-1 shall energize and run at the minimum airflow of 580 cfm. Unit shall modulate to a maximum of 1100 cfm to maintain a 0.2-in wc differential at location of the pressure sensor.
 - 2) 900-EF-1 shall energize and run continuously.
 - 3) Upon detection of CO2 elevated levels in FC-3 return air duct, Damper MCD-3 shall modulate open. Set damper maximum open position to allow 514 cfm of makeup air to the fan coils.
 - b. Unoccupied mode:
 - 1) 900-AHU-1 shall remain off.
 - 2) 900-EF-1 shall remain off
5. Over-ride buttons on each temperature sensor shall cause 900-AHU-1 to operate in occupied mode.
6. Discharge air temperature shall be set by the FMS initially to dry bulb of 70F and dew point of 50F. This value shall be editable from the FMS interface.
7. RTU shall monitor outside air temperature. On call for cooling with outside air temperature above 55°F, adjustable, RTU shall stage on compressors, condenser fans and refrigerant solenoids (if applicable) as required to meet discharge air temperature and dew point setpoint.
8. Upon detection of no duct pressure and fan called to run, alarm shall be sent.
9. Upon drop in discharge air temperature below 39°F, adjustable, supply and exhaust fans shall stop, outside air damper shall close, and alarm shall be sent.
10. Upon drift in space temperature 5F from setpoint, an alarm shall be sent to the FMS interface.
11. Differential pressure across the filters shall be monitored by the FMS, upon rise in differential above Manufacturer recommended setpoint, alarm shall be sent.

N. Building 900 Conference Room Economizer Fan Coil 2:

1. Units Served:
 - a. 900-MCD-1, -4.
2. FMS Contractor shall provide DDC controller, unit discharge air temperature sensor (for monitoring), outside air temperature sensor, and other components and wiring as required to meet the sequence of operation.
3. When outside air temperature is less than 55F, MCD-1 and MCD-4 shall be modulated to provide cooling to the conference room.

- a. DDC shall determine mixed air temperature set point to achieve desired space temperature. DDC shall reset mixed air temperature setpoint as required to maintain temperature. The mixed air temperature shall not drop below 50F. If mixed air temperature is below 45F, an alarm shall be sent to the operator interface, MCD-1 shall open fully, and MCD-4 shall close fully.
 - 4. When outside air temperature is greater than 55F, MCD-1 shall fully open and MCD-4 shall fully close.
- O. Building 900 Conference Room Economizer Fan Coil 3:
 - 1. Units Served:
 - a. 900-MCD-2, -5.
 - 2. FMS Contractor shall provide DDC controller, unit discharge air temperature sensor (for monitoring), duct discharge pressure sensor, outside air temperature sensor, and other components and wiring as required to meet the sequence of operation.
 - 3. When outside air temperature is less than 55F, MCD-2 and MCD-5 shall be modulated to provide cooling to the conference room.
 - a. DDC shall determine mixed air temperature set point to achieve desired space temperature. DDC shall reset mixed air temperature setpoint as required to maintain temperature. The mixed air temperature shall not drop below 50F. If mixed air temperature is below 45F, an alarm shall be sent to the operator interface, MCD-2 shall open fully, and MCD-5 shall close fully.
 - 4. When outside air temperature is greater than 55F, MCD-2 shall fully open and MCD-5 shall fully close.
- P. Building 900 Bathroom Exhaust:
 - 1. Units Served:
 - a. 900-EF-2.
 - 2. FMS Contractor shall coordinate with electrical contractor to wire 900-EF-2 to a wall switch. The wall switch shall operate the exhaust fan.

3.18 CONTROL SYSTEM CHECKOUT AND TESTING

- A. Startup Testing. All testing listed in this Section shall be performed by the Contractor and shall make up part of the necessary verification of an operating control system. Testing shall be completed before Owner's representative is notified of the system demonstration.
 - 1. Contractor shall furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.
 - 2. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
 - 3. Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures according to Manufacturers' recommendations.
 - 4. Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that normal positions are correct.
 - 5. Verify that all analog output devices (I/Ps, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. Contractor shall check all

control valves and automatic dampers to ensure proper action and closure. Contractor shall make any necessary adjustments to valve stem and damper blade travel.

6. Verify that system operation adheres to Control Sequences. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops.
7. Alarms and Interlocks:
 - a. Check each alarm separately by including an appropriate signal at a value that will trip alarm.
 - b. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
 - c. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

3.19 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Demonstration:

1. Prior to acceptance, control system shall undergo a series of performance tests to verify operation and compliance with this specification. Tests shall occur after Contractor has completed the installation, started up the system, and performed his/her own tests.
2. Tests described in this Section are to be performed in addition to the tests that the Contractor performs as a necessary part of the installation, start-up, and debugging process and as specified in Control System Checkout and Testing paragraph of this Section. Engineer may be present to observe and review these tests. Engineer shall be notified at least 10 days in advance of the start of the testing procedures.
3. The demonstration process shall follow process which has been submitted and approved prior to system installation. Approved checklists and forms shall be completed for all systems as part of demonstration.
4. Contractor shall provide at least two persons equipped with two-way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. Purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by the Contractor.
5. As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.
6. Demonstrate compliance with System Performance paragraph of this Section.
7. Demonstrate compliance with Control Sequences through all modes of operation.
8. Demonstrate complete operation of operator interface.
9. Additionally, the following items shall be demonstrated:
 - a. DDC loop response. Contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in set point, which represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by the Contractor.
 - b. Interface to the building fire alarm system.
 - c. Operational logs for each system that indicate all set points, operating points, valve positions, mode, and equipment status shall be submitted to the architect/engineer. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and disk formats.

10. Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. Contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.

B. Acceptance:

1. All tests described in this Section shall have been performed to satisfaction of both the Engineer and Owner prior to the acceptance of the control system as meeting requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the completion requirements if stated as such in writing by the Engineer. Such tests shall then be performed as part of the warranty.
2. System shall not be accepted until all forms and checklists completed as part of demonstration are submitted and approved.

3.20 CLEANING

- A. Contractor shall clean up all debris resulting from his/her activities daily. Contractor shall remove all cartons, containers, crates, etc., under his/her control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.
- B. At completion of work in any area, Contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.
- C. At completion of work, all equipment furnished under this Section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.21 TRAINING

- A. Provide training for a designated staff of Owner's representatives. Training shall be provided via self-paced training, web-based or computer-based training, classroom training, or a combination of training methods.
- B. Training shall enable students to accomplish the following objectives:
 1. Day-to-day Operators:
 - a. Proficiently operate the system
 - b. Understand control system architecture and configuration
 - c. Understand DDC system components
 - d. Understand system operation, including DDC system control and optimizing routines (algorithms)
 - e. Operate the operator interface and peripherals
 - f. Log on and off the system
 - g. Access graphics, point reports, and logs
 - h. Adjust and change system set points, time schedules, and holiday schedules
 - i. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals
 - j. Understand system drawings and Operation and Maintenance manual
 - k. Understand the job layout and location of control components
 - l. Access data from DDC controllers and ASCs
 - m. Operate portable operator's terminals

2. Advanced Operators:

- a. Make and change graphics on the workstation
- b. Create, delete, and modify alarms, including annunciation and routing of these
- c. Create, delete, and modify point trend logs and graph or print these both on an ad-hoc basis and at user-definable time intervals
- d. Create, delete, and modify reports
- e. Add, remove, and modify system's physical points
- f. Create, modify, and delete programming
- g. Add panels when required
- h. Add operator interface stations
- i. Create, delete, and modify system displays, both graphical and others
- j. Perform DDC system field checkout procedures
- k. Perform DDC controller unit operation and maintenance procedures
- l. Perform workstation and peripheral operation and maintenance procedures
- m. Perform DDC system diagnostic procedures
- n. Configure hardware including PC boards, switches, communication, and I/O points
- o. Maintain, calibrate, troubleshoot, diagnose, and repair hardware
- p. Adjust, calibrate, and replace system components

3. System Managers/Administrators:

- a. Maintain software and prepare backups
- b. Interface with job-specific, third-party operator software
- c. Add new users and understand password security procedures

C. Organize the training into sessions or modules for the three levels of operators listed above. (Day-to-Day Operators, Advanced Operators, System Managers and Administrators). Students will receive one or more of the training packages, depending on knowledge level required.

D. Training shall be provided in three separate sessions, each session further divided into the modules described above. Sessions shall be as follows:

- 1. Initial Training (minimum 8 hours): After system is started up and at least one week before first acceptance test. Manual shall have been submitted at least two weeks prior to training so that the Owners' personnel can start to familiarize themselves with the system before classroom instruction begins.
- 2. First Follow-Up Training (minimum 8 hours): Approximately four weeks after initial training, and before Formal Acceptance. These sessions will deal with more advanced topics and answer questions.
- 3. Warranty Follow Up (minimum 8 hours): To be scheduled at the request of Owner during the one year warranty period. These sessions shall cover topics as requested by the Owner such as; how to add additional points, create and gather data for trends, graphic screen generation or modification of control routines.

E. Provide course outline and materials which was submitted and approved a minimum of four weeks prior to scheduling of training. Provide one copy of training material per student.

F. Instructor(s) shall be factory-trained and experienced in presenting this material.

G. Classroom training shall be done using a network of working controllers representative of installed hardware.

3.22 START-UP AND CHECKOUT PROCEDURES

A. Start up, check out, and test all hardware and software and verify communication between all components.

- B. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
 - 1. Verify that all analog and binary input/output points read properly.
 - 2. Verify alarms and interlocks.
 - 3. Verify operation of the integrated system.

END OF SECTION

SECTION 23 11 23
FACILITY NATURAL GAS PIPING

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. Drawings and General Requirements of Contract including General and Supplementary Conditions and Division 1 specification sections apply to Work of this Section.
- B. Extent of natural gas piping system work, is indicated on drawings and schedules, and by requirements of this Section.
- C. Applications for natural gas piping systems include the following:
 - 1. Building distribution system from existing gas service to gas-fired equipment connections.
 - 2. Building distribution system from new gas service to gas-fired equipment connections.

1.02 QUALITY ASSURANCE

- A. ANSI Code Compliance - Comply with applicable provisions of ANSI B31.2 "Fuel Gas Piping".
- B. National Fuel Gas Code Compliance - Comply with applicable provisions of NFPA 54 (ANSI Z223.1) "National Fuel Gas Code", and ANSI Z223.1a "Supplement to National Fuel Gas Code".
- C. Local Utility Compliance - Comply with requirements of local natural gas utility.

1.03 SUBMITTALS

- A. Product Data - Submit manufacturer's data for fuel gas piping systems materials and products.
- B. Documentation demonstrating compliance with Spec. Section 00 30 80 regarding the use of American iron and steel in the products being furnished under this Section.
- C. Submit in accordance with Section 01 33 00.

1.04 IEPA LOAN REQUIRED DOCUMENTATION – AMERICAN IRON & STEEL

- A. Pursuant to the IEPA loan being used to finance the project, the CONTRACTOR and his/her suppliers shall comply with Section 436 of federal H.R. 3547, which are requirements regarding the use of American iron and steel products. These requirements apply to and are binding to the manufacturer of the products specified in this Section.
- B. The manufacturer shall provide with the shop drawing submittal one (1) signed and dated original of the AIS Certification Letter (a blank copy of which is provided on page A-00 30 80-3 of this manual). Said letter shall demonstrate compliance with Section 436 of federal H.R. 3547.

PART 2 - PRODUCTS

2.01 NATURAL GAS PIPING MATERIALS AND PRODUCTS

- A. Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, and capacities as indicated. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in natural gas piping systems. Where more than one type of material or products are indicated, selection is Installer's option.

2.02 BASIC PIPE, TUBE, AND FITTINGS

- A. Provide all welded fittings in Building 120.
- B. Building Distribution Piping (5 psi and below)
 - 1. Pipe Size 2-in and smaller: Black steel pipe, ASTM A53.
 - a. Pipe Weight: Schedule 40.
 - b. Fittings: Malleable iron threaded.
 - 2. Pipe Size 2-in and smaller located in Building 120: Black steel pipe, ASTM A53.
 - a. Pipe Weight: Schedule 40.
 - b. Fittings: Forged-steel socket welding meeting requirements of ASTM B16.11.
 - 3. Pipe size 2-1/2-in and larger: Black Steel Pipe.
 - a. Pipe weight: Schedule 40.
 - b. Fittings: Wrought-steel butt welding.
- C. Underground Distribution Piping
 - 1. Pipe size 6" and smaller
 - a. Thermoplastic polyethylene gas pressure pipe ASTM D2513.
 - b. Fittings: butt-weld or socket-type polyethylene fusion joints and fittings.

2.03 BASIC PIPING SPECIALTIES

- A. Provide piping specialties complying with Section 22 00 05, in accordance with the following listing:
 - 1. Pipe escutcheons.
 - 2. Pipe sleeves.
 - 3. Sleeve seals.

2.04 BASIC SUPPORTS, ANCHORS, AND SEALS

- A. Provide supports, anchors, and seals complying with Section 40 05 07, in accordance with the following listing:
 - 1. Clevis hanger or band hangers for horizontal-piping.
 - 2. Two-bolt riser clamps for vertical piping supports.
 - 3. Concrete anchors and clamps for building attachments.

4. Piping indicated to be routed above the roof structure shall be supported with non-penetrating roof supports.

2.05 VALVES

A. Isolation/Plug Valves.

1. Manufacturers:
 - a. Milliken 625 Series.
 - b. Key Port Figure 425.
 - c. Or equal.
2. Non-lubricated, resilient seated eccentric plug valve.
3. UL Listed for natural gas service.
4. Drip-tight shut-off up to full pressure rating of valve with pressure in either direction.
5. Pressure rating: 175-psig.
6. Cast iron body and plug.
7. Flanged end connections for sizes 2-inch and larger. Threaded (FNPT) connections for sizes 1-1/2-inch and smaller.
8. Wrench nut operator.
9. Buna-N plug and stem seals.
10. Secondary seal of plug metal to metal seat interface.
11. Corrosion resistant bearings.

2.06 PRESSURE REGULATORS

A. Natural Gas Appliance Pressure Reducing Valve

1. Manufacturers:
 - a. Sensus, Model 143 series.
 - b. Fisher, Model CS200 series.
 - c. Or equal.
2. Valve Manufacturer to recommend valve size based on scheduled flow rates and pressures.
3. Direct sensing pressure reducing valve with internal relief valve.
4. Suitable for inlet pressures up to 25-psig.
5. Adjustable outlet pressure range from 7 to 14-inch W.C.
6. Internal relief shall be capable of preventing outlet pressure of the valve from rising greater than 7-in. w.c. above outlet pressure setpoint.
7. Cast iron body with threaded end connections.
8. Die cast aluminum alloy diaphragm case.
9. Diaphragm shall be of Buna-N construction with nylon fabric insert or Nitrile (NBR).
10. Stainless steel or aluminum orifice and stem.

2.07 NON-PENETRATING ROOF SUPPORTS

A. Manufacturer:

1. Portable Pipe Hangers.
2. Or equal.

- B. Supports shall adjustable roller guide type designed to support metallic piping on an existing roofing system without voiding the roofing warranty or requiring roof material penetration or modification.
- C. Support shall be adjustable up to a 10" mounting height.
- D. Support rods, nuts, and washers shall be of stainless steel construction.
- E. Rollers shall be of cast iron construction with hot dipped galvanized finish.
- F. Guide shall be of steel construction with hot dipped galvanized finish.
- G. Base shall be injection molded high density polypropylene with UV-inhibitors and antioxidants.

PART 3 - EXECUTION

3.01 INSTALLATION OF NATURAL GAS PIPING

- A. Install natural gas distribution piping in accordance with applicable codes and local utility company requirements.
- B. Use sealants on metal gas piping threads which are chemically resistant to natural gas. Use sealants sparingly, and apply to only male threads of metal joints.
- C. Remove cutting and threading burrs before assembling piping.
- D. Do not install defective piping or fittings. Do not use pipe with threads which are chipped, stripped or damaged.
- E. Plug each gas outlet, including valves, with threaded plug or cap immediately after installation and retain until continuing piping, or equipment connections are completed.
- F. Ground gas piping electrically and continuously within project, and bond tightly to grounding connection.
- G. Install drip-legs in gas piping where indicated, and where required by code or regulation.
- H. Install "Tee" fitting with bottom outlet plugged or capped, at bottom of pipe risers.
- I. Install piping with 1" drop in 60' pipe run (0.14%) in direction of flow.
- J. Install piping parallel to other piping.
- K. All gas piping in concealed locations such as ceiling plenums shall have welded joints.
- L. All joints in underground polyethylene gas pipe must be made by qualified personnel proficient in the joining methods of ASTM D2513 thermoplastic gas pressure pipe and polyethylene fittings.
- M. Do not install polyethylene gas pipe inside buildings.
- N. Gas piping installed at the roof level shall be installed on "non-penetrating roof supports" as specified in this Section.

- O. Vent all interior regulators to the building exterior. Vent termination shall be located a minimum of 10'-0" away from any outside air intake and 5'-0" from any combustion exhaust outlet.
- P. Paint gas piping in color directed by Owner after all testing is complete in accordance with Section 09 96 00.
- Q. Label piping in accordance with Section 40 05 10.

3.02 GAS SERVICE

- A. Schedule any interruptions of existing gas service with Owner.
- B. Contact natural gas Utility to provide new gas service at Building 900 as indicated on Plans. Fees for service to be shall be paid by the Owner. Contractor shall perform all coordination with Utility.

1. Utility Contact:

Dan McEvilly
815.272.9251

3.02 INSTALLATION OF SUPPORTS, ANCHORS, AND SEALS

- A. Install supports, anchors, and seals in accordance with Section 40 05 07.

3.03 INSTALLATION OF VALVES

- A. Provide gas cocks at connection to gas train for each gas-fired equipment item; and on risers and branches where indicated.
- B. Locate gas cocks where easily accessible, and where they will be protected from possible injury.

3.04 INSTALLATION OF PRESSURE REGULATORS

- A. Install pressure regulators where indicated in accordance with manufacturer's instructions.
- B. Regulators installed indoors shall be vented to outdoors.

3.05 EQUIPMENT CONNECTION

- A. Connect gas piping to each gas-fired equipment item, with drip leg, pressure regulating valve (where required), and shutoff gas cock. Comply with equipment manufacturer's instructions.

3.06 PIPING TESTS

- A. Test natural gas piping in accordance with ANSI B31.2 or other recognized testing procedure.

END OF SECTION

SECTION 23 21 13
HYDRONIC PIPING

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. Drawings and general requirements of contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this Section.
- B. Extent of hydronic piping systems work, is indicated on drawings and by requirements of this Section.
- C. Applications for hydronic piping systems include the following:
 - 1. Heating water piping systems. (HWR and HWS)

1.02 SUBMITTALS

- A. Product Data; Manufacturer's specifications, catalog cuts, and literature for all items specified herein.
- A. Submit outside coating system for buried, interior, exterior, and submerged piping locations. Include submittal information specified in Section 09 96 00.
- B. Submit all product data and coating system information specified above in one complete submittal.
- C. Shop drawings showing layout for piping systems shall be submitted in accordance with and transmitted under appropriate piping system Specification section.
- D. Submit in accordance with Section 01 33 00.

1.03 QUALITY ASSURANCE

- A. Comply with applicable standards:
 - 1. ANSI/ASME B31.9 Building Services Piping

1.04 IEPA LOAN REQUIRED DOCUMENTATION – AMERICAN IRON & STEEL

- A. Pursuant to the IEPA loan being used to finance the project, the CONTRACTOR and his/her suppliers shall comply with Section 436 of federal H.R. 3547, which are requirements regarding the use of American iron and steel products. These requirements apply to and are binding to the manufacturer of the products specified in this Section.
- B. The manufacturer shall provide with the shop drawing submittal one (1) signed and dated original of the AIS Certification Letter (a blank copy of which is provided on page A-00 30 80-3 of this manual). Said letter shall demonstrate compliance with Section 436 of federal H.R. 3547.

PART 2 - PRODUCTS

2.01 WATER PIPING MATERIALS AND PRODUCTS

- A. Provide piping materials and factory fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated.
- B. Where more than 1 type of materials or products are indicated, selection is Installer's option.
- C. Gaskets for flanged connections of HWR and HWS systems shall be suitable for water operating a temperature of 225°F.

2.02 BASIC PIPE, TUBE, VALVES, AND FITTINGS

- A. Provide pipe, tube, and fittings in accordance with the following listing:
 - 1. Pipe Size 2" and Smaller.
 - a. Black Steel Pipe - ANSI/ASTM A 53, A 106 or A 120.
 - b. Pipe Weight: Schedule 40.
 - c. Pipe Weight: Schedule 80 for ½" pipe.
 - d. Fittings: Class 125 cast-iron threaded, ANSI B16.4.
 - 2. Pipe Size 2-1/2" and Larger:
 - a. Black Steel Pipe - ANSI/ASTM A 53, A 106 or A 120.
 - b. Pipe weight: Schedule 40.
 - c. Fittings: Wrought Steel Buttwelding.
 - 3. Wye Pattern Strainers:
 - a. Manufacturer:
 - 1) Nibco.
 - 2) Or equal.
 - b. Provide in sizes indicated on Plans. Where no size indicated, provide full line size as connecting piping system.
 - c. Class 125 iron body construction.
 - d. Flanged end connections.
 - e. Bolted cast iron bonnet with NPT cast iron plug.
 - f. Unless indicated otherwise on Plans, provide with 40-mesh, 304 stainless steel removable screen.
 - g. Provide all strainers larger than 3/4-inch in size with a Type V336 ball valve on blowdown connection of size matching blowdown plug.
- B. Pump Connector Stainless Steel Expansion Joints
 - 1. Manufacturers:
 - a. Hyspan, Series 4500.
 - b. Or Equal.
 - 2. Threaded end braided metal hose pump connector.
 - 3. Type 321 stainless steel annular corrugated metal hose.
 - 4. Type 304 stainless steel braid.

5. 500°F working temperature.
6. 175-psig working pressure.

C. Valves:

1. Provide valves meeting the requirements of Section 23 21 16 and as indicated below.

2.03 BASIC SUPPORTS AND ANCHORS

- A. Provide supports, anchors, and seals complying with Section 15060, in accordance with the following listing:
1. Steel clevises for horizontal piping hangers and supports.
 2. Two-bolt riser clamps, for vertical-piping clamps.
 3. Concrete anchors, C-clamps, beam clamps, and steel brackets for building attachment.
 4. Protection saddles, for saddles and shields.
 5. Materials in accordance with Section 15060.

PART 3 - EXECUTION

3.01 INSTALLATION OF HYDRONIC PIPING

- A. Insulate piping systems in accordance with Section 23 07 00.
- B. Provide adequate and accessible unions for disassembly and maintenance/replacement of valves and equipment.
- C. Expansion, Contraction, and Bending: Install piping with provisions for expansion and contraction using expansion loops, swing or expansion joints where required. Provide for expansion and contraction in mains, risers, and runouts. Do not spring or force piping during installation. Do not bend piping without use of bending machine.
- D. Reduce sizes (where indicated) by use of reducing fittings. Align accurately at connection, within 1/16" misalignment tolerance.
- E. Comply with ANSI B31 Code for Pressure Piping.
- F. Locating piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams or details.
- G. Hold piping close to walls, overhead construction, columns and other structural and permanent-enclosure elements of building; limit clearance to 1/2" where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. When possible, locate insulated piping for 1.0" clearance outside insulation.
- H. Avoid routing piping over electrical equipment. Where piping must pass over electrical equipment, provide galvanized steel drip pan below piping, minimum 1-in. deep with soldered joints.
- I. Install eccentric reducers where pipe is reduced in size in direction of flow, with tops of both pipes and reducer flush.
- J. Install piping level with no pitch.

- K. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.
- L. Connect water piping to equipment as indicated on drawings and equipment manufacturer's written instructions.
- M. Thread pipe in accordance with ANSI B2.1; cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.
- N. Weld pipe joints in accordance with ANSI B31.
- O. Coat carbon steel piping systems and iron body valves in accordance with Section 09 96 00 prior to installation of insulation. Unless otherwise noted below, provide first coat of System 8.
- P. Coat brass body valves in accordance with Section 09 96 00 prior to insulation installation. Unless otherwise noted below, provide first coat of System 12.
- Q. Provide pipe, valve, and equipment identification in accordance with Section 15190. Banding colors shall be selected by Owner.

3.02 EXPANSION LOOPS, GUIDES, AND ANCHORS

- A. Expansion: Calculate expansion from 0 degrees F to maximum operation temperature of system.
- B. Anchors: Provide concrete mass anchors and thrust blocks of an approved design to control movement in piping. Anchors anchor plates required at bends and building entry shall be factory installed on piping and factory seals to insulation system. Field installation of plates to piping system will not be accepted.

3.03 INSTALLATION OF SUPPORTS AND ANCHORS

- A. Install supports, anchors, and seals in accordance with Section 15060.

3.04 INSTALLATION OF VALVES

- A. Install valves in accordance with manufacturer's installation instructions and Section 15280.
- B. Shutoff Valves: Install on inlet and outlet of each mechanical equipment item, and on inlet of heating/cooling terminal, and elsewhere as indicated.
- C. Drain Valves: Provide ½-in ball valve drain at all low points in piping system.
- D. Vent Valves: Provide 1/2-in ball valve vent at all high points in piping system.

3.05 INSTALLATION OF HYDRONIC SPECIALTIES

- A. Install hydronic specialties in accordance with Section 15710.

3.06 CLEANING, FLUSHING, AND INSPECTING

- A. Clean and flush system, with clear water, of all dirt, metal chips, sand, and foreign matter.
- B. After flushing remove, clean, and replace all strainer baskets or screens.

- C. Inspect each run of each system for completion of joints, supports, accessory items, and obvious leaks.

3.07 LEAK TESTING

- A. Provide temporary equipment for testing, including pump and gauges.
- B. Test piping system before insulation is installed, wherever feasible, and remove control devices before testing.
- C. Subject entire piping system to leak tests, either as a whole, or in sections; but leave no part untested.
- D. Provide temporary blind flanges or caps at boiler connections, boilers not to be subjected to test pressure.
- E. Fill piping systems with clear water, vent all air, and pressurize at to 75-psig for 2 hours. Test fails if leakage is observed, or pressure drop exceeds 5% of test pressure.
- F. Test must be witnessed by Owner's representative.
- G. Repair piping systems which fail required piping test, by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.
- H. Retest system as required to show system is leak free.
- I. Obtain the services of Owner's existing water treatment system supplier to analyze system make-up water and existing water chemistry. Provide chemical additions to each water system as recommended by Supplier. Fill HWR/HWS systems with water and initial fill of corrosion inhibitor chemicals.

END OF SECTION

SECTION 23 21 16
HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. Applicable provisions of Division 1 and the General and Supplemental Conditions govern the Work of this Section.
- B. Extent of hydronic specialties required by this Section is indicated on drawings, and/or specified in other Division 23 hydronic piping system sections.
- C. Types of hydronic specialties specified in this Section include the following:
 - 1. Valves.
 - 2. Vent Valves.
 - 3. Gauges.

1.02 SUBMITTALS

- A. Product Data - Submit catalog cuts, specifications, installation instructions, and dimensioned drawings for each type manufactured hydronic specialty. Include pressure drop curb or chart for each type and size of hydronic specialty. Submit schedule showing manufacturer's figure number, size, location, rated capacities, and features for each required hydronic specialty.
- B. Maintenance Data - Submit maintenance data and spare parts list for each type of manufactured hydronic specialty. Submit these data in Maintenance Manual in accordance with Section 01 78 23.
- C. Hydronic Specialty Types - Provide hydronic specialties of same type by same manufacturer.

PART 2 - PRODUCTS

2.01 VALVES

- A. Type V305: Carbon Steel, Threaded Ball Valve
 - 1. Manufacturers:
 - a. Nibco, Figure T-580-CS-66.
 - b. Or Equal.
 - 2. Two-piece carbon steel bar stock body.
 - 3. Threaded end connections.
 - 4. Conventional port.
 - 5. Stainless steel ball and stem.
 - 6. Reinforced TFE Seats.
 - 7. 1,500 WOG rating.
- B. Multi-function Valves, 1-1/2 in and smaller: Type V910.
 - 1. Manufacturers:
 - a. Bell and Gossett, Model 3DV.
 - b. Or Equal.

2. 1-1/2-inch and smaller.
3. Straight pattern multifunction valve which performs the functions of a non-slam check valve, throttling valve, shut-off valve, and calibration balancing valve.
4. Brass body with threaded ends.
5. Reinforced Teflon seats and EPDM seals.
6. Brass stem.
7. Stainless steel spring.
8. Rated for 200 psig working pressure at 250 deg F.
9. Minimum Cv values as follows:
 - a. 1-inch: 9
 - b. 1-1/4-inch: 14.
 - c. 1-1/2-inch: 25.
10. Provided with a brass readout valve with integral check valve for taking differential pressure readings across the orifice.

2.02 VENT VALVES

- A. Provide manual stainless steel vent valves designed to be operated manually with screwdriver or thumbscrew, 1/8" N.P.T. connection.

2.03 GAUGES

- A. Pressure Gauges in accordance with Section 40 73 00.
- B. Thermometers:
 1. Weiss Instruments 9-in scale Vari-angle, or equal.
 2. Liquid filled glass type thermometer.
 3. Black polyester case with heavy protected glass front.
 4. Base shall be fully adjustable through 360° in vertical plane and 180° in horizontal plane with locking nut.
 5. Stem shall be corrosion resistant allow of length required for pipe size in which it is installed.
 6. Tube and capillary shall be filled with a blue liquid and visible through a magnifying lens.
 7. Scale shall be permanently baked bold black markings on a white coated aluminum backing.
 8. Accuracy: 1% of scale range.
 9. 30-240°F range.
- C. Thermometer Wells:
 1. Description: Fitting with protective well for installation in threaded pipe fitting to hold test thermometer.
 2. Material: Stainless steel, for use in steel piping.
 3. Extension-Neck Length: Nominal thickness of 2 inches but not less than thickness of insulation. Omit extension neck for wells for piping not insulated.
 4. Insertion Length: To extend to center of pipe.

PART 3 - EXECUTION

3.01 GENERAL

- A. Install hydronic specialties where shown and as required in accordance with manufacturer's installation instructions and local codes.

3.02 INSTALLATION OF VENT VALVES:

- A. Install manual vent valves on each hydronic terminal at highest point, and on each hydronic piping drop in direction of flow for mains, branches, and runouts, and elsewhere as indicated.

3.03 INSTALLATION OF GAUGES:

- A. Install gauges and accessories according to manufacturer's written instructions for applications where used.

- B. Thermometer Installation:

- 1. Install thermometers and adjust vertical and tilted positions.
- 2. Install in the following locations:
 - a. Inlet and outlet of each hydronic boiler.
 - b. Elsewhere as indicated on the Drawings.
- 3. Install separable sockets in vertical position in piping tees where fixed thermometers are indicated. Install with socket extending a minimum of 2 inches into fluid.
- 4. Install thermometer wells in vertical position in piping tees where test thermometers are indicated.
- 5. Install with stem extending a minimum of 2 inches into fluid.

- C. Pressure-Gauge Installation

- 1. Install pressure gauges in piping tees with pressure-gage valve located on pipe at most readable position.

END OF SECTION

SECTION 23 21 23
HEATING SYSTEM PUMPS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. Drawings and general requirements of contract, including General and Supplementary Conditions and Division 1 specification sections apply to work of this Section.
- B. Extent of pumps required by this Section is indicated on drawings and/or specified in other Division 23 sections.
- C. Types of pumps specified in this Section include the following:
 - 1. Inline Mounted Centrifugal:
 - a. Circulating Pump No. 1: (120-CP-1).
 - b. Circulating Pump No. 2: (120-CP-2).
- D. Refer to appropriate Division 26 sections for motors starters, disconnects, and wiring of pump motors; not work of this section.

1.02 DEFINITIONS, ABBREVIATIONS AND ACRONYMS

- A. Acronyms:
 - 1. TEFC: Totally Enclosed Fan Cooled
 - 2. XP: Explosion Proof
 - 3. Eff: Efficiency
 - 4. ECM: Electronically Commutated Motor
- B. Unit Abbreviations:
 - 1. °F: Degrees Fahrenheit
 - 2. CFM: Cubic Feet per Minute
 - 3. GPH: Gallons per Hour
 - 4. GPM: Gallons per Minute
 - 5. HP: Horsepower
 - 6. kW: Kilowatts
 - 7. PSI: Pounds per Square Inch
 - 8. RPM: Revolutions per Minute

1.03 QUALITY ASSURANCE

- A. Provide electric motors and products which have been listed and labeled by Underwriters Laboratories and comply with NEMA standards.

1.05 SUBMITTALS

- A. Product Data and Shop Drawings:
 - 1. Submit in accordance with Section 01 33 00 in sufficient detail to confirm compliance with the Drawings and this Section.
 - 2. Submittal shall, at a minimum, include the items listed below.

- a. Pump curve with operating point clearly identified.
- b. Dimensional drawing.
- c. Summary of materials of construction.
- d. Motor Data. Submit in accordance with Section 26.
- e. Coating systems. Submit in accordance with Section 09 96 00.

B. Instructional Services Documentation:

- 1. Submit in accordance with Section 01 61 00.

C. Operation and Maintenance (O&M) Data:

- 1. Submit in accordance with Section 01 78 23.

1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. All equipment and parts shipped to the job site shall be properly protected from the elements so that no damage or deterioration occurs from the time of delivery to the time when the installation is complete and the units are placed into operation.
- B. Manufacturer shall define the requirements to properly protect the equipment and parts shipped to the job site.

PART 2 - PRODUCTS

2.01 PUMPS

- A. Provide factory tested pumps, thoroughly cleaned, and painted, with one coat of machinery enamel prior to shipment. Provide pumps of same type by same manufacturer.

B. Capacities:

- 1. Digester Nos. 1 and 2 Heating Pump: (120-CP-1,-2)

- a. Type: Inline mounted.
- b. B&G Model: Series e-90 model 1AAB, 5" impeller trim.
- c. Flow: 15 gpm
- d. Head: 24 feet of water
- e. Minimum Eff: 48%
- f. RPM: 1800
- g. Horsepower: 1/2 hp
- h. Electrical: 120V/1-phase/60-Hertz

2.02 IN-LINE CENTRIFUGAL PUMPS: (120-CP-1,-2)

- A. Manufacturer - Subject to compliance with requirements, provide in-line booster pumps of one of the following:

- 1. Bell & Gossett ITT
- 2. Armstrong Pumps, Inc.
- 3. Taco, Inc.

- B. Horizontal or Vertical, oil-lubricated, designed for 125 psi working pressure, 225°F. (107°C) continuous water temperature.

- C. Body - Cast-iron.
- D. Casing - Shall have gauge ports at nozzles, and vent and drain ports in casing.
- E. Shaft - Steel, ground and polished, integral thrust collar.
- F. Impeller - Bronze/brass, enclosed type, dynamically balanced, keyed and secured to shaft.
- G. Bearings - Two horizontal sleeve bearings designed to circulate oil.
- H. Seal - Mechanical, with carbon seal face rotating against ceramic seat.
- I. Motor - Non-overloading at any point on pump curve, sleeve bearings, quiet operating, rubber mounted construction, built-in thermal overload protection. Provide motors in accordance with Division 26.
- J. Coupling - Self-aligning, flexible coupling.
- K. Each pump shall be factory tested.

PART 3 - EXECUTION

3.01 INSTALLATION OF PUMPS

- A. Install pumps where indicated, in accordance with manufacturer's published installation instructions, with recommended clearances provided for service and maintenance.
- B. Install in-line pumps, supported from piping, located for access to oil cups, service, and maintenance.
- C. Provide piping; accessories; hangers, supports, and anchors; valves; meters and gauges; vibration isolation; and equipment supports; as indicated and in manufacturer's installation instructions for complete installation.
- D. Check alignment, and where necessary, realign shafts of motors and pumps within recommended tolerances by manufacturer, and in presence of manufacturer's service representative.
- E. Lubricate pumps before start-up. Start-up in accordance with manufacturer's instructions.
- F. Ensure that pump units are wired properly, with rotation in correct direction, and that pump and motor grounding have been provided.

3.02 FIELD QUALITY CONTROL

Manufacturer's Field Services:

1. Representative for equipment specified herein shall be present at the job site or classroom designated by Owner a minimum of three separate occasions for the minimum workdays specified below, travel time excluded.
 - a. 1/4 workdays for Installation Services
 - b. 1/4 workday for Instructional Services
 - c. 1/4 workday for Post-Startup Services

2. After installation is complete, test and demonstrate operation of equipment in accordance with Section 01 79 10. In addition to services specified above, provide Supplier's or Manufacturer's field services as required to successfully complete systems demonstrations in accordance with Section 01 79 10.
3. Supplier or Manufacturer shall direct services to system and equipment operation, maintenance, troubleshooting, and equipment and system related areas other than wastewater treatment process. See Section 01 61 00.

END OF SECTION

SECTION 23 23 00
REFRIGERANT PIPING SYSTEMS

PART 1 - GENERAL

1.01 SUBMITTALS

A. Submittal Information:

1. Product Data: Submit manufacturer's technical product data and installation instructions for refrigerant piping materials and products.
2. Shop Drawings: Submit scaled layout drawings of refrigerant pipe and fittings including, but not necessarily limited to, pipe and tube sizes, locations, elevations, and slopes of horizontal runs, walls and floor penetrations, and connections. Show interface between piping and equipment.
3. Shop Drawings, Wiring Diagrams: Manufacturer's ladder type for interlock and control wiring. Clearly differentiate between portions of wiring factory-installed and portions to be field-installed.

B. Submit in accordance with Section 01 33 00.

C. Information submitted by Contractor, but not designated to be submitted will be returned without action by Engineer.

1.02 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of refrigerant piping products of types, materials, and sizes required whose products have been in satisfactory use in similar service for not less than 3 yrs.

B. Installer's Qualifications: Firm with at least 3 yrs successful installation experience on projects with refrigerant piping work similar to that required for Project.

C. Regulatory Requirements:

1. ASME Compliance: Fabricate and install refrigerant piping in accordance with ASME B31.5 and extend applicable lower pressure limits to pressures below 15 psig.
2. UMC Compliance: Fabricate and install refrigerant piping in accordance with ICBO "Uniform Mechanical Code."
3. ASHRAE Compliance: Fabricate and install refrigerant piping in accordance with ASHRAE 15.

PART 2 - PRODUCTS

2.01 GENERAL

A. Contractor shall furnish and install all refrigerant specialties recommended by Manufacturer of equipment served.

2.02 MANUFACTURERS

A. Manufacturer's equipment used as basis of design for Project is name indicated in Specification for particular type of equipment or application contained in these Contract Documents. If no manufacturer is listed, basis of design is industry standard indicated.

2.03 MATERIALS

- A. Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by Contractor to comply with installation requirements. Provide materials and products complying with ASME B31.5 where applicable, base pressure rating on refrigerant piping system maximum design pressures. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in refrigerant piping systems. Where more than one type materials or products indicated, selection is Contractor's option.
- B. Provide insulation in accordance with Section 23 07 00.

2.04 BASIC IDENTIFICATION

- A. Comply with Section 40 05 97 and in accordance with following:
 - 1. Refrigerant Piping: Plastic pipe markers.

2.05 PIPES AND PIPE FITTINGS

- A. Construct piping systems of the in accordance with the following:
 - 1. Tube Size 4 1/8 in. and Smaller: Copper tube; Type ACR, hard-drawn temper; wrought copper, solder joint fittings; soldered joints.
 - 2. Soldered Joints: Solder joints using silver-lead solder, ASTM B32, Grade 96 TS.
 - 3. Brazed Joints: Braze joints using AWS classification BCuP-4 for brazing filler metal.

2.06 SUPPORTS AND ANCHORS

- A. Comply with Section 40 05 07 and in accordance with following:
 - 1. Adjustable steel clevises, adjustable roller hangers, and adjustable pipe roll stands for horizontal piping hangers and supports.
 - 2. 2-bolt riser clamps for vertical piping supports.
 - 3. Concrete inserts, C-clamps, and steel brackets for building attachments.
 - 4. Protection shields for insulated piping support in hangers.
 - 5. Copper flashings for piping penetrations.

2.07 SPECIAL REFRIGERANT VALVES

- A. Globe and Check Valves:
 - 1. Manufacturers:
 - a. Henry Valve Company.
 - b. Parker Hannifin Corporation, Refrigeration and Air Conditioning Division.
 - c. Sporlan Valve Company.
 - d. Or equal.
 - 2. Globe Shutoff Valves: Forged brass, packed, back seating, winged seal cap, 300°F (149°C) temperature rating, 500 psi working pressure.
 - 3. Check Valves: Forged brass, accessible internal parts, soft synthetic seat, fully guided brass piston and stainless steel spring, 250°F (121°C) temperature rating, 500 psi working pressure.

B. Solenoid Valves:

1. Manufacturers:

- a. Alco Controls, Division of Emerson Electric Company.
- b. Automatic Switch Company.
- c. Sporland Valve Company.
- d. Or equal.

2. 2-Way Solenoid Valves: Forged brass, designed to conform to ARI 760, normally closed, teflon valve seat, NEMA 1 solenoid enclosure, 24 v, 60 Hz, UL-listed, 1/2 in. conduit adapter, 250°F (121°C) temperature rating, 400 psi working pressure.

- a. Manual Operator: Provide manual operator to open valve.

2.08 REFRIGERANT SPECIALTIES

A. Manufacturers:

1. Alco Controls, Division of Emerson Electric Company.
2. Henry Valve Company.
3. Parker-Hannifin Corporation, Refrigeration and Air Conditioning Division.
4. Sporlan Valve Company.
5. Or equal.

B. Refrigerant Strainers: Brass shell and end connections, brazed joints, monel screen, 100 mesh, UL listed, 350 psi working pressure.

C. Moisture-Liquid Indicators: Forged brass, single port, removable cap, polished optical glass, solder connections, UL-listed, 200°F (93°C) temperature rating, 500 psi working pressure.

D. Refrigerant Filter Dryers: Corrosion-resistant steel shell, steel flange ring and spring, wrought copper fittings, ductile iron cover plate with steel cap screws, replaceable filter dryer core, 500 psi working pressure.

E. Evaporator Pressure Regulators: Provide corrosion-resistant, spring loaded, stainless steel springs, pressure operated, evaporator pressure regulator in size and working pressure indicated, with copper connections.

F. Refrigerant Discharge Line Mufflers: Provide discharge line mufflers recommended by equipment manufacturer for use in service indicated, UL listed.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions under which refrigerant piping system materials and products to be installed. Do not proceed with Work until unsatisfactory conditions are corrected.

3.02 INSTALLATION OF BASIC IDENTIFICATION

- A. Comply with Section 40 05 97.

3.03 INSTALLATION OF REFRIGERANT PIPING

- A. Install refrigerant piping in accordance with equipment manufacturer's recommendations.

- B. Install refrigerant piping with slope as recommended by manufacturer. Provide oil traps and double risers where required by ASHRAE and recommended by equipment Manufacturer to provide oil return.
- C. Clean refrigerant piping by swabbing with dry lintless (linen) cloth, followed by refrigerant oil soaked swab. Remove excess oil by swabbing with cloth soaked in high flash point petroleum solvent, squeezed dry.
- D. Bleed dry nitrogen through refrigerant piping during brazing operations.
- E. Insulation in accordance with Section 23 07 00.

3.04 INSTALLATION OF SUPPORTS AND ANCHORS

- A. Comply with Section 40 05 07.

3.05 INSTALLATION OF SPECIAL REFRIGERANT VALVES

- A. Install refrigerant valves where indicated and in accordance with manufacturer's instructions. Remove accessible internal parts before soldering or brazing and replace after joints complete.
- B. Solenoid Valves: Install in refrigerant piping as indicated with stem pointing upwards.
 - 1. Wiring of solenoid valves is specified in applicable Division 15 sections and is not Work of this section.

3.06 INSTALLATION OF REFRIGERANT ACCESSORIES

- A. Refrigerant Strainers: Install in refrigerant lines in accessible location for service.
- B. Moisture-Liquid Indicators: Install on refrigerant liquid lines in accessible location.
- C. Refrigerant Filter Dryers: Install in refrigerant lines in accessible location for service.
- D. Evaporator Pressure Regulators: Install in refrigerant suction lines or evaporator outlets. Adjust, if required, for proper evaporator pressure.
- E. Refrigerant Discharge Line Mufflers: Install in horizontal or downflow portion of hot gas lines immediately after leaving compressor, not in riser.

3.07 EQUIPMENT CONNECTIONS

- A. Connect refrigerant piping to mechanical equipment in accordance with equipment manufacturer's instructions where not otherwise indicated.

3.08 DEHYDRATION AND CHARGING SYSTEM

- A. Install core in filter dryer after leak test but before evacuation.
- B. Evacuate refrigerant system with vacuum pump until temperature of 35°F (2°C) indicated on vacuum dehydration indicator.
- C. During evacuation, apply heat to pockets, elbows, and low spots in piping.
- D. Maintain vacuum on system for minimum of 5 hrs after closing valve between vacuum pump and system.

- E. Break vacuum with refrigerant gas and allow pressure to build up to 2 psi.
- F. Complete charging of system, using new filter dryer core in charging line. Provide full operating charge.

3.09 FIELD QUALITY CONTROL

- A. Refrigerant Piping Leak Test: Prior to initial operation, clean and test refrigerant piping in accordance with ASME B31.5. Perform initial test with dry nitrogen, using soap solution to test all joints. Perform final test with 27 in. vacuum, then 200 psi using halide torch. System shall be entirely leak-free.
- B. Repair or replace refrigerant piping as required to eliminate leaks and retest as specified to demonstrate compliance.

END OF SECTION

SECTION 23 31 13
METAL DUCTS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. Drawings and General Requirements of contract including General and Supplementary Conditions and Division 1 specification sections apply to work of this Section.
- B. Extent of ductwork is indicated on drawings and in schedules, and by requirements of this Section.
- C. Types of ductwork required for project include the following:
 - 1. Air conditioning supply and return air systems.
 - 2. Fresh air supply systems.
 - 3. Mechanical exhaust systems.

1.02 QUALITY ASSURANCE

- A. Installer: Firm with at least 3 yrs successful installation experience on projects with ductwork systems work similar to that required for Project.
- B. NFPA Compliance - Comply with ANSI/NFPA 90A "Standard For The Installation Of Air-Conditioning And Ventilating Systems" and ANSI/NFPA 90B "Standard For The Installation Of Warm Air Heating And Air-Conditioning Systems".
- C. Underwriters Laboratories - UL 181 - Factory-Made Air Ducts and Connectors.
- D. Design Criteria:
 - 1. Construct all ductwork to be free from vibration, chatter, objectionable pulsations and leakage under specified operating conditions.
 - 2. Use material, weight, thickness, gauge, construction and installation methods as outlined in the following SMACNA publications, unless noted otherwise:
 - a. HVAC Duct Construction Standards, Metal and Flexible.
 - b. HVAC Air Duct Leakage Test Manual.
 - c. HVAC Systems - Duct Design.
 - d. Rectangular Industrial Duct Construction Standard.
 - e. Round Industrial Duct Construction Standards.

1.03 SUBMITTALS

- A. General:
 - 1. Submit Product Data in sufficient detail to confirm compliance with requirements of this Section.
 - 2. Documentation demonstrating compliance with Spec. Section 00 30 80 regarding the use of American iron and steel in the products being furnished under this Section.

B. Product Data:

1. Manufacturer's specifications for duct system materials showing thicknesses, weights, materials of construction, corrosion resistance characteristics, and method of construction.

C. Submit in accordance with Section 01 33 00.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Protect shop-fabricated and factory-fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings.
- B. Where possible, store ductwork inside and protect from weather. Where necessary to store outside, store above grade and enclose with waterproof wrapping.

1.05 IEPA LOAN REQUIRED DOCUMENTATION – AMERICAN IRON & STEEL

- A. Pursuant to the IEPA loan being used to finance the project, the CONTRACTOR and his/her suppliers shall comply with Section 436 of federal H.R. 3547, which are requirements regarding the use of American iron and steel products. These requirements apply to and are binding to the manufacturer of the products specified in this Section.
- B. The manufacturer shall provide with the shop drawing submittal one (1) signed and dated original of the AIS Certification Letter (a blank copy of which is provided on page A-00 30 80-3 of this manual). Said letter shall demonstrate compliance with Section 436 of federal H.R. 3547.

PART 2 - PRODUCTS

2.01 DUCTWORK MATERIALS

- A. General: All ductwork shall be constructed of non-combustible or conforming to requirements for Class 0 or 1 air duct materials, or UL 181.
- B. Exposed Ductwork Materials - Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, oil canning, stains and discolorations, and other imperfections, including those which would impair painting.
- C. Sheet Metal
 1. Galvanized Sheet Steel - ANSI/ASTM A 527, lockforming quality, with ANSI/ASTM A 525, G90 zinc coating; mill phosphatized for exposed locations.
 2. Aluminum Sheet - ANSI/ASTM B209 aluminum sheet, alloy 3003H-14.
 3. Stainless Steel Sheet - ASTM A167, 304 stainless steel sheet No. 2B finish for concealed work and No. 3 finish for exposed work.
 4. Stainless Steel Sheet - ASTM A167, 316 stainless steel sheet No. 2B finish for concealed work and No. 3 finish for exposed work.
- D. Ductwork Material Selection
 1. All other ductwork, unless indicated otherwise on the Plans or below, shall be constructed of aluminum.

2. Ductwork installed in Building 120 shall be of galvanized steel construction. Ductwork serving the lab hood shall be 316 stainless steel.
3. All ductwork installed in Building 125 shall be FRP construction as specified in 23 31 16.
4. Exterior ductwork between 125-MAU-1 and Building 125 shall be stainless steel as shown on Plans.
5. Supply ductwork installed in the GBT Room of Building 600 shall be of 304 stainless steel construction.
6. Exhaust ductwork installed in the GBT Room of Building 600 shall be of FRP construction as specified in 23 31 16.
7. Ductwork installed in Building 900 shall be of galvanized steel construction.

2.02 MISCELLANEOUS DUCTWORK MATERIALS

- A. Duct Sealant: Non-hardening, water resistant, fire resistive, compatible with mating materials; liquid used alone or with tape, or heavy mastic.
- B. Ductwork Support Materials and Fasteners: Provide hot-dipped galvanized steel fasteners, anchors, rods, straps, trim and angles for support of galvanized steel ductwork. Provide 316 stainless steel fasteners, anchors, rods, straps, trim and angles for support of stainless steel or aluminum ductwork.

2.03 FABRICATION - GENERAL

- A. Fabricate ductwork of gauges and reinforcement complying with SMACNA Duct Construction Standards and ASHRAE handbooks for 2-In. W.C. Pressure Class.
- B. Ductwork shall be constructed to provide the minimum clear inside dimensions indicated on the Drawings.
- C. Fabricate duct fittings to match adjoining ducts, and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with centerline radius 1.5 times the associated duct width; and fabricate to include airfoil turning vanes in elbows where shorter radius is necessary. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fiber insulation.
- D. Construct so that all interior surfaces are smooth. Use slip and drive or flanged and bolted construction when fabricating rectangular ductwork. Use spiral lock seam construction when fabricating round spiral ductwork. Sheet metal screws may be used on duct hangers, transverse joints and other SMACNA approved locations if the screw does not extend more than 1/2 inch into the duct.
- E. Limit angular tapers to 30°(for contracting tapers and expanding tapers).
- F. Provide expanded take-offs or 45 degree entry fittings for branch duct connections with branch ductwork airflow velocities greater than 700 fpm. Square edge 90-degree take-off fittings or straight taps will not be accepted.
- G. Button punch snaplock construction will not be accepted on aluminum ductwork.
- H. When approved by the Engineer, size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts. No variation of duct configuration or sizes permitted except by written permission.
- I. Provide easements where low pressure ductwork conflicts with piping and structure. Where easements exceed 10 percent duct area, split into two ducts maintaining original duct area.

- J. Use double nuts and lock washers on threaded rod supports.
- K. Fabricate ductwork with accessories installed during fabrication to the greatest extent possible. Refer to Section 23 33 00, AIR DUCT ACCESSORIES, for accessory requirements.

2.05 DUCT SEALANTS

A. Manufacturers:

1. 3M 800.
2. H.B. Fuller/Foster.
3. Or equal.

- B. Install sealants in strict accordance with manufacturer's recommendations, paying special attention to temperature limitations. Allow sealant to fully cure before pressure testing of ductwork, or before startup of air handling systems.

2.06 GASKETS

- A. For 2-IN. Pressure Class and lower, provide soft neoprene or butyl gaskets in combination with duct sealant for flanged joints.

PART 3 - EXECUTION

3.01 INSTALLATION OF DUCTWORK

- A. Provide ductwork insulation in accordance with Section 23 07 00.
- B. Assemble and install ductwork to achieve SMACNA seal Class B and noiseless (no objectional noise) systems. Install each run with minimum of joints.
- C. A rigid ductwork support or form of lateral bracing shall be provided at each change in ductwork directions, each end or run and elsewhere as noted on Plans to minimize ductwork sway to no more than ½-inch of total travel.
- D. Pittsburgh lock seams and slip joints or ductmate shall be used for all rectangular ducts.
- E. Align ductwork accurately at connections, within 1/8" misalignment tolerance and with internal surfaces smooth.
- F. Coordinate ductwork layout with lighting, suspended ceilings, piping, and structural components.
- G. Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible.
- H. Locate runs as indicated by diagrams, details, and notations. Ensure ductwork does not obstruct usable space or block access for servicing building and its equipment.
- I. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building. Limit clearance to 1/2" where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork for 1" clearance outside of insulation.

- J. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- K. Where ducts pass through interior partitions and exterior walls, conceal space between construction opening and duct or duct-plus-insulation with sheet metal flanges of same gauge and material as duct. Overlap opening on 4 sides by at least 1-1/2".
- L. Coordinate duct installations with installation of accessories, dampers, equipment, controls and other associated work of ductwork system.
- M. Sealant shall be pumped or painted into joints, as required, after assembly. Sealant shall be allowed to set for 48 hours before any air pressure is put on system. All tie bars, bolts and rivets shall be sealed with the specified sealant.
- N. All ductwork shall be airtight before concealment and/or before insulation is applied.
- O. All tie rods shall be 3/8" dia. When one tie rod is required, it shall be installed in the center of the duct. When two tie rods are required, installation shall be at 1/3 points across ducts. When three tie rods are required, installation shall be at 1/4 points across ducts. Where tie rods are required in the horizontal and vertical side, they shall be welded together where they cross. All tie rods shall be welded to reinforcing angles or joints
- P. Install concrete inserts for support of ductwork in coordination with formwork.
- Q. Support ductwork in manner complying with SMACNA "Duct Construction Standards - Metal and Flexible"- Latest Edition hangers and supports section.
- R. Where dissimilar metals meet, provide positive electric isolation using insulating material, sealants, and fasteners.

3.02 DUCT OBSTRUCTIONS

- A. Install steamlined metal sleeve around any obstruction which must run through ducts with approval by the Engineer only.
- B. Sleeves to have rounded noses on upstream face and tapered back to point on downstream side of obstructions. Sleeves to extend completely between walls of duct and be firmly riveted in place.

3.03 PIPE SEALS

- A. All openings around pipes thru sheet metal ducts, casings, or other sheet metal surfaces shall be sealed and made air tight by this Contractor.
- B. Seal shall consist of 1/4" thick split felt gasket tightly fitted around pipe and held in place with either a split rigid steel ring or a Crane No. 20 chrome-plated split floor plate drilled and bolted to the sheet metal surface.

3.04 INSTALLATION OF AUTOMATIC DAMPERS

- A. Install all automatic dampers furnished by and under the supervision of the automatic temperature control manufacturer.

- B. All blank-off plates and conversions necessary to install smaller than duct size dampers shall be the responsibility of the ductwork installer.
- C. The temperature control manufacturer shall submit a schedule of damper sizes to the ductwork installer, with a copy to the Engineer.

3.05 CAULKING AND TAPING

- A. Caulk all joints, rivets, flanges, flexible connections, filter frames, openings, seams, etc.
- B. Caulk all casings airtight.
- C. Caulking shall be 3M No. EC-800 premium grade.
- D. Where pressure testing indicates a leak that caulking has not sealed, provide a sheet metal jacket over the seam or joint and weld in place. Weldments to be continuous.

3.06 CLEANING AND PROTECTION

- A. Clean ductwork internally, unit-by-unit as it is installed, of dust and debris. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.
- B. At ends of ducts which are not connected to equipment or any distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris until time connections are to be completed.

END OF SECTION

SECTION 23 31 16
THERMOSET FIBERGLASS-REINFORCED PLASTIC DUCTS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Odorous air fiberglass ductwork and accessories.
2. Fiberglass manual volume dampers.
3. Expansion joints/flexible connectors for equipment with FRP ductwork.

1.02 SUBMITTALS

A. Submittal information is identified below:

1. Product Data: Manufacturer's specifications for duct system materials showing dimensions, wall thicknesses, laminate construction, weights, materials of construction, corrosion resistance characteristics, and method of construction.
2. Shop Drawings: Dimensioned layouts of ductwork showing accurately scaled ductwork, including locations of expansion joints.
3. Resin Manufacturer's corrosion charts indicating that selected resin is approved for service defined in this section.
4. After completion of ductwork installation, Manufacturer shall inspect installation and submit a Certificate of Proper Installation.

B. Submit in accordance with Section 01 33 00.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:

1. PS 15-69: Comply with National Bureau of Standards "Voluntary Product Standard PS 15-69" for construction and fabrication of fiberglass reinforced plastic duct.
2. ASTM C582: Comply with ASTM C582 - Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment.
3. ASTM D3982: Comply with ASTM D3982 - Standard Specification for Contact Molded "Fiberglass" (Glass Fiber Reinforced Thermosetting Resin) Duct and Hoods.
4. SMACNA Thermoset FRP Duct Construction Manual.

B. Contractor shall field verify existing dimensions. Maximum out-of-tolerance shall not exceed ½-inch at connection to existing expansion joint at 70°F. Ductwork having greater tolerance shall be rejected and replaced by this Contractor at no additional cost to Owner.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Protect ductwork, accessories, and purchased products from damage during shipping, storage, and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings.

B. Where possible, store ductwork inside and protect from weather. Where necessary to store outside, store above grade protected from wind.

PART 2 – PRODUCTS

2.01 FRP DUCTWORK

A. Manufacturer:

1. Manufacturer shall have experience in fabricating duct, flanges, fittings, and isometric spools with the filament wound process for greater than 3-years.
2. Fittings, flanges, dampers, and ducts shall be from same manufacturer.
3. Approved Manufacturers:
 - a. Perry Fiberglass Products, Inc.
 - b. ECS Environmental Solutions.
 - c. Belco.
 - d. Ershings.
 - e. Or Equal.

B. Design Conditions:

1. Service:
 - a. Odorous air collection, 100-ppm H₂S maximum, 750-ppm NH₃ maximum, 100-ppb mercaptans maximum, 100-ppb organic sulphides maximum, in an air stream saturated with water vapor.
2. Design System Maximum Pressure: 15-In. W.C.
3. Design System Maximum Vacuum: 15-In. W.C.
4. Ambient Temperature: 0 to 115°F.
5. Wind loading for external ducts see wind rating notes on drawing 999-S-1.
6. Buried ducts shall be suitable for bury up to 10'-0" below grade. Sections of duct passing under roadways shall be suitable for installation under roadways serving vehicles.
7. All buried ductwork must be designed for DOT H-20 loading.

C. General:

1. Rectangular, square, and circular-shaped fiberglass FRP ductwork, transition pieces, and plenums shall be provided at locations shown on Drawings. All fittings shall be FRP as appropriate.
2. Ductwork shall be fabricated in accordance with SMACNA's Thermoset FRP Duct Construction Manual, Chapters 3 and 5.2.
3. Ductwork located outdoors shall be designed for external wind and snow loads indicated in General Structural Notes on the Drawings, standard detail sheets.
4. To greatest extent possible, complete joining of FRP duct components in shop to minimize number of field joints. Pre-fabrication shall be completed at the factory of manufacturer and not by Contractor or a third party.
5. All ducts shall have an internal corrosion barrier/liner thickness of not less than 100-mil. Internal corrosion liner shall be built with an innermost corrosion barrier of approximately 20-mils reinforced with C-Veil surfacing veil, followed by two layers of chopped strand mat. Corrosion liner shall be followed by a filament wound structural wall laminate.
6. Provide duct tinted light grey.
7. Out of roundness of duct shall be limited to 1% of diameter.

D. Duct Design:

1. All ductwork shall be of filament wound construction.
2. Duct diameters shall meet the requirements of referenced Regulator Requirements.

3. Duct wall thickness shall be dictated by the greater thickness calculated in accordance with the following:
 - a. Pressure Service:
 - 1) Safety factor of 10.
 - 2) Minimum wall thickness based on limiting strain.
 - 3) Strength contributed by corrosion barrier/liner shall not be included in calculations.
 - 4) Structural wall thickness shall be calculated by using the formula $t=(P*D)/(2*E*Z)$ where: t=filament wound wall thickness in inches, P=design pressure in PSI, D=inside duct diameter in inches, E=filament wound tensile modulus, and Z=maximum allowable strain (0.0015 in/in).
 - b. Vacuum Service:
 - 1) Safety factor of 5.
 - 2) Minimum wall thickness shall be determined using Roark's formula for elastic buckling for very long tubes with free ends.
 - 3) Strength contributed by corrosion barrier/liner shall not be included in calculations.
 - 4) Collapse pressure shall be determined using a modulus of elasticity for the filament wound structural portion of the duct not to exceed 3,600,000.
 - c. Buried Ductwork:
 - 1) All burial calculations for deflection, ring bending, combined loads and buckling. All buried ductwork must be designed for DOT H-20 wheel loading.
 - d. The filament wound structural portion of the duct shall be rounded up to the nearest 40-mils. The total wall thickness shall be the corrosion barrier/liner thickness of 100-mils plus the calculated wall thickness. The filament wound structural duct wall thickness shall never be less than 0.120-in, for a total minimum wall thickness of 0.160-in.

E. Resin:

1. High performance premium grade brominated fire-retardant vinyl polyester resin (AOC K022, Hetron 992, Interplastics 8441, Derakane 510, or equal) shall be used throughout the laminate of all ducts.
2. Resin for ducts shall be fire retardant complying with UL 181 requirements for a Class 0 or 1 duct material. At Contractor's option, FRP duct systems not meeting this requirement may be installed and coated with an intumescent paint tested to achieve a Class 1 flame and smoke spread. If coating option selected, testing showing compliance with ASTM E84 shall be submitted.
3. After fabrication, all components shall be coated with a UV resistant gel coat.

F. Fittings:

1. All fittings shall be of filament wound or hand lay-up construction with same resins and corrosion barriers as defined for the duct.
2. Structural portions of filament wound walls shall be supplemented with fiberglass unidirectional reinforcement as required.
3. Structural wall thickness shall be no less than that provided for duct of same size and pressure rating.

4. Elbows 24-in and smaller shall be one-piece sweep, smooth radius elbows with a radius of 1.5 times duct diameter. Elbows 30-in and larger may be mitered with minimum of two mitered joints (3-piece) with a radius of 1.5 times duct diameter.

G. Joints:

1. Field joints shall be butt and strap joints in accordance with ASTM D3982.
2. Field welds shall be made with use of manufacture furnished overlay weld kit.
3. Field welds shall made by an installer approved by the FRP manufacturer.
4. Weld kits shall be supplied to provide a final thickness equal to the minimum wall thickness in Figure 5 of ASTM D3982 and minimum total weld width as specified in Table

H. Flanges:

1. Flanges shall be of hand lay-up construction.
2. Flanges shall be constructed of same premium grade vinylester resin as specified for the duct.
3. Flanges shall be perpendicular to axis of duct to within $\frac{1}{2}^\circ$ and flat to within 1/32-in for 18-in and smaller flanges and to within 1/16-in for 20-in and larger flanges.
4. Duct to duct flanges shall meet the dimensional requirements of NBS PS 15-69 and drilled in accordance with Table 2 of NBS PS 15-69. Manufacture shall coordinate flange requirements with equipment connections and provide ANSI sized and drilled flanges where required. All bolting hardware shall be of 304 stainless steel construction.

I. Ducting Deflection:

1. The FRP duct shall be designed to limit duct sag of horizontal installed round duct to less than 1% of the dia. based on the below identified support spacing.

J. Supports:

1. Duct supports shall be designed to meet the general requirements of Manufacturer's recommendations, SMACNA's Thermoset FRP Duct Construction Manual, and as follows.
2. Spacing:
 - a. Vertical ducts shall be supported at the base of the riser and provided with lateral support at the top of the riser.
 - b. Horizontal Spacing:
 - 1) 3-18-in duct: 10-ft maximum.
 - 2) 20-36-in duct: 15-ft maximum.
 - c. Where flexible connectors shown on drawings, or expansion joints recommended by ductwork Manufacturer, supports shall be provided on each side of joint.
 - d. Supports shall be provided on each side of a horizontally installed valve and at the point of connection to equipment.
3. All support saddles and duct attachment components shall be of Fiberglass Reinforced Plastic (FRP) and/or non-metallic construction.
4. All threaded rods and miscellaneous support materials (not in direct contact with duct) shall be of Fiberglass Reinforced Plastic (FRP) and/or non-metallic construction.

K. Workmanship:

1. The finished laminate shall be free from visual defects such as foreign inclusions, dry spots, air bubbles, pin holes, pimples, delamination, exposed reinforcement (glass fibers), and runoff as described below. Care shall be taken to fill voids and crevices at joints and fittings:

Surface Inspected

<u>Defect</u>	<u>Process Side</u>	<u>Exposed Side</u>
a. Cracks	None	None
b. Crazeing (fine surface cracks)	None	Max dimension 1/2", max density 5/ft ² , min 2-in apart
c. Blisters	None	Max 1/4-in dia x 1/8-in high, max 1/ft ² , min. 2-in apart
d. Wrinkles and solid blisters	Max deviation of 20% wall thickness but not greater than 1/8-in	Max deviation of 20% wall thickness but not greater than 1/8-in
e. Pits	Max dimensions, 1/8" dia x 1/32" deep, max number of 10/ft ²	Max dimensions, 1/8" dia x 1/16" deep, max number of 10/ft ²
f. Surface porosity (pinholes)	None	None
g. Chips	None	Max dimension of 1/4-in and no deeper than 20% of wall thickness, max density 1/ft ²
h. Dry Spot (non-wetted surface)	None	Max dimension 2 in ² /ft ²
i. Entrapped air	1/16" max dia. 10/in ² max density, none to depth of 1/32-in	1/8" max dia. 4/in ² max density, none to depth of 1/32-in
j. Exposed glass	None	None
k. Burned areas	None	None
l. Exposure of cut edge	None	None
m. Scratches	None	Max length 1-in, max depth 0.01-in
n. Foreign matter	None	1/16-in dia., max density 1/SF

L. Accessories:

1. Bolts, washers, and nuts: Fiberglass Reinforced Plastic (FRP) and/or non-metallic construction.
2. Gaskets: Gaskets shall be full-faced, EPDM, minimum 1/8 inch thick and 40 – 60 durometer.

2.02 FIBERGLASS DAMPERS

A. General:

1. Fiberglass round butterfly dampers shall be provided at the locations shown on Drawings. The dampers will be used to isolate and balance malodorous airflows. The malodorous air will consist of air, hydrogen sulfide gas, methane, and various aromatic hydrocarbon vapors.
2. Leakage rate shall not exceed 3 cfm/SF at 10-in w.c..

- B. Frame:
 - 1. Fiberglass reinforced plastic with vinyl ester resin.
- C. Blade:
 - 1. Fiberglass reinforced plastic with vinyl ester resin; stiffeners as required.
 - 2. 0.25-in. thick.
- D. Axle: Continuous fiberglass reinforced plastic rod with stiffeners as required; 6-in. extension beyond frame.
- E. Bearing: Molded PTFE.
- F. Blade Stop: Fiberglass reinforced plastic bar.
- G. Blade and Shaft Seals: Neoprene.
- H. Flanges: Flanges shall conform to specifications in ASTM D3982., Table 2.
- I. Butterfly Damper (MVD) Construction:
 - 1. Dampers shall be of single blade type complete with channel-type frame, close fitting blade, full length axle, and bearings. Dampers shall be constructed of fiberglass reinforced plastic using a vinyl ester resin and shall have the same inside dimensions as the connecting ducting. Axles shall not be less than 3/4-in. in diameter and shall be continuous through damper.
 - 2. Dampers for balancing service shall be equipped with blade stop and shall have a minimum pressure rating of 30- in. water column.
 - 3. Dampers for isolation service shall be equipped with full circumference blade edge seal, angle type blade stop, and shaft seal. Isolation dampers shall have a minimum pressure rating of 30-in. water column and shall have a maximum leakage rate of 5.3 cu. ft per minute per sq. ft of damper area at minimum pressure rating.
- J. Operators:
 - 1. All dampers 24-inch in diameter and larger shall be furnished with an epoxy coated worm gear.
 - 2. Hand Operators:
 - a. Heavy-duty, having a locking quadrant suitable for positioning the blade at any intermediate position.
- K. Accessories:
 - 1. Bolts, washers, and nuts: Fiberglass Reinforced Plastic (FRP) and/or non-metallic construction.
 - 2. Gaskets: Gaskets shall be full-faced, EPDM, minimum 3/16 inch thick and 40 – 60 durometer.

2.03 EXPANSION JOINTS/FLEXIBLE CONNECTIONS

- A. Manufacturers:
 - 1. Holz Rubber Company, Inc., Style 942.
 - 2. Red Valve Co., Inc.

3. Mercer Rubber Co.
4. Or Equal.

B. General:

1. Expansion joints/flexible connections shall be furnished and installed at the locations indicated on the Drawings and as recommended by FRP ductwork system supplier as required for proper duct installation to account for all thermal expansion of duct system from -10°F to 110°F. At minimum, expansion joints/flexible connectors shall be provided at the inlet and outlet of each fan served, at connection to equipment with moving parts, and at every point where the ductwork changes vertical or horizontal direction and continues for at least 20 feet. Expansion joints/flexible connections shall be of EPDM construction resistant to ultraviolet light and shall be suitable for malodorous air containing air, hydrogen sulfide gas, methane, and various aromatic hydrocarbon vapors.

C. Construction:

1. Expansion joints/flexible connections shall be of EPDM construction. Connections shall be flanged type, compatible with duct flanges specified above and equipment duct flanges, suitable for minimum pressure and vacuum load of 20-in. water column.
2. Where specifically indicated on the Drawings, provide slip-on type flexible connectors. Slip-on type shall be sized to fit tightly on the outside circumference of the duct and shall be secured in place by adjustable stainless steel band type clamps.

PART 3 – INSTALLATION

3.01 INSPECTION

- A. General: Examine areas and conditions under which FRP ductwork, dampers, and expansion joints/flexible connections are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION

A. General:

1. Assemble and install ductwork in accordance with recognized industry practices which will achieve air-tight and noiseless (no objectionable noise) systems, capable of performing each indicated service.
2. Install each run with minimum number of joints.
3. Align ductwork accurately at connections, within 1/8-in. misalignment tolerance and with internal surfaces smooth.
4. Support ducts as dictated by ductwork manufacturer.
5. Support vertical ducts at every floor.

B. Field Fabrication:

1. Complete fabrication of work at project as necessary to match shop-fabricated work and accommodate installation requirements.

C. Duct Routing:

1. Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible.

2. Located runs as indicated by diagrams, details, and notations or, if not otherwise indicated, run ductwork in shortest route which does not obstruct useable space or block access for servicing building and its equipment.
 3. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
 4. Limit clearance to ½-in. where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any.
 5. Coordinate layout with other piping and lighting layouts.
- D. Where ducts pass through interior partitions, exterior walls, floor, or roof, refer to Drawings for detail.
- E. Coordinate duct installations with installation of accessories, dampers, equipment, controls, and other work associated with duct system.
- F. Apply all ductwork coating in accordance with manufacturer's requirements.
- G. Trench, backfill and compact in accordance with Section 31 23 33.
- H. Slope ductwork as specified on Plans.

3.03 FIELD QUALITY CONTROL

- A. Any duct found to be improperly installed shall be removed and replaced with ductwork or fittings meeting these specifications. This shall include the following:
1. Fiberglass pipe smaller than specified.
 2. Construction joints no properly sealed.

3.04 EQUIPMENT CONNECTIONS

- A. General:
1. Connect ductwork to equipment as indicated, provide flexible connection for each ductwork connection to equipment mounted on vibration isolators, equipment containing rotating machinery, and/or where indicated on Drawings.

3.05 ADJUSTING AND CLEANING

- A. Clean ductwork internally, unit by unit as it is installed, of dust and debris. Clean external surfaces of foreign substances.
- B. Temporary Closure:
1. At ends of duct which are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris until time connections are to be completed.
- C. Balancing:
1. Refer to Section 23 05 93, not work of this Section. Seal any leaks in ductwork that become apparent in balancing process.

END OF SECTION

SECTION 23 31 17
PREINSUALTED BURIED DUCT SYSTEMS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Preinsulated buried duct system for building 900.

1.02 SUBMITTALS

B. Submittal information is identified below:

1. Product Data: Manufacturer's specifications for duct system materials showing dimensions, wall thicknesses, weights, and materials of construction.
2. Shop Drawings:
 - a. Dimensioned layouts of ductwork showing accurately scaled ductwork, including locations of expansion joints.
 - b. CAD-generated showing fabrication and installation details for all ducts to include
 - 1) Isometric view of duct assembly with duct sections indicated on drawing to match part number tagging on delivered duct sections.
 - 2) Fabrication and assembly instructions.
 - 3) Details for connecting to other components (i.e. curbs, rooftop units, mechanical room walls, etc.)
 - 4) Duct layout indicating sizes and pressure classes.
 - 5) Elevations of top and bottom of ducts.
 - 6) Dimensions of main duct runs from building grid lines.
 - 7) Reinforcement and spacing.
 - 8) Seam and joint construction.
 - 9) Equipment installation based on equipment being used on Project.
 - 10) Duct accessories, including access doors and panels.

C. Submit in accordance with Section 01 33 00.

D. Field quality-control test reports.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:

1. American Standards: ASTM C 518 2004
2. Standard Test Methods for Water Vapor Transmission of Materials: ASTM E 84-08a
3. Standard Test Method for Surface Burning Characteristics of Building Materials: UL 723
4. Test for Surface Burning Characteristics of Building Materials: NFPA 90A
5. Standard for the Installation of Air Conditioning and Ventilating Systems: NFPA 90B
6. Standard for the Installation of Warm Air Heating and Air-Conditioning Systems: UL/ULC 181
7. SMACNA HVAC Phenolic Duct Construction Standards

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Protect ductwork, accessories, and purchased products from damage during shipping, storage, and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings. Protect from weather and sunlight exposure.
- B. Where possible, store ductwork inside and protect from weather. Where necessary to store outside, store above grade protected from wind.

PART 2 – PRODUCTS

2.01 PREINSULATED BURIED DUCT SYSTEM

A. Manufacturer:

- 1. Manufacturer shall have experience in fabricating duct, flanges, fittings, and isometric spools with the filament wound process for greater than 3-years.
- 2. Fittings, flanges, dampers, and ducts shall be from same manufacturer.
- 3. Approved Manufacturers:
 - a. QDuct, AQC Industries.
 - b. Or Equal.

B. System Description:

- 1. Double layered, double wall, pre-insulated, weatherproof outdoor duct system designed for exterior application. Inter-locking, double sealing joint system to ensure minimal leakage
- 2. Panel jacketing combined with an additionally factory applied weather resistant cladding to ensure maximum protection from the elements.
- 3. Ductwork shall be suitable for use in the following exterior applications: exterior supply, return, fresh air and general exhaust ductwork.
- 4. Insulation shall be a minimum of 2-inch thickness with minimum R value of 10.

C. System is to be a double layered duct system using the Pal Phenolic Duct panels pre-fabricated and assembled into inter-locking sections.

D. The panels used in the fabrication of the ductwork system shall rigid phenolic insulation panels with a thermal conductivity of 0.1977 BTU-in/hr•ft² °F and a minimum compressive strength of 29 psi, as manufactured by Pal International.

E. Rigid phenolic insulation panels shall comprise a 3.4–3.75 pcf nominal density CFC/HCFC–free rigid Phenolic insulation core with zero Ozone Depletion Potential (ODP), autohesively bonded on both sides: 60 micron aluminum internal liner and a 200 micron aluminum external liner. Both liners are to be solid aluminum with no perforations.

F. All other components required for the fabrication of the duct system shall be from the manufacturers guidelines including the sealant, contact adhesive, aluminum tape, self–adhesive gasket, ductwork reinforcements, closures, connectors and flanges.

G. Exterior cladding shall be 5 ply, puncture resistant, tear resistant, flexible, and meet UL1709.

H. Foam trench blocks will be provided for all buried ductwork.

I. Fire and smoke performance

1. The rigid Phenolic insulation panels used in the fabrication of the duct system shall achieve the following fire and smoke performance requirements:
2. ASTM E 84—low contribution to fire growth not exceeding 25 Flame Spread and 50 Smoke Developed indices;
3. UL 723 —low contribution to fire growth not exceeding 25 Flame Spread and 50 Smoke Developed indices; and
4. UL 181 – UL/ULC classification as a Class 1 Air Duct to NFPA Standards 90A & 90B.

J. Sealant materials

1. All internal seams must be fully sealed with an unbroken layer of Pal Phenolic sealant.
2. Each ductwork section must be duly connected with an inter-locking, double sealed jointing system. Sufficient sealant should be applied to each layer in order to seal the rigid Phenolic insulation panels and ensure minimum air leakage.
3. Ductwork reinforcement, if necessary, shall be applied to protect against side deformation from both positive and negative pressure.
4. All external seams where two separate panels join must be tiger clipped, taped and jacketed in watershed fashion whenever possible to achieve a permanent bond with weather protection and a smooth appearance.

PART 3 – INSTALLATION

3.01 INSPECTION

- A. General: Examine areas and conditions under which ductwork is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 AIR LEAKAGE

- A. Ductwork system air leakage shall be in accordance with the requirements of the relevant jurisdiction.

3.03 INSTALLATION

A. General:

1. Installation and fabrication of duct system shall be in strict accordance with manufacturer's installation guide lines.

B. Field Fabrication:

1. Complete fabrication of work at project as necessary to match shop-fabricated work and accommodate installation requirements.

C. Duct Routing:

1. Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible.
2. Located runs as indicated by diagrams, details, and notations or, if not otherwise indicated, run ductwork in shortest route which does not obstruct useable space or block access for servicing building and its equipment.
3. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

4. Limit clearance to ½-in. where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any.
 5. Coordinate layout with other piping and lighting layouts.
- D. Where ducts pass through interior partitions, exterior walls, floor, or roof, refer to Drawings for detail.
- E. Coordinate duct installations with installation of accessories, dampers, equipment, controls, and other work associated with duct system.
- F. Trench, backfill and compact in accordance with Section 31 23 33.

3.04 FIELD QUALITY CONTROL

- A. Any duct found to be improperly installed shall be removed and replaced with ductwork or fittings meeting these specifications. This shall include the following:
1. Duct smaller than specified.
 2. Construction joints not properly sealed.

3.05 EQUIPMENT CONNECTIONS

- A. General:
1. Connect ductwork to equipment as indicated, provide flexible connection for each ductwork connection to equipment mounted on vibration isolators, equipment containing rotating machinery, and/or where indicated on Drawings.

3.06 ADJUSTING AND CLEANING

- A. Clean ductwork internally, unit by unit as it is installed, of dust and debris. Clean external surfaces of foreign substances.
- B. Temporary Closure:
1. At ends of duct which are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris until time connections are to be completed.
- C. Balancing:
1. Refer to Section 23 05 93, not work of this Section. Seal any leaks in ductwork that become apparent in balancing process.

END OF SECTION

SECTION 23 33 00
AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. Drawings and General Requirements of contract including General and Supplementary Conditions and Division 1-specification sections apply to Work of this Section.
- B. Extent of duct accessories work is indicated on drawings and in schedules, and by requirements of this section.
- C. Types of duct accessories required for project include the following:
 - 1. Manual Dampers.
 - 2. Gravity Backdraft Dampers (BDD).
 - 3. Turning Vanes.
 - 4. Duct Hardware.
 - 5. Duct Access Doors.
 - 6. Flexible Connections.

1.02 QUALITY ASSURANCE

- A. SMACNA Compliance - Comply with applicable portions of Sheet Metal and Air Conditioning Contractor's National Association (SMACNA) "Duct Construction Standards - Metal and Flexible"
- B. NFPA Compliance - Comply with applicable provisions of ANSI/NFPA 90A "Air Conditioning and Ventilating Systems", pertaining to installation of duct accessories.

1.03 SUBMITTALS

- A. General:
 - 1. Submit Product Data in sufficient detail to confirm compliance with requirements of this Section.
 - 2. Documentation demonstrating compliance with Spec. Section 00 30 80 regarding the use of American iron and steel in the products being furnished under this Section.
- B. Product Data:
 - 1. Manufacturer's specifications for duct system materials showing thicknesses, weights, materials of construction, corrosion resistance characteristics, and method of construction.
- C. Submit in accordance with Section 01 33 00.

1.04 IEPA LOAN REQUIRED DOCUMENTATION – AMERICAN IRON & STEEL

- A. Pursuant to the IEPA loan being used to finance the project, the CONTRACTOR and his/her suppliers shall comply with Section 436 of federal H.R. 3547, which are requirements regarding the use of American iron and steel products. These requirements apply to and are binding to the manufacturer of the products specified in this Section.

- B. The manufacturer shall provide with the shop drawing submittal one (1) signed and dated original of the AIS Certification Letter (a blank copy of which is provided on page A-00 30 80-3 of this manual). Said letter shall demonstrate compliance with Section 436 of federal H.R. 3547.

PART 2 - PRODUCTS

2.01 RECTANGULAR MANUAL BALANCING DAMPERS

- A. Provide dampers of single blade type or multi-blade type, constructed in accordance with SMACNA Standards. Dampers greater than 10-in height shall be multi-blade type.
- B. 16-gage galvanized steel frame and damper blade with 20-gage blade stop. Dampers installed in aluminum, stainless steel, or FRP duct systems shall be constructed of 304 stainless steel.
- C. ½-in hex axle with molded synthetic bearings.
- D. All dampers shall be furnished with locking hand quadrant. Dampers installed on insulated duct systems shall be furnished with extended quadrant.
- E. Manufacturer - Subject to compliance with requirements, provide dampers of one of the following:
 - 1. Ruskin model MD35.
 - 2. Or equal.

2.02 GRAVITY BACKDRAFT DAMPERS

- A. Parallel blade, counterbalanced, adjustable backdraft damper.
- B. Provide in vertical or horizontal configuration as required by installation location.
- C. Aluminum frame and blade construction with vinyl blade seals.
- D. Units installed in electrical rooms shall be set for 0.05 beginning pressure relief.
- E. Manufacturer – Subject to compliance with requirements, provide dampers of one of the following:
 - 1. Greenheck model BR.
 - 2. Or equal.

2.03 TURNING VANES

- A. Provide turning vanes constructed of curved blades supported with bars perpendicular to blades and set into side strips suitable for mounting in ductwork.
- B. Turning vanes installed in aluminum and stainless steel ductwork shall be of aluminum construction.
- C. Manufacturer - Subject to compliance with requirements, provide turning vanes of one of the following:

1. Cain Mfg Co.
2. Tuttle & Bailey.
3. Or equal.

2.04 DUCT HARDWARE

- A. Quadrant Locks: Provide for each damper, quadrant lock device on one end of shaft; and end bearing plate on other end for damper lengths over 12". Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.
- B. Manufacturers - Subject to compliance with requirements provide duct hardware of one of the following:
 1. Ventfabrics, Inc.
 2. Young Regulator Co.
 3. Or equal.

2.05 DUCT ACCESS DOORS

- A. Construct of same or greater gauge as ductwork served, provide insulated doors for insulated ductwork. Access doors shall be constructed of same material as the duct system served.
- B. Provide flush frames for uninsulated ductwork, extended frame for externally insulated duct.
- C. Provide one side hinged, other side with 1 handle-type latch for doors 12" high and smaller, 2 handle-type latches for larger doors.
- D. Provide access doors on exhaust systems upstream of all elbows with turning vanes and upstream of electric heating coils.
- E. Manufacturers - Subject to compliance with requirements provide duct access doors of one of the following:
 1. Ruskin Mfg. Co.
 2. Ventfabrics, Inc.
 3. Or equal.

2.06 FLEXIBLE CONNECTIONS

- A. Provide flexible duct connections wherever ductwork connects to vibration isolated equipment.
- B. Construct flexible connections of neoprene-coated flameproof fabric crimped into duct flanges for attachment to duct and equipment. Make air tight joint.
- C. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibrations of connected equipment.
- D. Manufacturers - Subject to compliance with requirements provide flexible connections of one of the following:
 1. Ventfabrics.
 2. Or equal.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which duct accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install duct accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards.
- B. Install turning vanes in square or rectangular 90° elbows in supply and exhaust air systems, and elsewhere as indicated.
- C. Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter. Install access doors where indicated and at each control damper.
- D. Coordinate with other work, including ductwork, as necessary to interface installation of duct accessories properly with other work.

3.03 FIELD QUALITY CONTROL

- A. Operate installed duct accessories to demonstrate compliance with requirements.
- B. Test for air leakage while system is operating.
- C. Repair or replace faulty accessories, as required to obtain proper operation and leakproof performance.

END OF SECTION

SECTION 23 34 23
HVAC POWER VENTILATORS

PART 1 – GENERAL

1.01 SUMMARY

- A. This section identifies power and gravity ventilators to be furnished and installed as shown on HVAC drawings and schedules and as specified herein. Power and gravity ventilators required for this project include:
 - 1. Centrifugal roof ventilators.
 - 2. Centrifugal wall ventilators.
- B. The following is not work of this section, refer to Division 26.
 - 1. Power supply wiring from power source to power connection on ventilators. All components required to make a complete installation shall be provided, including but not limited to starters, disconnects and required electrical devices. Electrical equipment specified to be furnished or factory installed by manufacturer shall be provided under this section in accordance with Division 26.
- C. Control and interlock wiring between ventilators and field installed devices shall be work of Section 23 09 23, installed in accordance with Division 26. Interlock and control wiring specified as factory installed is work of this section.

1.02 DEFINITIONS, ABBREVIATIONS AND ACRONYMS

- A. Acronyms:
 - 1. CCW: Counterclockwise
 - 2. CW: Clockwise
 - 3. ODP: Open Drip Proof
 - 4. TEFC: Totally Enclosed Fan Cooled
- B. Unit Abbreviations:
 - 1. CFM: Cubic Feet per Minute
 - 2. FLA: Full Load Amps
 - 3. RPM: Revolutions per Minute
 - 4. V: Volts

1.03 REFERENCES

- A. Standard References:
 - 1. AMCA: Air Movement and Control Association
 - 2. NEMA: National Electrical Manufacturers Association
 - 3. NRCA: National Roofing Contractors Association
 - 4. UL: Underwriters Laboratories Incorporated

1.04 SUBMITTALS

- A. General:
 - 1. Submit Product Data in sufficient detail to confirm compliance with requirements of this

Section. Submit Product Data and Shop Drawings in one complete submittal package. Partial submittals are unacceptable.

B. Product Data:

1. Catalog cuts and product specifications for ventilators specified.
2. Capacity curve or chart with specified operating point clearly identified.
3. List of furnished accessories and accompanying accessory data.

C. Shop Drawings:

1. Installation and assembly drawings and specifically prepared technical data for ventilators.
2. Equipment dimension and weights.
3. Wiring Diagrams: Show power and control connections and distinguish between factory-installed and field-installed wiring.

D. Submit in accordance with Section 01 33 00.

E. Operation and Maintenance (O&M) Data:

1. Operating instructions and maintenance data for materials and products for inclusion in O&M Manual.
2. Manufacturer's written instructions for periodic tests of ventilators in service.
3. Submit in accordance with Section 01 78 23.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Provide power and gravity ventilators from firms regularly engaged in manufacture of power and gravity ventilators of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Regulatory Requirements:

1. AMCA Compliance - Provide power ventilators which have been tested and rated in accordance with AMCA standards, and bear AMCA Certified Ratings Seal.
2. UL Compliance - Provide power ventilators which are designed, manufactured, and tested in accordance with UL 705 "Power Ventilators".
3. NEMA Compliance - Provide motors and electrical accessories complying with NEMA standards

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver ventilators to their final locations in protective wrappings, containers, and other protection that will exclude dirt and moisture and prevent damage from construction operations. Remove protection only after equipment is made safe from such hazards.

B. Store ventilators in clean, dry location.

1.07 MAINTENANCE

A. Extra Materials:

1. Furnish extra materials matching products installed, as described below, packaged with protective covering for storage, and identified with labels describing contents.
 - a. Furnish one spare set of belts for all belt driven ventilators.

PART 2 – PRODUCTS

2.01 CENTRIFUGAL ROOF VENTILATORS

- A. Manufacturers:
 - 1. Greenheck.
 - 2. Carnes Company.
 - 3. Cook Company.
 - 4. Or equal.
- B. General: Provide centrifugal roof ventilators of types, sizes, direct or belt-driven and capacities as shown on drawings or schedules.
- C. Type:
 - 1. Upblast: Aluminum upblast fan housing with backward inclined aluminum fan wheel.
 - 2. Hooded Dome: Aluminum domed fan housing with backward inclined aluminum fan wheel.
- D. Construction: Fan and motor housing shall be constructed of material described above, fan hood shall be beaded or internally supported for rigidity. Fans shall be provided with pre-punched square curb cap for mounting to roof curb. Up-blast fans shall be provided with drain for the wind band. Drive assembly shall be isolated from fan plate to reduce vibration and noise transmission. All fasteners shall be of stainless steel construction. Fans scheduled to be of spark resistant construction shall be constructed of non-ferrous materials in accordance with AMCA Type B Spark Resistant Construction.
- E. Wheel, Shaft and Drive: Fan wheel shall be backward inclined non-overloading or forward curved as noted above. Fan shaft shall be of stainless steel construction. Bearings shall be heavy-duty pillow block bearings selected for minimum life of 100,000 hours at maximum rated speed of the fan. Drives shall be sized for a minimum of 150% of installed motor horsepower. Sheaves shall be of cast iron construction. Motor sheaves shall be adjustable for system balancing. Fans shall be dynamically and statically balanced and tested before shipment.
- F. Electrical: Provide factory-wired, fusible type disconnect switch in accordance with Division 16. Fans designated to be of spark-resistant construction and provided with explosion-proof motors shall be provided with a factory wired disconnect switch suitable for the environment in which it is installed and wired in accordance with Division 26.
- G. Motors: Provide TEFC motors for all belt drive fans unless specified to be explosion proof, ODP for direct drive fans. Provide motors of scheduled horsepowers in accordance with Division 26.
- H. Accessories: Provide fans with the following accessories and as scheduled:
 - 1. Dampers: Provide motor operated or gravity actuated dampers as scheduled. Gravity actuated dampers shall meet the requirements of Section 23 33 00.
 - 2. Birdscreen: Provide manufacturer's standard aluminum birdscreen.
 - 3. Provide stainless steel fasteners and fan shaft.
 - 4. Provide special coatings as scheduled.
 - 5. Roof Curb: Provide manufacturer's standard aluminum roof curb in height as scheduled.

2.02 BATHROOM FAN

- A. Manufacturers:
 - 1. Greenheck.

2. Carnes Company.
3. Cook Company.
4. Or equal.

B. General: Provide a ceiling mounted exhaust fan. Direct drive type. Fan housing shall be constructed of galvanized steel.

2.03 AXIAL CEILING FANS: (125-CF-1)

A. Manufacturers:

1. Leading Edge, Marley Engineering, Model 60001RDP.

B. Type: Heavy-duty, industrial, axial, reversing, suspended ceiling fan.

C. Construction:

1. UL Listed.
2. 36-inch blade diameter.
3. 12,500 -CFM (minimum rating).
4. Area coverage of 1600 ft².
5. White finish.
6. 120V/1-phase, direct drive with permanent split capacitor motors. Maximum FLA 1.4.
7. Permanently sealed ball bearings.
8. Secondary support cable.
9. Wall mounted speed control switch (125-CFC-1).

2.04 AXIAL WALL FANS

A. Manufacturers:

1. Greenheck.
2. Carnes Company.
3. Cook Company.
4. Or equal.

B. Type: Axial flow, direct or belt driven propeller fan as scheduled.

C. Construction: Fan panel shall be single piece construction of galvanized or painted steel with deep formed inlet venturi and pre-punched mounting holes. Drive support frame shall be of heavy gauge steel construction.

D. Wheel, Shaft and Drive: Propeller shall be constructed of cast aluminum blades securely fastened to cast hub. Hub shall be keyed to ground and polished shaft. Bearings shall be heavy-duty pillow block bearings selected for minimum life of 100,000 hours at maximum rated speed of the fan. Drives shall be sized for a minimum of 150% of installed motor horsepower. Sheaves shall be of cast iron construction, motor sheaves shall be adjustable for system balancing. Fans shall be dynamically and statically balanced and tested before shipment.

E. Electrical: Provide factory-wired, fusible type NEMA 4X disconnect switch in accordance with Division 16.

F. Motors: Provide TEFC motors of scheduled horsepowers in accordance with Division 16.

G. Finish: Factory applied prime and finish coatings in manufacturer's standard corrosion resistant paint.

H. Accessories: Provide fans with the following accessories as scheduled:

1. Dampers: Provide motor operated or gravity actuated dampers as scheduled.
2. Wall Housing: Provide manufacturer's standard wall housing for scheduled fan size. Housing shall be constructed of galvanized steel with pre-punched mounting holes. Provide housing with motor side guard of welded steel wire construction.
3. Provide special coatings as scheduled.
4. Damper Guard: Provide manufacturer's standard damper guard constructed of aluminum.
5. Propeller: Provide manufacturer's aluminum propeller.

2.05 ROOF CURBS

A. Manufacturers:

1. Same manufacturer as fan.
2. Or equal.

B. Provide manufacturer's standard shop-fabricated units, modified if necessary to comply with requirements. Provide curbs of heights and constructed of metal gauges as shown on drawings, where not noted, provide curbs of height required, constructed of 14 gauge metal.

C. Fabricate units from aluminum.

D. Provide treated wood nailer, not less than 1-5/8 inch thick and of width of support wall assembly. Anchor nailer securely to top of metal frame unit.

E. Insulate units inside structural support wall with rigid glass fiber insulation board of approximately 3-pound per cubic foot density and 1-1/2 inch minimum thickness, except as otherwise indicated and cover insulation with aluminum liner.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions under which power and gravity ventilators are to be installed. Do not proceed with installation until unsatisfactory conditions are corrected.

3.02 GENERAL

A. Install all equipment in accordance with manufacturer's installation instructions, industry standards, local Mechanical Code and as indicated in this section and on the Drawings.

B. Coordinate installation with electrical work for power wiring to each piece of powered equipment.

3.03 INSTALLATION

A. Ventilators:

1. Coordinate installation of power and gravity ventilators with work of roofing, walls and ceiling as necessary for proper interfacing.
2. Connect ductwork to roof ventilators as shown and in accordance with manufacturer's installation instructions. Solder bottom joints and up 2-inches of side joints of duct under roof ventilator to retain any moisture entering ventilator.
3. Remove shipping bolts and temporary supports within power ventilators. Adjust dampers for

free operation.

B. Roof Curbs:

1. Curbs furnished under this section shall be installed as work of Division 7. Mount ventilator securely to roof curb in accordance with manufacturer's instructions and recognized industry standards.
2. Install in accordance with manufacturer's instructions and recommendations.
3. Comply with installation provisions of installer of existing roofing system to maintain existing system warranty.
4. Anchor units securely to supporting structural substrates, adequate to withstand lateral and thermal stresses and inward and outward loading pressures.
5. Except as otherwise indicated, install roof accessory items in accordance with construction details of "NRCA Roofing and Waterproofing Manual".
6. Where metal surfaces of units to be installed come in contact with noncompatible metal or corrosive substrates, including wood, apply bituminous coating on concealed metal surfaces, or provide other permanent separation.

3.04 IDENTIFICATION

- A. Provide equipment identification for all ventilators in accordance with Section 40 05 07.

3.05 FIELD QUALITY CONTROL

- A. Upon completion of installation, start-up and test each power and gravity ventilator to demonstrate capabilities and compliance with requirements.
- B. Where possible, field correct malfunctioning units then retest to demonstrate compliance.
- C. Replace units which cannot be satisfactorily corrected.

3.06 ADJUSTMENT AND CLEANING

- A. Clean factory-finished surfaces. Repair marred or scratched surfaces with manufacturer's touch-up paint

END OF SECTION

SECTION 23 36 16
VARIABLE-AIR-VOLUME UNITS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. Drawings and General Requirements of Contract including General and Supplementary Conditions and Division 1 specification sections apply to Work of this Section.
- B. Variable air volume control box for installation in a ceiling that permits access to the unit. Manufacturer shall supply units of the design, number, size and performance as shown on equipment drawings and schedules. Units are for use in conjunction with air distribution manifolds, distribution ductwork and ceiling-mounted diffusers.

1.02 QUALITY ASSURANCE

- A. Insulation shall meet NFPA-90A requirements for flame spread and smoke generation and UL-181 requirements for anti-erosion, corrosion and fungus properties.
- B. Electric heating coils, when specified shall be UL or ETL listed and designed to comply with UL Standard 1096.
- C. Sound power levels shall be ARI certified in accordance with the requirements of ARI-880-98.

1.03 SUBMITTALS

- A. Product Data - Submit manufacturer's specifications for VAV Boxes showing dimensions, weights, capacities, ratings, accessories to be provided, electrical characteristics, gauges and finishes of materials, and installation instructions.
- B. Shop Drawings - Submit assembly-type shop drawings showing unit dimensions, construction details, and field connection details.
- C. Wiring Diagrams - Submit manufacturer's electrical requirements for power supply wiring for rooftop heating and cooling units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- D. Submit in accordance with Section 01 33 00.
- E. Maintenance Data - Submit maintenance instructions and spare parts lists. Submit these data in maintenance manuals in accordance with Section 01 78 23.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Handle VAV Boxes carefully to avoid damage to components, enclosures, and finish. Do not install damaged components; replace and return damaged components to rooftop unit manufacturer.
- B. Store VAV Boxes in clean dry place and protect from weather and construction traffic.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Factory-assembled, externally powered, variable air volume control terminal. Unit shall be complete with a damper assembly, flow sensor, externally mounted volume controller, collars for duct connection and all required features. Control box shall be clearly marked with an identification label that lists such information as nominal cfm, maximum and minimum factory-set airflow limits, coil type and coil hand, where applicable.

2.02 UNIT CABINET

- A. Constructed of minimum 22-gage optional galvanized steel with round or rectangular inlet collar and rectangular discharge with slip and drive connection.
- B. All primary air inlet collars shall accommodate standard flex duct sizes.

2.03 INSULATION

- A. Cabinet insulation shall be 1/2-in. thick, 1-1/2-lb equivalent density mat-faced insulation that meets the requirements of UL-181 and NFPA-90A.

2.04 DAMPER ASSEMBLY

- A. The control air damper assembly shall be constructed of heavy gage steel with solid shaft rotating in bearings.
- B. Damper shaft shall be marked on the end to indicate damper position.
- C. Damper blade shall incorporate a flexible gasket for tight airflow shutoff and operate over a full 90 degrees.

2.05 FANS

- A. Where fan powered VAV boxes are identified in the schedules, unit shall be furnished with a fan:
 - 1. Forward curved, centrifugal type.
 - 2. Single speed.
 - 3. 120-volt, single phase.
 - 4. Permanently lubricated, split capacitance motor with thermal overload protection.
 - 5. Fan shall be capable of meeting scheduled airflow requirements.

2.06 HOT WATER HEATING COIL

- A. Coil shall be mounted in a minimum 20 gage galvanized steel casing with slip and drive discharge connections, and factory mounted on the base unit as shown on the equipment drawings.
- B. Coils shall have:
 - 1. Aluminum fins (10 fins/in.) bonded to the copper tubes by mechanical expansion.
 - 2. Number of coil rows and circuits shall be selected to provide scheduled performance with up to 4 rows as scheduled.
 - 3. Right or left-hand fittings with sweat connection sizes implied by Drawings.

- C. Heater coils shall be designed for the airflow and heating capacity as shown on the equipment schedule.

2.07 CONTROLS

- A. Provide units without controls, control module to be provided as work of Section 23 09 23.

2.08 MANUFACTURER'S

- A. Carrier.
- B. Or Equal.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which VAV Boxes are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF VAV BOXES

- A. Install VAV Boxes where indicated, in accordance with equipment manufacturer's written instructions.
- B. Coordinate with other work, including ductwork, piping, and electric as necessary to interface installation of VAV Boxes with other work.

3.03 TESTING

- A. Upon completion of installation of VAV Boxes, start-up and operate equipment to demonstrate capability and compliance with requirements. Field correct malfunctioning units, then retest to demonstrate compliance.

END OF SECTION

SECTION 23 37 00
AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. Drawings and General Requirements of contract including General and Supplementary Conditions and Division 1 specification sections apply to Work of this Section.
- B. Extent of outlets and inlets work is indicated by drawings and schedules, and by requirements of this Section.
- C. Types of outlets and inlets required for project include the following:
 - 1. Ceiling Air Diffusers.
 - 2. Air Grilles.
 - 3. Floor Grilles.
 - 4. Gravity Ventilators.

1.02 QUALITY ASSURANCE

- A. ASHRAE Standards - Comply with American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE) Standard 70 "Methods Of Testing For Rating The Air Flow Performance Of Outlets and Inlets".
- B. ADC Test Code - Comply with Air Diffusion Council (ADC) Equipment Test Code 1062R4 "Certification, Rating and Test Manual".
- C. AMCA Standards - Comply with Air Movement and Control Association, Inc. (AMCA) Standard 500 "Test Method For Louvers, Dampers and Shutters".
- D. ANSI/NFPA Standards - Comply with National Fire Protection Association (NFPA) Standard 90A "Installation of Air Conditioning and Ventilating Systems".
- E. ARI Standard - Comply with Air Conditioning and Refrigeration Institute (ARI) Standard 650 - "Air Outlets and Inlets".

1.03 SUBMITTALS

- A. Product Data - Submit manufacturer's data on outlets and inlets including the following:
 - 1. Schedule of outlets and inlets indicating drawing designation, model number, size, and accessories furnished.
 - 2. Data sheet for each type of outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details.
 - 3. Performance data for each type of outlet and inlet furnished, including pressure drop, throw and drop, and noise criteria ratings. Indicate selections on data.
- B. American Iron and Steel Compliance Certification:
 - 1. Products specified in this Section shall be provided compliant with State Revolving Fund American Iron and Steel requirements.
 - 2. Manufacturer shall provide a certification letter in project submittals documenting compliance with American Iron and Steel requirements.

Example certification letters are included in the Appendix.

- C. Submit in accordance with Section 01 33 00.
- D. Maintenance Data - Submit maintenance instructions, including cleaning instructions for finishes, and spare parts lists in accordance with Section 01 78 23. Include this data in maintenance manuals.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver outlets and inlets wrapped in factory-fabricated fiberboard type containers. Identify on outside of container type of outlet or inlet and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.
- B. Store outlets and inlets in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.01 CEILING AIR DIFFUSERS

- A. Provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type indicated on schedule; constructed of materials and components as indicated on schedule.
- B. Provide ceiling air diffusers that have, as minimum, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data. Diffusers shall be of the 4-way throw pattern type, unless noted otherwise.
- C. Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems, which will contain each type of ceiling air diffuser.
- D. Diffusers scheduled to be laminar flow pattern shall be of aluminum construction with a removable, totally enclosed air distribution baffle box and perforated face plate with egg crate grid on plate rear for even airflow distribution. Face plate shall be provided with safety chains to support plate when disconnected from grille housing.
- E. Manufacturer - Subject to compliance with requirements, provide diffusers of one of the following:
 - 1. Carnes.
 - 2. Metal Aire.
 - 3. Krueger Mfg. Co.
 - 4. Price.
 - 5. Titus.
 - 6. Or equal.

2.02 AIR GRILLES

A. Manufacturers:

1. Carnes.
2. A-J Manufacturing Company.
3. Titus.
4. Or equal.

B. Construction: Provide grilles constructed of aluminum or stainless steel as scheduled.

C. Performance: Provide grilles that do not exceed scheduled maximum pressure drop and noise criteria ratings at scheduled airflow rate or airflow rate as shown on drawings.

D. Substrate Compatibility: Provide grilles with border styles that are compatible with adjacent substrate and specifically manufactured to fit into construction openings with accurate fit and adequate support. Refer to Drawings and Specifications for types of substrate which will contain each type of grille.

E. Grille Face / Pattern: Provide grilles of the following face / pattern type as scheduled. Blade width and spacing shall be dictated by the model number shown in the schedules.

1. Single Deflection: Provide grilles with $\frac{3}{4}$ -inch horizontal sets of blades. Refer to schedules for position of each set of blades.
2. Double Deflection: Provide grilles with $\frac{3}{4}$ -inch horizontal and vertical sets of blades. Refer to schedules for position of each set of blades.
3. Egg crate

F. Finish: Provide grilles with anodized, satin polish with clear lacquer, matte, clear or white baked enamel finish as scheduled.

2.03 AIR GRILLES

A. Manufacturers:

1. Nailor.
2. Or equal.

B. Construction: Provide grilles constructed of aluminum.

C. Performance: Provide grilles that do not exceed scheduled maximum pressure drop and noise criteria ratings at scheduled airflow rate or airflow rate as shown on drawings.

D. Grille Face / Pattern:

1. Cores shall have 1/4-inch spacing and 1/8-inch thickness bars.
2. Bars shall have a 15 degree deflection.
3. Openings shall be heel proof.

E. Frame shall be flush mounted without the use of a flange

F. Finish: Provide grilles with anodized, satin polish with clear lacquer, matte, clear or white baked enamel finish as scheduled.

2.04 GRAVITY ROOF VENTILATORS

- A. Manufacturers:
 - 1. Greenheck.
 - 2. Carnes Company.
 - 3. Cook Company.
 - 4. Or equal.
- B. General: Provide gravity roof ventilators of types, sizes, and capacities as shown on drawings or schedules.
- C. Type:
 - 1. Hooded Dome: Aluminum domed hood.
- D. Construction: Ventilators shall be provided with pre-punched square curb cap for mounting to roof curb.
- E. Accessories: Provide gravity ventilators with the following accessories as scheduled:
 - 1. Dampers: Provide gravity actuated dampers as scheduled. Gravity actuated dampers shall meet the requirements of Section 23 33 00.
 - 2. Birdscreen: Provide manufacturer's standard aluminum birdscreen.
 - 3. Insect screen: Provide manufacturer's standard stainless steel insect screen as scheduled.
 - 4. Insulation: Provide fiberglass insulation on underside of hooded low silhouette ventilators to prevent condensation as scheduled.
 - 5. Roof Curb: Provide roof curb as scheduled.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which outlets and inlets are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install outlets and inlets in accordance with manufacturer's written instructions.
- B. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.
- C. Provide balancing dampers on duct take-off to diffusers, and grilles and registers.
- D. Paint ductwork visible behind air outlets and inlets matte black.
- E. Insulate the body of all diffusers installed within a ceiling plenum (includes laminar diffusers, slot diffusers, and square diffusers).

END OF SECTION

SECTION 23 74 33
DEDICATED OUTDOOR-AIR UNITS

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

- A. Drawings and General Requirements of Contract including General and Supplementary Conditions apply to Work of this Section.
- B. Extent of dedicated outdoor air units work required by this section is indicated on drawings and schedules, and by requirements of this section.

1.02 QUALITY ASSURANCE

- A. UL or ETL Compliance - Provide units which are designed, manufactured, and tested in accordance with UL or ETL requirements.

1.03 SUBMITTALS

- A. Product Data - Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, weights, furnished specialties and accessories, electrical components and installation and start-up instructions.
- B. Shop Drawings - Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.
- C. Wiring Diagrams - Submit manufacturer's electrical requirements for power supply wiring for gas-fired heating and ventilating units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- D. Maintenance Data - Submit maintenance data and parts list for each unit, control, and accessory; including "trouble-shooting" maintenance guide in accordance with Section 01 78 23. Include this data and product data in maintenance manual.
- E. Submit in accordance with Section 01 33 00.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Handle units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged units or components; replace with new.
- B. Store units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.
- C. Comply with Manufacturer's rigging and installation instructions for unloading units, and moving them to final location.

PART 2 - PRODUCTS

2.01 AIR HANDLING UNITS

- A. Manufacturers:

1. Rupp.
2. Or Equal.

B. Configuration:

1. Configuration orientation is from unit inlet toward unit discharge. Access and coil connection locations are right/left as viewed in the direction of airflow (air hitting the back of head).
2. 900-AHU-1: Outdoor horizontal unit, filter mixing box with rear outside air inlet and damper, 2-inch throwaway filters, extra blank 2-inch filter section, DX cooling coil, DX reheat, plenum section, indirect fired heat exchanger, fan section with horizontal discharge. Unit configured for roof curb installation. Right hand access. Maximum dimensions of 82-inch x 81-inch x 61-inch (LxWxH).

C. Housing Construction

1. Unit casing shall be of minimum 20-gauge satin coat galvanized sheet metal. Base shall be a minimum 14 ga galvanized steel.
2. All units shall be internally insulated with 2-in. thick 1-½ lb./cu.ft. density, neoprene coated fiberglass thermal insulation and 22-gauge liner.
3. Surfaces shall be cleaned with a degreasing solvent to remove oil and metal oxides and primed with a two part acid based etching primer.
4. Finish coat shall be a two coat primer and paint finish that meets the requirements of a 1,000 hour salt spray test to all exposed surfaces inside and out. For outdoor units add UV topcoat to externally exposed metal. All unprotected metal and welds shall be factory coated.
5. All walls, roofs and floors shall be of formed construction, with at least two breaks at each joint. Joints shall be secured by sheet metal screws or pop rivets. Wall and floor joints shall be broken in and, on all outdoor units roof joints broken out (exposed) for rigidity. All joints shall be caulked with a water resistant sealant.
6. Units shall be provided with access doors to the following components: fans and motors; filters; dampers and operators; access plenums and electrical control panels; coils; burner and compressor compartments. Access doors shall be large enough for easy access. Removal of screwed wall panels will not be acceptable.
7. Provide hinged access doors in welded steel frames. Doors shall be fully lined with closed cell bulb gasket and Leverlok handles. Units of sufficient size in which a person may enter shall have handles operable from each side.
8. Whenever possible, hinged access doors to areas of negative pressure shall open out, and to areas of positive pressure shall open in. Where space constrictions require the use of outward opening doors to an area of positive pressure, a clear warning label must be affixed.
9. Casings shall be supported on formed galvanized steel channel or structural channel supports, designed and welded for low deflections. Integral lifting lugs shall be provided for hoisting.
10. Cooling coil drain pans shall be fabricated of stainless steel and shall be an integral part of the floor paneling, a minimum of 2-in deep, with welded corners. Drain pans shall extend a minimum of 6-in downstream of coil face and be provided with a 1-½-in stainless steel M.P.T. drain connection. Drain pans shall have a fast pan & be sloped and pitched such that there is no standing water. Intermediate fast pans shall be provided between cooling coils where required for effective moisture removal.
11. Units shall be provided in horizontal configuration unless otherwise noted and shall be provided with discharge orientation as scheduled.
12. Units scheduled to be provided with a roof curb shall be suitable for curb installation. Units scheduled for concrete pad or suspended installation shall be provided with a suitable steel base frame with same coating system as unit housing.

D. Air Dampers

1. Damper frames shall be u-shaped galvanized metal sections securely screwed or welded to the unit chassis.
2. Dampers shall be coated with same coating system as unit.
3. Pivot rods of ½-in. aluminum, shall turn in nylon or bronze bushings. Rods shall be secured to the blade by means of straps and set screws.
4. Blades shall be 18-gauge galvanized metal with two breaks on each edge and three breaks on centerline for rigidity.
5. Pivot rod shall “nest” in the centerline break.
6. Damper edges shall interlock.
7. Maximum length of damper between supports shall be 42-in.
8. Damper linkage brackets shall be constructed of galvanized metal.
9. Standard construction for all dampers includes blade ends sealed with an adhesive backed foam polyurethane gasketing. Outdoor air dampers shall also include an all weather PVC seal, fastened with a positive lock grip and pliable overlap edge on entering air side of interlocking edges. Dampers shall be interlocked from the center.
10. Mixing dampers shall be opposed blade type.
11. Two position inlet dampers shall be parallel blade type.
12. On units equipped with economizer provide a gasketed single or multiple blade barometric relief damper.
13. Gravity relief dampers shall be single blade gasketed design.

E. Supply Blowers

1. Centrifugal fans shall be rated in accordance with AMCA Standard Test Code, Bulletin 210. Fan manufacturer shall be a member of AMCA.
2. All fans and fan assemblies shall be dynamically balanced during factory test run.
3. Fan shafts shall be solid ground and polished provided with a rust inhibiting coating.
4. Fans shall have backward inclined or airfoil type fan wheels.
5. Fan assemblies shall be equipped with greaseable pillow block bearings, supported on a rigid structural steel frame. Wheel bearings shall be designed for at least 100,000 hours average life.
6. Drives:
 - a. Variable speed with variable frequency drive (900-AHU-1)
7. Motor mounting shall be adjustable to allow for variations in belt tension.
8. Fan-motor assemblies shall be provided with vibration isolators. Isolators shall be bolted to steel channel welded to unit floor which is welded to the structural frame of the unit. All other fans shall incorporate vertical spring type isolators with leveling bolts, bridge bearing waffled pads with minimum 1-in. static deflection designed to achieve high isolation efficiency.
9. Fans shall be attached to the discharge panel by a polyvinyl chloride coated polyester woven fabric, with a sealed double locking fabric to metal connection.
10. Motor shall be TEFC meeting the requirements of Section 26 05 84.

F. Heating Section

1. Heat Exchanger:
 - a. Shall be a primary drum and multi-tube secondary assembly constructed of 409 stainless steel with multi-plane tubulators, and shall be of a floating stress relieved design.
 - b. Shall be provided with condensate drain connection.
 - c. Casing shall have 1-in of insulation between the outer cabinet and inner liner.

- d. Shall be tested and certified to ANSI standards to provide a minimum of 80% efficiency throughout the entire operating range as required by ASHRAE 90.1.

2. Burner:

- a. The burner assembly shall be an induced draft combustion type with direct spark ignition and redundant gas valves.
- b. Flame surveillance shall be with a solid state programmed flame relay with flame rod.
- c. The burner and gas train shall be in a cabinet enclosure. Insulation in the burner section shall be covered by a heat reflective galvanized steel liner.
- d. Unit shall be capable of the following turndown:

(1) 900-AHU-1: minimum 15:1 modulating.

G. Cooling System:

1. Shall suitable for mechanical cooling operation down to 50°.
2. Units shall have minimum 7:1 modulating capacity variable speed scroll technology.
3. Where applicable, multiple refrigeration circuits shall be separate from each other.
4. Refrigeration circuits shall be complete with liquid line filter-driers, and service ports fitted with Schraeder fittings.
5. The complete piping system shall be purged and pressure tested with dry nitrogen, then tested again under vacuum. Each system shall be factory run and adjusted prior to shipment.
6. Variable capacity compressor, inverter scroll.
7. Condenser fan shall be of aluminum construction and provided with ECM fan motor.
8. Compressors shall have a minimum five year warranty.
9. Provide Polymer E-Coated, Heresite P-413, or equivalent coating system capable of passing a 10,000 hr salt spray test. A pure phenolic thermosetting resinous coating, to protect the coils against exposure to corrosive atmospheres. The process shall be accomplished by a multiple coat application of degreasing and etching, dipping and baking (four times), resulting in complete coating coverage of the fins, tubes, headers and casing. Air dried coatings are not acceptable.

H. DX Reheat

1. Modulating hot gas reheat capable of 0 to 100% capacity via two modulating valves for precise humidity control.
2. Provide Polymer E-Coated, Heresite P-413, or equivalent coating system capable of passing a 10,000 hr salt spray test. A pure phenolic thermosetting resinous coating, to protect the coils against exposure to corrosive atmospheres. The process shall be accomplished by a multiple coat application of degreasing and etching, dipping and baking (four times), resulting in complete coating coverage of the fins, tubes, headers and casing. Air dried coatings are not acceptable.

I. Coils:

1. Coils shall be ½-in O.D. for DX, constructed of copper tube, aluminum fin, and copper headers.
2. Fins constructed of aluminum or copper shall be rippled for maximum heat transfer and shall be mechanically bonded to the tubes by mechanical expansion of the tubes.
3. Coils shall have a galvanized steel casing.
4. All coils shall be factory tested with air at 300-psig while immersed in an illuminated water tank.
5. Provide Polymer E-Coated, Heresite P-413, or equivalent coating system capable of passing a 10,000 hr salt spray test. A pure phenolic thermosetting resinous coating, to

protect the coils against exposure to corrosive atmospheres. The process shall be accomplished by a multiple coat application of degreasing and etching, dipping and baking (four times), resulting in complete coating coverage of the fins, tubes, headers and casing. Air dried coatings are not acceptable.

J. Filters:

1. Filter sections shall be provided with adequately sized access doors to allow easy removal of filters.
2. For units with filter banks up to 72" (1825 mm) high, the filter modules shall be designed to slide out of the unit. Side removal 2-in filters shall slide into a formed metal track, sealing against metal spacers at each end of the track.
3. 2" Replaceable Media Filters: Disposable glass fiber media type enclosed in permanent galvanized metal frames with metal retainers on both sides.
4. Provide a 2" spare filter section downstream of replaceable filters.

K. Economizer

1. 100% outside air economizer.

I. Controls:

1. Local control panel with fan starters and overloads, compressor contactors, and control transformer.
2. Provide cabinet heater as required for installation location.
3. Temperature controller designed to control cooling compressors, return and outside air dampers, and burner as required to maintain discharge air setpoint temperature received from Facilities Management System (FMS). Controller shall have low-limit (freezestat) controls to shut-down unit and send alarm on drop in supply air temperature. Controller shall have functionality to meet the temperature control sequences specified in Section 23 09 23.
 - a. Controller shall be capable of receiving the following signals from FMS:
 - 1) Supply fan start/stop.
 - 2) Supply fan speed control.
 - 3) Discharge air temperature setpoint.
 - 4) Dew point (for humidity control)
 - b. Controller shall be capable of outputting the following signals to the FMS:
 - 1) Supply fan status (from proof of airflow).
 - 2) Percent of mechanical cooling energized.
 - 3) Gas valve position.
 - 4) Common alarm.
 - 5) Freezestat shut-down.
4. NEMA 4X disconnect switch in accordance with Division 26.
5. Low limit temperature sensor to shutdown unit when temperature downstream of heat exchanger falls below 39°F.

J. Accessories (Provide the following accessories as scheduled):

1. Motorized outside air damper.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF DEDICATED OUTDOOR AIR UNITS

- A. General - Install heating and cooling units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- B. Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
- C. Verify that electrical wiring installation is in accordance with manufacturer's submittal. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.
- D. Ductwork Connect supply and return ducts to unit with flexible duct connections. Provide transitions to exactly match unit duct connection sizes.

3.03 START-UP

- A. Start-up units per manufacturer's written start-up instructions.

3.04 GROUNDING

- A. Provide positive equipment ground for dedicated outdoor air unit components.

3.05 SPARE PARTS

- A. General - Furnish to Owner, with receipt, the following spare parts for each unit:
 - 1. 1 set of matched fan belts for each belt-driven fan.
 - 2. 2 sets of throwaway filters.

3.06 TRAINING/START-UP SERVICES

- A. Provide one half day training session for Owners' personnel. Training schedule shall be approved by Owner.
- B. Provide one half day start-up/installation inspection services.

END OF SECTION

SECTION 23 75 16
CUSTOM-PACKAGED, ROOFTOP AIR-CONDITIONING UNITS

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

- A. Drawings and General Requirements of Contract including General and Supplementary Conditions apply to Work of this Section.
- B. Extent of rooftop units work required by this section is indicated on drawings and schedules, and by requirements of this section.

1.02 QUALITY ASSURANCE

- A. UL or ETL Compliance - Provide units which are designed, manufactured, and tested in accordance with UL or ETL requirements.

1.03 SUBMITTALS

- A. Product Data - Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, weights, furnished specialties and accessories, electrical components and installation and start-up instructions.
- B. Shop Drawings - Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.
- C. Wiring Diagrams - Submit manufacturer's electrical requirements for power supply wiring for gas-fired heating and ventilating units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- D. Maintenance Data - Submit maintenance data and parts list for each unit, control, and accessory; including "trouble-shooting" maintenance guide in accordance with Section 01 78 23. Include this data and product data in maintenance manual.
- E. Submit in accordance with Section 01 33 00.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Handle units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged units or components; replace with new.
- B. Store units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.
- C. Comply with Manufacturer's rigging and installation instructions for unloading units, and moving them to final location.

PART 2 - PRODUCTS

2.01 AIR HANDLING UNITS

- A. Manufacturers:

1. Addison.
2. Or Equal.

B. Configuration:

1. Configuration orientation is from unit inlet toward unit discharge. Access and coil connection locations are right/left as viewed in the direction of airflow (air hitting the back of head).
2. 120-RTU-1: Outdoor horizontal unit, filter mixing box with rear outside air inlet and damper, bottom return air inlet and damper, 2-inch throwaway filters, filter section with 2-inch replaceable carbon filters, DX cooling coil, DX reheat, plenum section, indirect fired heat exchanger, fan section with down discharge. Unit configured for roof curb installation. Right hand access.
3. 120-RTU-2: Outdoor horizontal unit, filter mixing box with rear outside air inlet and damper, bottom return air inlet and damper, 2-inch throwaway filters, filter section with 2-inch replaceable carbon filters, DX cooling coil, DX reheat, plenum section, indirect fired heat exchanger, fan section with down discharge. Heat recovery wheel and variable speed exhaust air blower. Unit configured for roof curb installation. Right hand access.
4. 600-RTU-1: Outdoor horizontal unit, filter mixing box with rear outside air inlet and damper, bottom return air inlet and damper, 2-inch throwaway filters, DX cooling coil, DX reheat, plenum section, indirect fired heat exchanger, fan section with down discharge. Unit configured for roof curb installation. Right hand access.

C. Housing Construction

1. Unit casing shall be of minimum 18-gauge satin coat galvanized sheet metal.
2. All units shall be internally insulated with 1-in. thick 1-½ lb./cu.ft. density, neoprene coated fiberglass thermal insulation and 22-gauge liner.
3. Surfaces shall be cleaned with a degreasing solvent to remove oil and metal oxides and primed with a two part acid based etching primer.
4. Finish coat shall be a two coat primer and paint finish that meets the requirements of a 1,000 hour salt spray test to all exposed surfaces inside and out. For outdoor units add UV topcoat to externally exposed metal. All unprotected metal and welds shall be factory coated.
5. All walls, roofs and floors shall be of formed construction, with at least two breaks at each joint. Joints shall be secured by sheet metal screws or pop rivets. Wall and floor joints shall be broken in and, on all outdoor units roof joints broken out (exposed) for rigidity. All joints shall be caulked with a water resistant sealant.
6. Units shall be provided with access doors to the following components: fans and motors; filters; dampers and operators; access plenums and electrical control panels; coils; burner and compressor compartments. Access doors shall be large enough for easy access. Removal of screwed wall panels will not be acceptable.
7. Provide hinged access doors in welded steel frames. Doors shall be fully lined with closed cell bulb gasket and Leverlok handles. Units of sufficient size in which a person may enter shall have handles operable from each side.
8. Whenever possible, hinged access doors to areas of negative pressure shall open out, and to areas of positive pressure shall open in. Where space constrictions require the use of outward opening doors to an area of positive pressure, a clear warning label must be affixed.
9. Casings shall be supported on formed galvanized steel channel or structural channel supports, designed and welded for low deflections. Integral lifting lugs shall be provided for hoisting.
10. Cooling coil drain pans shall be fabricated of stainless steel and shall be an integral part of the floor paneling, a minimum of 2-in deep, with welded corners. Drain pans shall extend a minimum of 6-in downstream of coil face and be provided with a 1-½-in stainless steel M.P.T. drain connection. Drain pans shall have a fast pan & be sloped and

pitched such that there is no standing water. Intermediate fast pans shall be provided between cooling coils where required for effective moisture removal.

11. Units shall be provided in horizontal configuration unless otherwise noted and shall be provided with discharge orientation as scheduled.
12. Units scheduled to be provided with a roof curb shall be suitable for curb installation. Units scheduled for concrete pad or suspended installation shall be provided with a suitable steel base frame with same coating system as unit housing.

D. Air Dampers

1. Damper frames shall be u-shaped galvanized metal sections securely screwed or welded to the unit chassis.
2. Dampers shall be coated with same coating system as unit.
3. Pivot rods of ½-in. aluminum, shall turn in nylon or bronze bushings. Rods shall be secured to the blade by means of straps and set screws.
4. Blades shall be 18-gauge galvanized metal with two breaks on each edge and three breaks on centerline for rigidity.
5. Pivot rod shall "nest" in the centerline break.
6. Damper edges shall interlock.
7. Maximum length of damper between supports shall be 42-in.
8. Damper linkage brackets shall be constructed of galvanized metal.
9. Standard construction for all dampers includes blade ends sealed with an adhesive backed foam polyurethane gasketing. Outdoor air dampers shall also include an all weather PVC seal, fastened with a positive lock grip and pliable overlap edge on entering air side of interlocking edges. Dampers shall be interlocked from the center.
10. Mixing dampers shall be opposed blade type.
11. Two position inlet dampers shall be parallel blade type.
12. On units equipped with economizer provide a gasketed single or multiple blade barometric relief damper.
13. Gravity relief dampers shall be single blade gasketed design.
14. Mixing Box Controls: When scheduled for modulating outside air, provide a modulating normally closed damper operator controlled from an adjustable modulating mixed air temperature control with an adjustable minimum outside air positioning potentiometer.

E. Supply Blowers

1. Centrifugal fans shall be rated in accordance with AMCA Standard Test Code, Bulletin 210. Fan manufacturer shall be a member of AMCA.
2. All fans and fan assemblies shall be dynamically balanced during factory test run.
3. Fan shafts shall be solid ground and polished provided with a rust inhibiting coating.
4. Fans shall have backward inclined or airfoil type fan wheels.
5. Fan assemblies shall be equipped with greaseable pillow block bearings, supported on a rigid structural steel frame. Wheel bearings shall be designed for at least 100,000 hours average life.
6. Drives:
 - a. Variable speed with variable frequency drive (120-RTU-1, 120-RTU-2)
7. Motor mounting shall be adjustable to allow for variations in belt tension.
8. Fan-motor assemblies shall be provided with vibration isolators. Isolators shall be bolted to steel channel welded to unit floor which is welded to the structural frame of the unit. All other fans shall incorporate vertical spring type isolators with leveling bolts, bridge bearing waffled pads with minimum 1-in. static deflection designed to achieve high isolation efficiency.
9. Fans shall be attached to the discharge panel by a polyvinyl chloride coated polyester woven fabric, with a sealed double locking fabric to metal connection.

10. Motor shall be TEFC meeting the requirements of Section 26 05 84.

F. Heating Section

1. Heat Exchanger:

- a. Shall be a primary drum and multi-tube secondary assembly constructed of 409 stainless steel with multi-plane tubulators, and shall be of a floating stress relieved design.
- b. Shall be provided with condensate drain connection.
- c. Casing shall have 1-in of insulation between the outer cabinet and inner liner.
- d. Shall be tested and certified to ANSI standards to provide a minimum of 80% efficiency throughout the entire operating range as required by ASHRAE 90.1.

2. Burner:

- a. The burner assembly shall be an induced draft combustion type with direct spark ignition and redundant gas valves.
- b. Flame surveillance shall be with a solid state programmed flame relay with flame rod.
- c. The burner and gas train shall be in a cabinet enclosure. Insulation in the burner section shall be covered by a heat reflective galvanized steel liner.
- d. Unit shall be capable of the following turndown:
 - (1) 120-RTU-1: minimum 5:1 modulating.
 - (2) 120-RTU-2: minimum 10:1 modulating.
 - (3) 600-RTU-1: minimum 5:1 modulating.

G. Cooling System:

1. Shall suitable for mechanical cooling operation down to 50°.
2. Units shall have a minimum cooling turndown of 4:1.
3. Where applicable, multiple refrigeration circuits shall be separate from each other.
4. Refrigeration circuits shall be complete with liquid line filter-driers, and service ports fitted with Schraeder fittings.
5. The complete piping system shall be purged and pressure tested with dry nitrogen, then tested again under vacuum. Each system shall be factory run and adjusted prior to shipment.
6. Variable capacity compressor, digital scroll.
7. Condenser fan shall be of aluminum construction and provided with ECM fan motor.
8. Compressors shall have a minimum five year warranty.

H. Coils:

1. Coils shall be ½-in O.D. for DX, constructed of copper tube, aluminum fin, and copper headers.
2. Fins constructed of aluminum or copper shall be rippled for maximum heat transfer and shall be mechanically bonded to the tubes by mechanical expansion of the tubes.
3. Coils shall have a galvanized steel casing.
4. All coils shall be factory tested with air at 300-psig while immersed in an illuminated water tank.
5. Provide Polymer E-Coated, Heresite P-413, or equivalent coating system capable of passing a 10,000 hr salt spray test. A pure phenolic thermosetting resinous coating, to protect the coils against exposure to corrosive atmospheres. The process shall be accomplished by a multiple coat application of degreasing and etching, dipping and baking (four times), resulting in complete coating coverage of the fins, tubes, headers and casing. Air dried coatings are not acceptable.

I. Filters:

1. Filter sections shall be provided with adequately sized access doors to allow easy removal of filters.
2. For units with filter banks up to 72" (1825 mm) high, the filter modules shall be designed to slide out of the unit. Side removal 2-in filters shall slide into a formed metal track, sealing against metal spacers at each end of the track.
3. 2" Replaceable Media Filters: Disposable glass fiber media type enclosed in permanent galvanized metal frames with metal retainers on both sides.
4. When scheduled, provide 2" carbon filters to be installed in common rack downstream of replaceable filters.
 - a. Manufacturer
 - (1) Air filter incorporated or Equal
 - b. Suresorb bonded panel aluminum carbon filter.
 - c. 2-inch thickness and dimensions to match air handling unit.
 - d. Activated carbon media.

J. Heat Recovery: (120-RTU-2)

1. Enthalpy wheel capable of the sensible and latent capacities scheduled.
2. Meet the requirements of AHRI Standard 1060.
3. Rotor shall be constructed of alternating layers of flat and corrugated synthetic fibrous media and shall be fluted or formed honeycomb geometry to eliminate internal wheel bypass.
4. The rotor shall be constructed of alternating layers of flat and corrugated synthetic fibrous media and shall be fluted or formed honeycomb geometry so as to eliminate internal wheel bypass.
5. The wheel shall include a desiccant that is permanently bound and uniformly dispersed throughout the matrix. The desiccant material shall be a 4 angstrom or smaller molecular sieve to minimize cross contamination.
6. The wheel frames shall be evenly spaced steel spokes with a galvanized steel outer band and rigid center hub.
7. The wheel seals shall be full contact nylon brush type.
8. Wheel cassettes shall be constructed of galvanized steel and shall have an integral purge section.
9. Bearings shall be inboard mounted, permanently sealed roller type or externally flanged type. The wheel cassette shall slide out of the cabinet side for service.
10. Capable of defrost and bypass.
11. Outside and exhaust air streams include MERV 8 filter upstream of heat recovery.

I. Controls:

1. Local control panel with fan starters, overloads, variable frequency drives, compressor contactors, and control transformer.
2. Outside air temperature sensor for control of economizer.
3. Discharge air temperature sensor between DX and DX reheat coil to provide control of dehumidification.
4. Temperature controller designed to control cooling compressors, economizer, DX reheat, return and outside air dampers, and burner as required to maintain discharge air setpoint temperature received from Facilities Management System (FMS). Controller shall have low-limit (freezestat) controls to shut-down unit and send alarm on drop in supply air

temperature. Controller shall have functionality to meet the temperature control sequences specified in Section 23 09 23.

a. Controller shall be capable of receiving the following signals from FMS:

- 1) Supply fan start/stop.
- 2) Discharge air temperature setpoint.
- 3) Discharge air dew point set point.
- 4) Supply fan speed control.
- 5) Heat recovery bypass (if applicable).
- 6) Exhaust blower speed control (if applicable).

b. Controller shall be capable of outputting the following signals to the FMS:

- 1) Supply fan status (from proof of airflow).
- 2) Damper positions.
- 3) Percent of mechanical cooling energized.
- 4) Common alarm.
- 5) Gas valve position.
- 6) Freezstat shut-down.

5. Return and outside air damper actuators.
6. NEMA 4X disconnect switch in accordance with Division 26.
7. Low limit temperature sensor to shutdown unit when temperature downstream of heat exchanger falls below 39°F.

J. Accessories (Provide the following accessories as scheduled):

1. Motorized outside air and return air dampers.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF ROOFTOP UNITS

- A. General - Install rooftop heating and cooling units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- B. Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
- C. Verify that electrical wiring installation is in accordance with manufacturer's submittal. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.
- D. Ductwork Connect supply and return ducts to unit with flexible duct connections. Provide transitions to exactly match unit duct connection sizes.

3.03 START-UP

- A. Start-up units per manufacturer's written start-up instructions.

3.04 GROUNDING

- A. Provide positive equipment ground for rooftop unit components.

3.05 SPARE PARTS

- A. General - Furnish to Owner, with receipt, the following spare parts for each rooftop heating and cooling unit:
 - 1. 1 set of matched fan belts for each belt-driven fan.
 - 2. 2 sets of throwaway filters.
 - 3. 1 set of carbon filters.

3.06 TRAINING/START-UP SERVICES

- A. 1 work-day for Instructional Services.
- B. 1 work-day for Post Startup Services. This shall include equipment start-up and installation inspection.
- C. 1 work-day start-up/coordination services. These services shall be coordinated to be onsite at the same time as the FMS Contractor of Section 23 09 23 to review and test controls of systems and equipment.

END OF SECTION

SECTION 23 75 23
CUSTOM-PACKAGED OUTDOOR HEATING AND VENTILATING MAKE-UP AIR UNITS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. Drawings and General Requirements of Contract including General and Supplementary Conditions apply to Work of this Section.
- B. Extent of heating units work required by this section is indicated on drawings and schedules, and by requirements of this section.
 - 1. Direct fired makeup air units.

1.02 QUALITY ASSURANCE

- A. UL or ETL Compliance - Provide gas fired heating and ventilating units which are designed, manufactured, and tested in accordance with UL or ETL requirements.
- B. AGA Compliance - Construct gas-fired heating and ventilating units sections in accordance with AGA safety standards, and provide AGA label.

1.03 SUBMITTALS

- A. General:
 - 1. Submit Product Data in sufficient detail to confirm compliance with requirements of this Section. Submit Product Data and Shop Drawings in one complete submittal package. Partial submittals are unacceptable.
 - 2. Documentation demonstrating compliance with Spec. Section 00 30 80 regarding the use of American iron and steel in the products being furnished under this Section.
- B. Product Data:
 - 1. Catalog cuts and product specifications for equipment specified, including at a minimum:
 - a. Fan performance curves with scheduled operating point identified.
 - b. Total static pressure (TSP) calculations depicting all internal losses with scheduled external (ESP) losses.
 - c. Heating performance data.
 - d. Filter data.
 - e. Materials of construction and coatings provided.
 - f. List of accessories included with supporting product data.
 - 2. Motor product data submitted in accordance with Section 26 05 10.
- C. Shop Drawings:
 - 1. Installation and assembly drawings and specifically prepared technical data for equipment.
 - 2. Wiring Diagrams: Show power and control connections and distinguish between factory-installed and field-installed wiring.
 - 3. Equipment dimension, weights and recommended clearance requirements.
 - 4. Method of assembly of components.

5. Written functional description of controls furnished with equipment.
- D. Submit in accordance with Section 01 33 00.
- E. Operation and Maintenance (O&M) Data:
1. Operating instructions and maintenance data for materials and products for inclusion in O&M Manual.
 2. Manufacturer's written instructions for periodic tests of equipment in service.
 3. Parts list of equipment.
 4. Submit in accordance with Section 01 78 23.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Handle units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged units or components; replace with new.
- B. Store units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.
- C. Comply with Manufacturer's rigging and installation instructions for unloading units, and moving them to final location.

PART 2 - PRODUCTS

2.01 DIRECT FIRED AIR MAKE UP UNITS

- A. Manufacturer's:
1. Greenheck.
 2. Or Equal.
- B. General:
1. Factory assembled, piped and wired, gas make up air unit.
 2. Heating units shall be natural gas-fired approved for both sea level and high altitude areas.
 3. Entire package, including damper controls, fan controls, and all other miscellaneous controls and accessories shall be approved by an independent testing authority, and carry the approval label of that authority as a complete operating package.
 4. All units must exceed the ASHRAE 90.1 requirement of steady state efficiency at low fire.
 5. Operating natural gas pressure at unit(s) manifold shall be 14-inch w.c.. When inlet pressure exceeds 14 inch w.c., contractor shall provide and install appropriate pounds to inches regulator to provide constant gas pressure at the manifold inlet.
 6. Provide make-up air unit of scheduled heating capacities and airflows.
 7. All units shall be installed on factory supplied 14" high curbs on roof.
- C. Configuration:
1. Configuration orientation is from unit inlet toward unit discharge. Access and coil connection locations are right/left as viewed in the direction of airflow (air hitting the back of head).
 2. 125-MAU-1: 100% outside air intake hood, filter section with 2 inch washable aluminum filters, direct fired blower section, plenum fan section with end discharge, and discharge air damper. Right hand unit access, controls and gas piping connections. Unit with double wall insulated bottom, configured for installation on Manufacturer provided roof curb.

3. 600-MAU-1: 100% outside air intake hood, filter section with 2 inch washable aluminum filters, direct fired blower section, plenum fan section with vertical up down discharge. Right hand unit access, controls and gas piping connections. Unit with double wall insulated bottom, configured for installation on Manufacturer provided roof curb.

D. Housing Construction:

1. Unit casing shall be of minimum 18-gauge satin coat galvanized sheet metal.
2. All units shall be internally insulated with 1-in. thick 1-½ lb./cu.ft. density, neoprene coated fiberglass thermal insulation and 22-gauge liner.
3. Surfaces shall be cleaned with a degreasing solvent to remove oil and metal oxides and primed with a two part acid based etching primer.
4. Finish coat shall be Hi-pro polyester to all exposed surfaces inside and out. For outdoor units add UV topcoat to externally exposed metal. All unprotected metal and welds shall be factory coated.
5. All walls, roofs and floors shall be of formed construction, with at least two breaks at each joint. Joints shall be secured by sheet metal screws or pop rivets. Wall and floor joints shall be broken in and roof joints broken out (exposed) for rigidity. All joints shall be caulked with a water resistant sealant.
6. Units shall be provided with access doors to the following components: fans and motors; filters; dampers and operators; access plenums and electrical control panels; burner compartments. Access doors shall be large enough for easy access. Removal of screwed wall panels will not be acceptable.
7. Provide hinged access doors in welded steel frames. Doors shall be fully lined with closed cell bulb gasket and Leverlok handles. Units of sufficient size in which a person may enter shall have handles operable from each side.
8. Whenever possible, hinged access doors to areas of negative pressure shall open out, and to areas of positive pressure shall open in. Where space constrictions require the use of outward opening doors to an area of positive pressure, a clear warning label must be affixed.
9. Casings shall be supported on formed galvanized steel channel or structural channel supports, designed and welded for low deflections. Integral lifting lugs shall be provided for hoisting.
10. Units shall be provided in horizontal configuration unless otherwise noted and shall be provided with discharge orientation as scheduled.
11. Units scheduled to be provided with a roof curb shall be suitable for curb installation.

E. Air Dampers:

1. Provide inlet or discharge air dampers as scheduled.
2. Damper frames shall be u-shaped galvanized metal sections securely screwed or welded to the unit chassis.
3. Dampers shall be coated with same coating system as unit.
4. Pivot rods of ½-in. aluminum, shall turn in nylon or bronze bushings. Rods shall be secured to the blade by means of straps and set screws.
5. Blades shall be 18-gauge galvanized metal with two breaks on each edge and three breaks on centerline for rigidity.
6. Pivot rod shall "nest" in the centerline break.
7. Damper edges shall interlock.
8. Maximum length of damper between supports shall be 42-in.
9. Damper linkage brackets shall be constructed of galvanized metal.
10. Standard construction for all dampers includes blade ends sealed with an adhesive backed foam polyurethane gasketing. Outdoor air dampers shall also include an all-weather PVC seal, fastened with a positive lock grip and pliable overlap edge on entering air side of interlocking edges. Dampers shall be interlocked from the center.

11. Discharge damper shall be ultra-low leakage type with damper actuator located in a separate enclosure located out of the airstream.
12. Two position inlet dampers shall be parallel blade type.

F. Supply Blowers:

1. Centrifugal fans shall be rated in accordance with AMCA Standard Test Code, Bulletin 210. Fan manufacturer shall be a member of AMCA.
2. Unless indicated otherwise in equipment schedules, supply blowers shall be backward inclined or airfoil type.
3. All fans and fan assemblies shall be dynamically balanced during factory test run.
4. Fan shafts shall be solid ground and polished provided with a rust inhibiting coating. Fan wheels to be heresite coated with baked on heresite. Fan housing to be coated with 2-part epoxy coating.
5. Fan assemblies shall be equipped with greaseable pillow block bearings, with extended lube lines supported on a rigid structural steel frame. Wheel bearings shall be designed for at least 100,000 hours average life.
6. Drives:
 - a. Drives shall be V-belt type, designed for a service factor not less than 1.25. Furnish with matched set of reinforced rubber belts.
 - b. Shall be adjustable on fans with motors 5-hp or smaller.
 - c. On fans with larger motors, fixed drives shall be provided.
 - d. All steel or iron drive components shall be provided with a rust inhibiting coating.
 - e. The air balancer shall provide for drive changes (if required) during the air balance procedure.
7. Motor mounting shall be adjustable to allow for variations in belt tension.
8. Fan-motor assemblies shall be provided with vibration isolators. Isolators shall be bolted to steel channel welded to unit floor which is welded to the structural frame of the unit. The isolators shall be neoprene-in-shear type of single 9-in. to 15-in. forward curved fans. All other fans shall incorporate vertical spring type isolators with leveling bolts, bridge bearing waffled pads with minimum 1-in. static deflection designed to achieve high isolation efficiency.
9. Fans shall be attached to the discharge panel by a polyvinyl chloride coated polyester woven fabric, with a sealed double locking fabric to metal connection
10. Motor shall be TEFC meeting the requirements of Section 26 05 10.
11. Motors with VFD shall be inverter duty ready.
12. Motors over 3hp and served by a VFD shall have shaft grounding.

G. Heating Section

1. Direct fired natural gas.
2. Burner assembly shall be capable of modulating turn down ratio of 25:1.
3. Units scheduled to be operated at differing flow rates shall be provided with a modulating burner damper to ensure proper burner velocities at all operating airflow conditions.
4. The assembly shall be constructed in a draw through arrangement. Outside air is drawn across the burner section at a constant velocity, within the allowable limits of the burner design.
5. Burner manifold shall be of aluminum construction with 400 series stainless steel mixing plates.
6. All burner combustion air openings shall be located in stainless steel burner plates to maintain design combustion air requirements at all inputs.

7. Designed to burn natural gas below the maximum non-contaminating levels required by OSHA and the ACGIH.
8. Service of and access to the burner igniter and flame rod shall be accomplished through an access door or panel.
9. Burner controls to comply with AGA regulations.
10. Burner assembly and piping to include modulating flow ration valve, fail-safe shut off valve(s), main and pilot pressure regulators, manual shut off valves and electric pilot valve. Flame surveillance shall be with a solid state programmed flame relay complete with flame rod.
11. Unit shall be capable of operating as inlet gas pressures of 11-14 in. w.c.
12. Gas train must be designed to comply with ANSI - Z83.4 and FM.
13. The gas train shall be in a cabinet enclosure.
14. Provide units with following accessories:
 - a. High gas pressure switch.
 - b. Low gas pressure switch.
 - c. Flame rod flame sensing device.

H. Filters:

1. Comply with NFPA 90A. Filter sections shall be provided with adequately sized access doors to allow easy removal of filters.
2. For units with filter banks up to 72" high, the filter modules shall be designed to slide out of the unit. Side removal 2-in filters shall slide into a formed metal track, sealing against metal spacers at each end of the track.
3. Two inch thick throwaway filters.

I. Controls:

1. Control panel and control transformer.
2. Discharge air temperature control with external reset. Controller shall be BACnet IP compatible and coordinated with Section 23 09 23 to allow for component interface and communication. Furnish with discharge air temperature sensor.
3. NEMA 4X disconnect switch.
4. High ambient lock-out switch to lock out burner controls when outside air temperature exceeds set-point (adjustable from 45°-65°F).
5. Air proving switch.
6. Low fire start.
7. Electronic flame supervision.
8. Main gas automatic safety shut-off valve.
9. High temperature limit control.
10. Low limit/freezestat control wired to stop unit and initiate freezestat alarm signal when discharge air temperature falls below adjustable setpoint of 35°F. Provide 3-minute time delay on alarm circuit.
11. Spark or hot surface ignited pilot.
12. Blower motor starter and overloads.
13. Damper contact that allows fan to energize after damper opens, damper to close after fan stops and on flame failure.
14. Auxiliary contacts for interlocked exhaust fans.
15. Circuit analyzer indication lights in unit mounted control panel.
16. Non-recycling auto by-pass low limit that has built-in sensor checking.
17. Control sequences shall be in accordance with Section 23 09 23.
18. Units shall be provided with VFD for soft start and air balancing purposes only.
19. Specific Controls:
 - a. 125-MAU-1, 600-MAU-1:

- 1) Units shall be provided with an integral microprocessor capable of monitoring and control using a BACNet IP protocol.
- 2) The following signals shall be capable of being controlled:
 - (a) Supply fan start/stop.
 - (b) Discharge air temperature setpoint.
 - (c) Burner permissive signal.
- 3) The following signals shall be capable of being transmitted to the FMS:
 - (a) Low limit/freezestat alarm condition.
 - (b) Burner percent fire.
 - (c) Common alarm.
 - (d) Discharge air temperature.

B. Accessories. Provide units with following accessories, when scheduled with equipment:

1. Outdoor air hood: Provide aluminum rain hood with aluminum bird screen and finish matching cabinet and sized to supply 100 percent outside air.
2. Roof Curb: Provide minimum 14-inch tall, aluminum roof curb with rigid, foil lined insulation.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions under which units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION

- A. General - Install units in accordance with manufacturer's installation instructions, in accordance with local mechanical codes and as indicated on Plans. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- B. Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
- C. Verify that electrical wiring installation is in accordance with manufacturer's submittal. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.
- D. Ductwork: Connect supply and return ducts to unit with flexible duct connections. Provide transitions to exactly match unit duct connection sizes.
- E. Gas Piping - Refer to Section 23 11 23. Connect gas piping to unit gas train with union, shut-off cock and drip leg.

3.03 GROUNDING

- A. Provide positive equipment ground for all units.

3.04 IDENTIFICATION

- A. Provide equipment identification marker complete with equipment name and tag number in

accordance with Section 40 05 10. Coordinate field location with Engineer.

3.05 START-UP

- A. Engage a factory-authorized service representative to perform start-up service.
- B. Start-up units per manufacturer's written start-up instructions
- C. Remove and replace malfunctioning components that do not pass tests and inspections and retest as specified above.

3.06 FIELD QUALITY CONTROL

A. Manufacturer's Field Services:

- 1. Supplier's or manufacturer's representative for equipment specified herein shall be present at jobsite or classroom designated by Owner for work-days indicated, travel time excluded, for assistance during plant construction, plant startup, and training of Owner's personnel for plant operation. Include:
 - a. 1/2 work-day for Instructional Services.
 - b. 1/2 work-day for Post Startup Services. This shall include equipment start-up and installation inspection.
 - c. 1/2 work-day start-up/coordination services. These services shall be coordinated to be onsite at the same time as the FMS Contractor of Section 23 09 23 to review and test controls of systems and equipment.
- 2. Supplier or manufacturer shall direct services to system and equipment operation, maintenance, troubleshooting, and equipment and system-related areas other than wastewater treatment process. See Section 01 78 23.
- 3. In addition to the services specified above, provide manufacturer's services as required to successfully complete systems demonstration as specified in Section 01 79 10.

END OF SECTION

SECTION 23 81 29
VARIABLE REFRIGERANT FLOW HVAC SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Outdoor Units.
2. Indoor Branch Controllers.
3. Indoor Cassette Fan Coil.
4. Indoor Ducted Fan Coil.

1.02 SUBMITTALS

A. Product Data:

1. Submit manufacturer's technical product data including rated capacities of selected model indicated, weights (shipping, installed, and operating), furnished specialties and accessories; and installation and startup instructions.
2. Motors: submit in accordance with requirements of Division 26.

B. Shop Drawings:

1. Submit manufacturer's assembly type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.
2. Piping Diagrams:
 - a. All refrigerant pipe sizes and lengths with connection diagram.
3. Wiring Diagrams:
 - a. Manufacturer's electrical requirements for power supply wiring to terminal units.
 - b. Ladder type wiring diagrams for interlock and control wiring. Differentiate between portions of wiring factory-installed and portions to be field-installed.

C. Operation and Maintenance (O&M) Data:

1. Maintenance instructions including lubrication instructions, control motor and drive replacement, and spare parts lists.

D. Submit in accordance with Section 01 30 00.

E. Information submitted by Contractor, but not designated to be submitted will be returned without action by Engineer.

1.03 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of condensing units of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 yrs.

B. Regulatory Requirements:

1. ARI Compliance: Provide capacity ratings for condensing units in accordance with ARI 360.
2. ASHRAE Compliance: Construct refrigerating system of condensing units in accordance with ASHRAE 15.
3. UL or ETL Compliance: Provide condensing units UL or ETL listed and having listing agency label affixed.
4. NRTL compliance: providing unit tested by a Nationally Recognized Testing Laboratory and in accordance with ANSI/UL 1995
5. NEC compliance: all wiring shall be in accordance with National Electric Code.
6. ASCE 7-2002 design compliance.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Handle condensing units and components to prevent damage, breaking, denting, and scoring. Do not install damaged condensing units or components; replace with new.
- B. Store condensing units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.
- C. Rig condensing units to final location under supervision of manufacturer's representative, who shall approve entire rigging operation.

PART 2 - PRODUCTS

2.01 OUTDOOR UNITS (900-ODU-1,-2, -3, -4)

- A. Manufacturers:
 1. Mitsubishi, R2-Series Hyper Heating
 2. Or Equal
- B. General: The condensing unit is designed specifically for use with Variable Refrigerant Flow Systems.
 1. The condensing unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of an inverter driven scroll hermetic compressor, motors, fans, condenser coil, electronic expansion valves, control valves, distribution headers, capillaries, filters, shut off valves, oil separators, service ports, and refrigerant regulator.
 2. All refrigerant piping must be individually insulated between the condensing and indoor units.
 3. Connection capacity ratio of indoor units to condensing unit shall be permitted up to 130% with submission of calculation showing non-concurrent load diversity justifies over allocation of equipment.
 4. Each condensing system shall be able to support the quantity of connected indoor units.
 5. The outdoor unit shall have a sound rating of no higher than 61 dB at a location 3'-0" from the equipment.
 6. The outdoor unit shall operate with a height difference of at least 30 feet.
 7. The outdoor unit shall have rated performance of heating operation at -13°F ambient temperatures and cooling mode down to 23°F ambient temperatures, without additional low ambient controls. The unit shall maintain 100% heat output at 0°F without a supplemental heat source or a second compressor to boost low ambient heating performance.
 8. The condensing unit shall be modular in design and should allow for side-by-side installation with minimum spacing.

9. The following safety devices shall be included on the condensing unit; high pressure sensor and switch, low pressure sensor, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter.
10. Unit must defrost all circuits simultaneously in order to resume full heating more quickly. Partial defrost which may extend "no or reduced heating" periods shall not be allowed.
11. System shall operate on R410A refrigerant.

C. Unit Cabinet:

1. The condensing unit shall be completely weatherproof and corrosion resistant.
2. The casing(s) shall be fabricated of galvanized steel, bonderized and finished.
3. Maximum dimensions of 29-inch wide by 97-inch long.

D. Heat Exchanger Circuit:

1. The outdoor unit shall contain a heat interchanger circuit for sub-cooling liquid prior to entering the outdoor coil during the heating mode.
2. The interchanger shall be of a copper tube within a tube construction.
3. The interchanger circuit refrigerant flow shall be controlled by an electronic expansion valve.

E. Compressor:

1. Inverter driven scroll hermetic compressors with variable capacity.
2. The capacity control range shall be 6% to 100% in heating mode and 12% to 100% in cooling mode.
3. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, overcurrent protection, and internal thermal overload protector.
4. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.
5. The compressor shall be mounted to avoid the transmission of vibration.

F. Fan:

1. Each outdoor unit module shall be furnished with one direct drive, variable speed propeller type fan. The fan shall be factory set for operation under 0 in. WG external static pressure, but capable of normal operation under a maximum of 0.24 in. WG external static pressure via dipswitch.
2. All fan motors shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.
3. All fan motors shall be mounted for quiet operation.
4. All fans shall be provided with a raised guard to prevent contact with moving parts.
5. The outdoor unit shall have vertical discharge airflow.

G. Coil:

1. The outdoor coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.
2. The coil fins shall have a factory applied corrosion resistant blue-fin finish.
3. The coil shall be protected with an integral metal guard.
4. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.
5. The outdoor coil shall include 4 circuits with two position valves for each circuit, except for the last stage.

H. Basepan Heater:

1. Each outdoor unit module shall be equipped with a basepan heater. Basepan heater shall activate only when compressor is operating in heating mode at an outdoor ambient temperature of 39F or below.

I. Controls

1. Each outdoor unit shall have an accumulator with refrigerant level sensors and controls.
2. The outdoor unit shall have a high pressure safety switch, over-current protection, crankcase heater and DC bus protection.
3. Compressors shall be controlled by integral microprocessors. Compressors shall modulate as required to heat and cool the spaces served by the VRF system.
4. Compressors shall alternate lead/lag on a weekly basis.

J. Electrical:

1. The power supply to the condensing unit shall be 460 volts, 3 phase, 60 hertz.
2. NEMA 4X disconnect switch in accordance with Division 26 requirements.
3. The control circuit between the indoor units, BC Controller and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

K. Accessories:

1. Outdoor units shall be provided with twinning kits to be installed in field to combine the output of two units.

2.02 INDOOR BRANCH CONTROLLERS (900-BC-1,-2)

A. Manufacturers:

1. Mitsubishi
2. Or Equal

B. General: The branch controller boxes are designed specifically for use with variable refrigerant flow system heat recovery system components.

1. Branch selector boxes shall be factory assembled, wired, and piped.
2. Suitable for use with R410A.
3. Simultaneous heating and cooling by allowing either hot gas refrigerant to flow to indoor unit(s) for heating or subcooled liquid refrigerant to flow to indoor unit(s) for cooling
4. Controlled by integral microprocessors.
5. Branch selector controllers must be run tested at the factory.
6. The control circuit between the indoor units and outdoor units shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.
7. The unit electrical power shall be 208/230 volts, 1 phase, and 60 hertz.

C. Unit Cabinet:

1. The casing shall be fabricated of galvanized steel.
2. Each cabinet shall house a liquid-gas separator and multiple refrigeration control valves.

3. The unit shall house two tube-in-tube heat exchangers.

D. Refrigerant Valves:

1. Each branch shall have multiple two-position valves to control refrigerant flow.
2. Service shut-off valves shall be field-provided/installed for each branch to allow service to any indoor unit without field interruption to overall system operation.
3. Linear electronic expansion valves shall be used to control the variable refrigerant flow.
4. The refrigerant connections must be of the brazed or flared type and all refrigerant lines shall be insulated from the condensing unit.

E. Integral Drain Pan:

1. An integral resin drain pan and drain shall be provided

F. Future Use:

1. Each VRF system shall include at least one (1) unused branches or branch devices for future use. Branches shall be fully installed & wired in central location with capped service shutoff valve & service port.

G. Controls:

1. Branch controller shall control refrigerant flow as required for fan coils and outdoor units to operate.

2.03 INDOOR 4-WAY FAN COIL UNITS: (900-FC-5,8,9,12,14)

A. Manufacturers:

1. Mitsubishi
2. Or Equal

B. General: Ceiling cassette fan coil unit, operable with R-410A refrigerant, equipped with an electronic modulating linear expansion device, for installation into the ceiling cavity equipped with an air panel grill.

C. Provide units with four-way air distribution type, white, impact resistant with a washable decoration panel. The cabinet shall be a compact 22-7/16" wide x 22-7/16" deep so it will fit within a standard 24" square suspended ceiling grid.

D. The indoor unit's sound pressure shall not exceed levels scheduled.

E. Indoor Unit:

1. Units shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.
2. All refrigerant lines shall be insulated from the outdoor unit.
3. Units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 21" of lift and has a built in safety shutoff and alarm.

4. Units shall be equipped with a return air thermistor and all electrical components are reached through the decoration panel, which reduces the required side service access.

F. Unit Cabinet:

1. The cabinet shall be located into the ceiling.
2. Provide opening for fresh air intake duct installation to the side of the unit cabinet.
3. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

G. Fan:

1. The fan shall be direct-drive turbo fan type with statically and dynamically balanced impeller with high, medium and low fan speeds available.
2. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range from 0.06 to 0.12 HP.
3. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
4. The fan motor shall be thermally protected.
5. The auto air swing vanes shall be capable of automatically swinging up and down for uniform air distribution.
6. The indoor unit shall have an adjustable air outlet system offering 4-way airflow, 3-way airflow, or 2-way airflow.

H. Filter:

1. The return air shall be filtered by means of a washable long-life filter with mildew proof resin.

I. Coil:

1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
2. The tubing shall have inner grooves for high efficiency heat exchange.
3. All tube joints shall be brazed with phos-copper or silver alloy.
4. The coils shall be pressure tested at the factory.
5. A condensate pan and drain shall be provided under the coil.
6. The unit shall be provided with an integral condensate lift mechanism that will be able to raise drain water 19-3/4" inches above the condensate pan.
7. Both refrigerant lines to the PLFY indoor units shall be insulated in accordance with the installation manual.

J. Control:

1. The unit shall have controls provided to perform functions necessary to operate the system.
2. Units shall respond to space temperature to heat and cool as required to maintain the space temperature setpoint.
3. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function and a test run switch.

K. Accessories:

1. Ducted supply fresh air intake kit. Duct to unit as shown on Plans.
2. Condensate Pump.

3. Temperature sensor with local temperature control, digital display, and occupancy override for each fan coil unit.

2.04 INDOOR DUCTED FAN COIL UNITS: (900-FC-1,-2,-3,-4,-6,-7,-10,-11,-13,-15,-16)

A. Manufacturers:

1. Mitsubishi
2. Or Equal

A. General: indoor units shall be a built-in ceiling concealed fan coil unit, operable with refrigerant R-410A, equipped with modulating linear expansion device, direct-drive DC (ECM) type fan with auto CFM adjustment at commissioning, for installation into the ceiling cavity.

B. Units shall be a horizontal discharge air with horizontal return air configuration.

C. The indoor unit's sound pressure shall not exceed levels scheduled on Plans.

D. Indoor Unit:

1. Units shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall be equipment with automatically adjusting external static pressure logic selectable during commissioning.
2. All refrigerant lines shall be insulated from the outdoor unit.
3. Units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 19-3/4" of lift from the center of the drain outlet.

G. Unit Cabinet:

1. Constructed of a galvanized steel casing.
2. The cabinet shall be located into the ceiling and ducted to the supply and return openings.
3. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

H. Fan:

1. The fan shall be direct-drive DC (ECM) type fan, statically and dynamically balanced impeller with three fan speeds available.
2. The unit shall be equipment with automatically adjusting external static pressure logic selectable during commissioning.
3. The fan motor shall operate on 208/230 volts, 1 phase, 60.
4. The fan motor shall be thermally protected.
5. The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings.

I. Coil:

1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
2. The tubing shall have inner grooves for high efficiency heat exchange.
3. All tube joints shall be brazed with phos-copper or silver alloy.
4. The coils shall be pressure tested at the factory.
5. A condensate pan and drain shall be provided under the coil.

6. The condensate shall be gravity drained from the fan coil.

J. Control:

1. The unit shall have controls provided to perform functions necessary to operate the system.
2. Units shall respond to space temperature to heat and cool as required to maintain the space temperature setpoint.

K. Accessories:

1. Return air filter box and filter where shown on Plans.
2. Condensate pump.
3. Temperature sensor with local temperature control, digital display, and occupancy override for each fan coil unit.

2.04 BACNET INTERFACE

A. Manufacturers:

1. Mitsubishi
2. Or Equal.

B. Compatible with fan coil units, branch controllers, and outdoor units.

C. Capable of controlling the complete VRF system with monitoring and control through a BACnet IP interface

D. BACnet interface for monitoring and control. Interface shall allow:

1. Operation, configuring, and monitoring of:
 - a. Individual indoor unit On/Off.
 - b. Individual indoor unit setpoint setting.
 - c. Individual indoor unit remote controller permit/prohibit.
 - d. Forced system stop.
 - e. Energy saving mode (reduction in setpoint for cooling and increase in setpoint for heating).
 - f. Individual indoor unit fan speed.
2. Monitoring of:
 - a. Individual indoor unit On/Off status.
 - b. Individual indoor unit alarms.
 - c. Individual indoor unit operating mode.
 - d. Individual indoor unit filter status.
 - e. Individual indoor unit zone temperature.
 - f. Individual indoor unit fan status.
 - g. Individual indoor unit heat/cool status.
 - h. Outdoor unit compressor status.

E. Capable of control sequence as described in 23 09 23.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions under which condensing units to be installed. Do not proceed with Work until unsatisfactory conditions corrected.

3.02 INSTALLATION

- A. Install outdoor units, fan coils, and branch controllers in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated or recommended and maintain manufacturer's recommended clearances.
- B. Install electrical devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
- C. Verify that electrical wiring installation is in accordance with manufacturer's submittal. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.
- D. Support:
 - 1. Install outdoor units on concrete pad meeting the requirements of the Manufacturer. Provide all support and fastener and install indoor units per manufacturer recommendation.
 - 2. All indoor ceiling mounted units shall be independently supported by the roof structure, not supported by suspended ceiling system.
- E. Electrical: Furnish electrical field-wiring diagrams for power wiring to outdoor condensing units, indoor concealed units and control wiring for field-mounted controls.
- F. Condensing units: Connect refrigerant piping to indoor units as shown on plan and per manufacturer's recommendation, provide for all refrigerant piping insulation per Section 23 07 00.
- G. Refer to Section 23 23 00 for refrigerant piping.
- H. Provide condensate drain connections.
 - 1. Install field-mounted accessories.
 - a. Provide PVC condensate drain piping and slope pipe per manufacturer recommendation
 - b. Condensate drain piping discharge to be routed to nearest hub drain and as shown on plans
 - c. Insulate all condensate piping in accordance with specification 23 07 00.

3.03 START-UP

- A. Start-up units per manufacturer's written start-up instructions.
- B. Test controls and demonstrate compliance with requirements.
- C. Replace damaged or malfunctioning controls and equipment.

3.04 GROUNDING

- A. Provide positive equipment ground for outdoor units and per manufacturer's recommendation.

3.05 SPARE PARTS

- A. General- Furnish to Owner, with receipt, the following spare parts:
 - 1. 1 set of filters for each unit requiring filters.

3.06 FIELD QUALITY CONTROL

A. Manufacturer's Field Services:

1. Supplier's or manufacturer's representative for equipment specified herein shall be present at jobsite or classroom designated by Owner for minimum workdays indicated, travel time excluded, for assistance during equipment startup, and training of Owner's personnel for equipment operation. Include:
 - a. 3 workdays for start-up/Installation inspection services.
 - b. 3 workdays for training session for Owner's personnel. Training schedule shall be approved by Owner.
 - c. 1 workday for coordination with BMS Contractor to be onsite at the same time to confirm specified interface and controls are functioning properly.

END OF SECTION

SECTION 23 82 00
CONVECTION HEATING AND COOLING UNITS

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

- A. Drawings and General Requirements of Contract including General and Supplementary Conditions apply to Work of this Section.
- B. Extent of hot water heating units work required by this section is indicated on drawings and schedules, and by requirements of this section.

1.02 QUALITY ASSURANCE

- A. UL or ETL Compliance - Provide units which are designed, manufactured, and tested in accordance with UL or ETL requirements.

1.03 SUBMITTALS

- A. Product Data - Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, weights, furnished specialties and accessories, electrical components and installation and start-up instructions.
- B. Shop Drawings - Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.
- C. Wiring Diagrams - Submit manufacturer's electrical requirements for power supply wiring for gas-fired heating and ventilating units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- D. Submit in accordance with Section 01 33 00.
- E. Maintenance Data - Submit maintenance data and parts list for each unit, control, and accessory; including "trouble-shooting" maintenance guide. Submit these data and product data in maintenance manual in accordance with Section 01 78 23.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Handle units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged units or components; replace with new.
- B. Store units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.
- C. Comply with Manufacturer's rigging and installation instructions for unloading units, and moving them to final location.

PART 2 - PRODUCTS

2.01 HOT WATER UNIT HEATERS

- A. Manufacturers:

1. Sterling.
 2. Trane.
 3. Or equal.
- B. Type: Propeller type indoor suspended, hot water unit heater.
- C. Construction: Unless otherwise scheduled, unit casing shall be constructed of heavy gauge galvanized steel with electrostatically applied epoxy powder coating.
- D. Coils: Copper tube with aluminum fins, tested at 350-psi. Coils shall be provided with heresite coating.
- E. Fans: Fan shall be of aluminum construction, dynamically and statically at factory, and provided with heavy duty fan guard. Provide with motors in accordance with Division 26. Provide TEFC motors.

2.02 HOT WATER BASEBOARD HEATER

- A. Manufacturers:
1. Sterling
 2. Or equal.
- B. The finned tube enclosure manufactured from 18-gauge bonderized steel with a baked powder prime finish.
- C. The air discharge louvers are to be die formed stamped into the steel enclosure. The louver openings are to be "Pencil Proof".
- D. All lateral bends are to be formed on bottoming dies to ensure continuity of all adjoining enclosures and accessories.
- E. Copper/Aluminum elements are to be provided with one end mechanically swaged (flared) for proper assembly. Steel/Steel element are to be provided with both ends threaded to accept all domestic NPT fittings or cut square and chamfered for field welding.

2.03 RADIANT PANELS

- A. Manufacturers:
1. Airtex
 2. Or equal.
- B. Modular style panel configured to mount within an acoustical ceiling system framework.
- C. Furnish with scheduled heating capacity.
- D. Construction:
1. Aluminum face plate, minimum 0.04-inch thickness.
 2. Nominal ½-inch copper tube heating elements with minimum 6-pass serpentine coil, metallurgically bonded to face plate.
 3. No grater then 1.5-pounds per square foot unit weight.
 4. Silkscreen finish to match ceiling tiles.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF HOT WATER HEATING UNITS

- A. General - Install units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- B. Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
- C. Verify that electrical wiring installation is in accordance with manufacturer's submittal. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.
- D. Ductwork Connect supply and return ducts to unit with flexible duct connections. Provide transitions to exactly match unit duct connection sizes.

3.03 START-UP

- A. Start-up units per manufacturer's written start-up instructions.

3.04 GROUNDING

- A. Provide positive equipment ground for air handling unit components.

END OF SECTION

SECTION 23 82 40
ELECTRIC HEATING TERMINALS

PART 1 – GENERAL

1.01 SUMMARY

- A. This section identifies electric heating terminals and all associated controls and accessories to be furnished and installed as shown on HVAC drawings and schedules and as specified herein. Electric heating terminals required for this project include:
 - 1. Electric Wall Heaters.
- B. The following is not work of this section, refer to Division 26.
 - 1. Power supply wiring from power source to power connection on electric heaters. All components required to make a complete installation shall be provided, including but not limited to starters, disconnects and required electrical devices. Electrical equipment specified to be furnished or factory installed by manufacturer shall be provided under this section.
- C. Control and interlock wiring between electric heaters and field installed devices is work of this section. All wiring shall be installed in accordance with Division 26.

1.02 SUBMITTALS

- A. Product Data - Submit manufacturer's technical data for electric heating terminals. Include in submittal, specifications, capacity ratings, dimensions, weights, materials, accessories furnished, and installation instructions.
- B. Shop Drawings - Submit assembly-type shop drawings showing unit dimensions, construction details, methods of assembly of components, and field connection details.
- C. Controls - Submit manufacturers technical data for all factory wired control devices
- D. Wiring Diagrams - Submit manufacturer's electrical requirements for power supply wiring to equipment. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- E. Maintenance Data - Submit maintenance data and parts list for piece of scheduled equipment, accessory, and control. Include this data and product data in maintenance manual in accordance with requirements of Section 01 78 23.
- F. Submit in accordance with Section 01 33 00.

1.03 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: electric heating terminals from firms regularly engaged in manufacture of same types and sizes of equipment required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Regulatory Requirements:
 - 1. NFPA Compliance - Comply with applicable requirements of NFPA pertaining to installation of space heating equipment. Comply with applicable requirements of NFPA 90A pertaining to installation of ac systems.

2. UL Compliance - Provide electric heating terminals which are designed, manufactured, and tested in accordance with UL 1042. Provide heating terminals that are UL listed and labeled.

PART 2 – PRODUCTS

2.01 PROPELLER ELECTRIC UNIT HEATERS

- A. Manufacturers:
 1. Reznor, Model EHL.
 2. Berko.
 3. Ruffneck
 4. Or equal.
- B. Type: Recessed electric wall heater.
- C. Construction: 20 gauge steel cabinet and 22 gauge steel front cover.
- D. Heating Element: Durable tubular heating element with fins.
- E. Controls: Provide the following control devices prewired to unit.
 1. Built in thermostat and fan control

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions under which equipment is to be installed. Do not proceed with installation until unsatisfactory conditions are corrected.

3.02 GENERAL

- A. Install all equipment in accordance with manufacturer's installation instructions, industry standards, Illinois Mechanical Code and as indicated in this section and on the Drawings.
- B. Coordinate equipment installation locations with other disciplines to avoid conflicts.
- C. Coordinate installation with electrical work for power wiring to each piece of powered equipment.

3.03 INSTALLATION

- A. Electric Wall Heaters:
 1. Install electric unit heaters in accordance with applicable installation requirements of NEC and NECA's "Standard of Installation".
 2. Touch up scratched or marred enclosure surfaces to match original finishes.
 3. Install in accordance with manufacturers instructions.
 4. Clean dust and debris from unit heaters as installed to ensure cleanliness.

3.04 FIELD QUALITY CONTROL

- A. Upon completion of installation, start-up and test each electric heating terminal and control devices to demonstrate capabilities and compliance with requirements.

B. Where possible, field correct malfunctioning units then retest to demonstrate compliance.

END SECTION

DIVISION 26
ELECTRICAL

SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Building wires and cables and associated splices, connectors, and terminations for wiring systems rated 600 volts and less.

1.02 DEFINITIONS

A. Underfloor Conduits.

1. Conduits run underground within perimeter of building walls under building floor. This may consist of 1 conduit, or several conduits grouped together.

B. Duct Bank Conduits

1. Conduits run underground outside perimeter of building walls. This may consist of 1 conduit, or several conduits grouped together.

C. Underground Conduits

1. Underground conduits are both underfloor conduits and duct bank conduits.

1.03 QUALITY ASSURANCE

A. Items provided under this Section shall be listed or labeled by Underwriters Laboratories, Inc. (UL) or other Nationally Recognized Testing Laboratory (NRTL).

1. Term "NRTL" shall be as defined in Occupational Safety and Health Administration (OSHA) Regulation 1910.7.
2. Terms "listed" and "labeled" shall be as defined in National Electrical Code, Article 100.

B. Regulatory Requirements:

1. National Electrical Code (NEC): Components and installation shall comply with National Fire Protection Association (NFPA) 70.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver wire and cable according to National Electrical Manufacturers Association (NEMA) WC 26.

PART 2 – PRODUCTS

2.01 BUILDING WIRES AND CABLES

A. UL-listed building wires and cables with conductor material, insulation type, cable construction, and rating as required to meet application and NEC requirements.

B. Wire and cable for 600 volts and below: Soft drawn, copper wire with 600 volt insulation.

1. Conductors:
 - a. Annealed, copper in accordance with American Society for Testing and Materials (ASTM) B33.
 - b. Stranding: Class B in accordance with ASTM B8.
2. Insulations and Coverings:
 - a. Rubber: Conform to NEMA WC 3.
 - b. Thermoplastic: Conform to NEMA WC 5.
 - c. Cross-Linked Polyethylene: Conform to NEMA WC 7.
 - d. Ethylene Propylene Rubber: Conform to NEMA WC 8.
- C. Feeders, service conductors, motor feeders, and Variable Frequency Drive (VFD) feeders: Single conductor Type XHHW-2.
- D. Branch Circuits:
 1. Single Conductor Type THHN/THWN (90 degrees Celsius): Above ground and underfloor conduits.
 2. Single Conductor Type XHHW-2: Duct bank conduit.
 3. No. 12 American Wire Gauge (AWG) minimum size (unless otherwise noted) for branch circuit wiring, including motor circuits.
 4. Size 120 volt branch circuits for length of run on following basis.
 - a. 0 to 50 feet Run From Panelboard to first outlet: No. 12 AWG minimum.
 - b. 51 to 100 feet Run: Increase one wire size, i.e., No. 12 AWG becomes No. 10 AWG.
 - c. 101 to 150 feet Run: Increase two wire sizes, i.e., No. 12 AWG becomes No. 8 AWG.
 - d. 151 feet and above: Wiring sized for 3% maximum voltage drop.
 5. For other branch circuits, voltage drop for branch circuits and feeder circuit combined shall not exceed requirements of the NEC 215.
- E. Control Circuits:
 1. Single conductor Type THHN/THWN (90 degrees Celsius): Above ground and underfloor conduits.
 2. No. 14 AWG minimum size (unless otherwise noted).
 3. Multi-wire cable assembly: Duct bank conduits.
- F. Non-shielded Instrumentation, Graphic Indication, and Other Control Wiring Operating at Less Than 120 volt: No. 14 AWG except as otherwise indicated with same insulation as control circuits.
 1. Single conductor Type THHW/THWN (90 degrees Celsius), above ground and underfloor conduits.
 2. Multi-wire cable assembly: Duct bank conduits.
- G. Shielded instrumentation wiring, above ground and underfloor conduits:
 1. Polyvinyl Chloride (PVC) insulation, tinned copper (19 by 29) stranded, No. 16 AWG, twisted pair or triplet cabled with aluminum mylar shielding, stranded, tinned, No. 18 AWG copper drain wire, and overall black FR-PVC, 90 degrees C, 600 volt jacket.
 2. Multi-wire cable assembly: duct bank conduits.
- H. Telephone Wire, above ground conduits:

1. Vinyl insulation, tinned copper, solid twisted pair, cabled conductors, and silver gray vinyl jacket.
 - a. Up to 4 conductors per cable: 22 AWG solid wire.
 - b. Over 4 conductors per cable: 24 AWG solid wire.

- I. Fire Alarm Circuits: In accordance with Section 28 46 00.

- J. Multi-Wire Control and Instrumentation Cable Assemblies:
 1. Multi-conductor, color-coded cable with number and size of conductors indicated.
 2. Where spare conductors are not indicated provide 10% spare conductors. One pair minimum.
 3. Control and non-shielded instrumentation.
 - a. Bare soft stranded No. 14 or 12 AWG copper in accordance with ASTM B3.
 - b. Class B stranded in accordance with ASTM B8.
 - c. Type THWN insulation also meeting requirements of NEMA WC-5 with armor-nylon in accordance with UL 83-THHN/THWN (90 degrees Celsius).
 - d. Color coded in accordance with NEMA WC-5 Method I Table K-2.
 - e. Cabled with suitable fillers.
 - f. Overall black FR-PVC, 90 degrees Celsius, 600 volt sunlight resistant jacket.
 - g. UL listed for installation in cable trays in accordance with NEC Art. 318, Class I, Division 2 hazardous areas and in accordance with NEC 340 and for direct burial.

 4. Shielded Instrumentation:
 - a. Bare soft stranded No. 16 AWG copper in accordance with ASTM B3.
 - b. Class B stranded tinned copper in accordance with ASTM B8.
 - c. PVC with nylon armor insulation.
 - d. Twisted pairs color coded in accordance with NEMA WC-5 Method I Table K-2, and numbered.
 - e. Individual and overall aluminum mylar shields and seven strand tinned copper drain wires.
 - f. Overall black FR-PVC 90 degrees C 600 volt sunlight resistant jacket.
 - g. UL listed for installation in cable trays in accordance with NEC 318, Class I, Division 2 hazardous areas in accordance with NEC 340 and for direct burial.

2.02 CONNECTORS AND SPLICES

- A. UL-listed factory-fabricated wiring connectors of size, ampacity rating, material, and type and class for application and for service indicated.

- B. Select to comply with Project's installation requirements and as required to meet application.

- C. Conductors No. 10 AWG and Smaller: 3M Electric Products, Skotchlok, or equal pre insulated spring connector. Comply with manufacturer's packaging requirements for number, size, and combination of conductors.

- D. Conductors No. 8 AWG and Larger: Bronze 2-bolt type connectors with spacer.

2.03 TERMINATIONS

- A. Power Conductors: Compression crimp type lugs.

- B. Control and Instrumentation Conductors: Compression crimp type fork tongue, insulated support type lugs on terminal strips. Do not splice.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Install wires and cables as indicated, according to manufacturer's written instructions and National Electrical Contractors Association (NECA) "Standard of Installation".
- B. Remove existing wire from raceway before pulling in new wire and cable.
- C. Run wire and cable in conduit unless otherwise indicated on Drawings. Pull conductors into raceway simultaneously where more than 1 is being installed in same raceway.
 - 1. Use pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation.
 - 2. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
 - 3. Do not draw conductor into conduits until building is enclosed, watertight, and work causing cable damage has been completed.
- D. Install cable supports for vertical feeders in accordance with NEC. Provide split wedge type which firmly clamps each individual cable and tightens due to cable weight.
- E. For panelboards, cabinets, wireways, switches, and equipment assemblies, neatly form, train, and tie cables in individual circuits.
- F. Seal cable and wire entering building from underground between wire and conduit, where cable exits conduit, with non-hardening approved compound.
- G. Install wire and cables in separate raceway systems as follows:
 - 1. Exit lights.
 - 2. ac Control.
 - 3. dc control.
 - 4. Shielded instrumentation.
 - 5. Sound system.
 - 6. Telephone cables.
 - 7. Network Cables.
 - 8. Fiber Optic Cables.
 - 9. Emergency system.
 - 10. Fire alarm system.
 - 11. As required by NEC.
- H. Where control or instrumentation cables are run in underground conduit and ducts provide multi-wire cable assemblies.
- I. Where power cables and instrument/signal cables enter and pass through same manhole, handhole, or distribution box, steel barrier or separate raceways shall continue through box manhole, handhole to avoid magnetic interaction between power cables and instrumentation conductors. In manholes and handholes, provide Type C raceway outlet body with 3/16 inch holes drilled in bottom for drainage.
- J. Do not run instrumentation cables into control cabinets or Motor Control Center (MCC) unless cables are terminated in cabinet or MCC.
- K. Wiring at Outlets: Install with at least 12 inch (300 millimeter) of slack conductor at each outlet.

- L. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL 486A.
- M. Drawings do not designate number of conductors in conduit nor does location of branch circuits and switch legs indicated on Drawings designate location or routing. Route branch circuits and switch legs as dictated by construction and these Specifications.

3.02 TERMINATIONS AND SPLICES

- A. Terminate control, instrumentation, and communication cables on terminal strips in separate terminal cabinets located near conduit entrances of buildings or as shown on Drawings.
- B. Power Cable Splices (no splices in cables unless approved by Engineer):
 - 1. Provide continuous lengths of cable without splices in motor circuits and feeders unless otherwise noted. Splices may be installed in motor circuits and feeders with prior approval by Engineer.
 - 2. Install splices and taps that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.
 - 3. Use splice and tap connectors that are compatible with conductor material.
 - 4. Where pre-insulated spring connectors are used for equipment connections, tape connector to wire to prevent loosening under vibration.
 - 5. Each tap, joint or splice in conductors No. 8 AWG and larger shall be taped with two half-lap layers of vinyl plastic electrical tape and finish wrap of color coding tape where required by code.
 - 6. Cable splices shall be made only in manholes, handholes, wireways, distribution boxes, and junction boxes.
- C. Power Cable Terminations:
 - 1. Termination of wires with full compression type lugs installed with appropriate hand or hydraulic tool. Use proper dies to achieve the desired compression.
 - 2. For screw type terminal blocks, terminations for stranded conductors shall be made with T & B lock-on fork connector with insulated sleeves.
 - 3. Motor lead conductor terminations shall be made with a T & B or approved equal, full compression lug, full ring type, bolted, and taped as required. For connecting motor lead to service wiring fasten full ring lugs together with cadmium plated steel cap screws, and cover with a minimum of 2 layers 1/2 lap, 3M Scotch No. 33 tape; option: T & B "Motor Stub Splice Insulator".

3.03 CONTROL CIRCUITS

- A. Control circuit home runs from same area for the same system returning to same panel, (e.g., Local Controls Panel (LCP), Control Station (CS), etc.,) may be combined provided signal and voltage types are not mixed.
- B. Following types of home runs shall not be combined with other types:
 - 1. 4-20 milliamp direct current analog; Type 2 shielded cable.
 - 2. 24 volts direct current discrete (e.g., field or LCP powered dry contacts).

3.04 BRANCH CIRCUITS

- A. Motor branch circuits and branch circuits for 3 phase circuits shall not be combined.
- B. Branch circuits for single phase equipment devices from same Lighting Panel (LP) or Power Panel (PP) may be combined provided that such combining does not result in having to derate ampacity of conductors.

3.05 FEEDERS:

- A. Extend feeders at full capacity from origin to termination.
- B. Each conduit raceway shall contain only those conductors constituting single feeder circuit.
- C. Where multiple raceways are used for single feeder, each raceway shall contain conductor of each phase and neutral if used.
- D. Where feeder conductors run in parallel, conductors shall be of same length, material, circular-mil area, insulation type, and terminated in same manner.
- E. Where parallel feeder conductors run in separate raceways, raceways shall have same physical characteristics.
- F. Confine feeders to insulated portions of building unless otherwise shown.
- G. On network systems, neutral shall be run with phase wires. Unbalanced neutral current shall not exceed normal or derated conductor capacity.

3.06 MOTORS AND EQUIPMENT WIRING

- A. Provide motor circuits in accordance with diagrams and schedules on Drawings and code requirements, from source of supply to associated motor starter and starter to motor terminal box, including necessary and required intermediate connections.
- B. Do not include associated control conductors in same conduit with power conductors.
- C. Provide branch circuits to conform with NEC requirements and nameplate ratings. CONTRACTOR responsible for verification of ratings of motors and installing proper branch circuits.

3.07 COLOR CODING

- A. Conductors for Lighting and Power Wiring:

Phase	208/120 volts	480/277 volts
A	Black	Brown
B	Red	Orange
C	Blue	Yellow
Travelers	Pink	Purple
Neutral	White	White with non-green stripe
Ground	Green	Green

- B. Colored pressure-sensitive plastic tape.
 1. Apply in half overlapping turns for minimum of three inches at terminal points, and in junction boxes, pull boxes, troughs, manholes, and handholes.
 2. 3/4 inch wide with colors as specified.

3. Apply last two laps of tape with no tension to prevent possible unwinding.
 4. Where cable markings are covered by tape, apply tags to cable stating size and insulation type.
- C. Color code for insulated power system wiring shall be in accordance with NEC.
- D. Color code for intrinsically safe systems shall be light blue.
- 3.08 CONTROL, COMMUNICATION AND SIGNAL SYSTEM IDENTIFICATION
- A. Install permanent wire marker at termination.
 - B. Identifying numbers and letters on wire markers shall correspond to those on terminal blocks or wiring diagrams used for installing systems.
 - C. Plastic sleeve or self adhesive vinyl cloth.
 - D. In each manhole and handhole, install embossed brass tags to identify system served and function.
 - E. Comply with Section 26 05 53.
- 3.09 FEEDER IDENTIFICATION
- A. Manholes, handholes, pullboxes, and junction boxes, install metal tags on circuit cables and wires to clearly designate circuit identification and voltage.
 - B. Provide tags of embossed brass type, in manholes and handholes showing cable type and voltage rating. Attach tags to cables with slip-free plastic cable lacing units.
 - C. Comply with Section 26 05 53.
- 3.10 INSTALLATION IN MANHOLES AND HANDHOLES
- A. Install and support cable in manholes, and handholes on steel racks with porcelain or equal insulators. Train cables around walls, but do not bend to radius less than 6 times overall cable diameter.
 - B. Electrical Fireproofing:
 1. Where low voltage cables are installed in same manholes or handholes with high voltage cables, cover low voltage cable with arcproof fireproof tape.
 2. Use same type as for high voltage cables, applied in single layer, one-half lapped or as recommended by manufacturer. Extend not less than 1 inch into each duct.
 3. Secure tape in place with random wrap of glass cloth tape.
- 3.11 FIELD QUALITY CONTROL
- A. Visual and Mechanical Inspection:
 1. Inspect cables for physical damage and proper connection in accordance with single-line diagram.
 2. Test cable mechanical connections to manufacturer's recommended values using calibrated torque wrench.
 3. Check cable color coding with specifications and NEC standards.

B. Electrical Tests:

1. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 1000 volts direct current for 1 minute.
2. Perform continuity test to insure proper cable connection.

C. Test Values:

1. Evaluation results by comparison with cables of same length and type. Investigate any value less than 50 megohms.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Grounding of electrical systems and equipment and basic requirements for grounding for protection of life, equipment, circuits, and systems.
2. Grounding requirements specified in this Section may be supplemented in other Sections of these Specifications.

1.02 SUBMITTALS

A. Report of Field Tests and Observations: Certified by Contractor.

B. Test Results:

1. Certified field tests and observation reports indicating and interpreting test reports for compliance with performance requirements.

C. Submit in accordance with Section 01 33 00.

1.03 QUALITY ASSURANCE

A. Comply with Underwriters Laboratories, Inc (UL) 467.

B. Items provided under this section shall be listed or labeled by UL or other Nationally Recognized Testing Laboratory (NRTL).

1. Term "NRTL" shall be as defined in Occupational Safety and Health Administration (OSHA) Regulation 1910.7.
2. Terms "listed" and "labeled" shall be as defined in National Electrical Code (NEC), Article 100.

C. Regulatory Requirements:

1. NEC: Components and installation shall comply with National Fire Protection Association (NFPA) 70.

PART 2 – PRODUCTS

2.01 GROUNDING AND BONDING PRODUCTS

A. Governing Requirements: Where types, sizes, ratings, and quantities indicated are in excess of NEC requirements, more stringent requirements and greater size, rating, and quantity indications govern.

2.02 WIRE AND CABLE GROUNDING CONDUCTORS

A. Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including stranding.

1. Material: Copper.

- B. Equipment Grounding Conductors: Insulated with green color insulation.
- C. Grounding-Electrode Conductors: Stranded cable.
- D. Underground Conductors: Bare, tinned, stranded, except as otherwise indicated.
- E. Bare Copper Conductors:
 - 1. Solid Conductors: American Society for Testing and Materials (ASTM) B3.
 - 2. Assembly of Stranded Conductors: ASTM B8.
 - 3. Tinned Conductors: ASTM B33.

2.03 MISCELLANEOUS CONDUCTORS

- A. Grounding Bus: Bare, annealed-copper bars of rectangular cross section.
- B. Braided Bonding Jumpers: Copper tape, braided No. 3/0 American Wire Gauge (AWG) bare copper wire, terminated with copper ferrules.
- C. Bonding Straps: Soft copper, 0.05 inch (1 millimeter) thick and 2 inches (50 millimeters) wide, except as indicated.

2.04 CONNECTOR PRODUCTS

- A. Pressure Connectors: High-conductivity-plated units.
- B. Bolted Clamps: Heavy-duty type.
- C. Exothermic-Welded Connections: Provided in kit form and selected per manufacturer's written instructions for specific types, sizes, and combinations of conductors and connected items.

2.05 GROUNDING ELECTRODES

- A. Grounding Rods: Copper-clad steel.
 - 1. Size: 3/4 inch by 120 inches (19 by 3000 millimeters).
- B. Test Wells: Fabricate from 36 inch (915 millimeters) long, square-cut section of 16 inch (406 millimeters) diameter, vitrified clay pipe with end bell as detailed on Drawings.

PART 3 – EXECUTION

3.01 APPLICATION

- A. Equipment Grounding Conductors: Comply with NEC Article 250 for types, sizes, and quantities of equipment grounding conductors, except where specific types, larger sizes, or more conductors than required by NEC are indicated.
 - 1. Install equipment grounding conductor with circuit conductors for items below in addition to those required by Code:
 - a. Feeders and branch circuits.
 - b. Lighting circuits.
 - c. Receptacle circuits.
 - d. Single-phase motor or appliance branch circuits.

- e. Three-phase motor or appliance branch circuits.
2. Computer Outlet Circuits: Install separate equipment grounding conductor in branch circuit runs from computer area power panels or power-distribution units.
 3. Isolated Grounding-Receptacle Circuits: Install separate insulated equipment grounding conductor connected to receptacle grounding terminal. Isolate grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding-conductor terminal of applicable derived system or service, except as otherwise indicated.
 4. Isolated Equipment Enclosure Circuits: For designated equipment supplied by branch circuit or feeder, isolate equipment enclosure from supply raceway with nonmetallic raceway fitting listed for purpose. Install fitting where raceway enters enclosure, and install separate equipment grounding conductor. Isolate equipment grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding-conductor terminal of applicable derived system or service, except as otherwise indicated.
 5. Nonmetallic Raceways: Install equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.
 6. Air-Duct Equipment Circuits: Install equipment grounding conductor to duct-mounted electrical devices operating at 120 volts and above, including air cleaners and heaters. Bond conductor to each unit and to air duct.
 7. Water Heater, Heat-Tracing, and Antifrost Heater Circuits: Install separate equipment grounding conductor to each electric water heater, heat-tracing assembly, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components.
- B. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding-electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on 1/4 by 2 by 12 inches (6 by 50 by 300 millimeter) grounding bus.
 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
 - C. Separately Derived Systems: Where NEC requires grounding, ground according to NEC Paragraph 250-30.
 - D. Common Ground Bonding with Lightning Protection System: Bond electric power system ground directly to lightning protection system grounding conductor at closest point to electric service grounding electrode. Use bonding conductor sized same as system grounding conductor and install in conduit.
 - E. Piping Systems and Other Equipment: Comply with NEC Article 250 for bonding requirements.

3.02 INSTALLATION

- A. Ground electrical systems and equipment according to NEC requirements, except where Drawings or Specifications exceed NEC requirements.
- B. Grounding Rods: Locate minimum of 1 rod length from each other and at least same distance from any other grounding electrode.
 1. Drive until tops are 2 inches (50 millimeters) below finished floor or final grade, except as otherwise indicated.
 2. Interconnect with grounding-electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make these connections without damaging copper coating or exposing steel.

- C. Grounding Conductors: Route along shortest and straightest paths possible, except as otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- D. Underground Grounding Conductors: Use bare tinned copper wire. Bury at least 24 inches (600 millimeters) below grade.
- E. Metal Water Service Pipe: Provide insulated copper grounding conductors, sized as indicated, 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 dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Do not install grounding jumper across dielectric fittings. Bond grounding-conductor conduit to conductor at each end.
- F. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding-clamp connectors.
- G. 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.
- H. Test Wells: One for each driven grounding electrode system, except as otherwise indicated. Set top of well flush with finished grade or floor.
- I. Concrete-Encased Grounding Electrode (grounding building/structure footing): Fabricate according to NEC Article 250 using minimum of 20 feet (6 meters) of bare tinned copper conductor not smaller than No. 4 AWG or minimum 20 feet (6 meters) rebar 1/2 inch or larger in diameter. Bond grounding conductor to reinforcing steel to at least 4 locations, and to anchor bolts. Extend grounding conductor up in foundation wall.

3.03 CONNECTIONS

- A. Make connections so possibility of galvanic action or electrolysis 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 assure high conductivity and to make contact points closer in 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-Wire Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

- D. Noncontact Metal Raceway Terminations: Where metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at both entrances and exits with grounding bushings and bare grounding conductors, except as otherwise indicated.
- E. Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and grounding rods.
- F. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. Where these requirements are not available, use those specified in UL 486A and UL 486B.
- G. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by manufacturer of connectors. Provide embossing die code or other standard method to make visible indication that connector has been adequately compressed on grounding conductor.
- H. Moisture Protection: Where insulated grounding conductors are connected to grounding rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.04 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

A. Manholes and Handholes:

1. Install driven grounding rod close to wall and set rod depth so 4 inches (100 millimeters) will extend above finished floor.
2. Where necessary, install grounding rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from grounding rod into manhole through waterproof sleeve in manhole wall.
3. Protect grounding rods passing through concrete floor with double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inches (50 millimeters) above to 6 inches (150 millimeters) below concrete.
4. Seal floor opening with waterproof, nonshrink grout.

B. Connections to Manhole Components:

1. Connect exposed metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to grounding rod or grounding conductor.
2. Make connections with minimum No. 4 AWG stranded, hard-drawn copper wire.
3. Train conductors plumb or level around corners and fasten to manhole walls.
4. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

C. Grounding System:

1. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes.

3.05 FIELD QUALITY CONTROL

A. Testing:

1. Subject completed grounding system to megger test at each location where maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells.
 - a. Measure ground resistance not less than 2 full days after last trace of precipitation, and without 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. Perform tests by 2 point method according to Section 9.03 of Institute of Electrical And Electronics Engineers (IEEE) 81.
2. Maximum grounding to resistance values are as follows:
 - a. Equipment Rated 500 kilovolt amps (kVA) and Less: 10 ohms.
 - b. Equipment Rated 500 to 1000 kVA: 5 ohms.
 - c. Equipment Rated More than 1000 kVA: 3 ohms.
 - d. Unfenced Substations and Pad-Mounted Equipment: 5 ohms.
 - e. Manhole Grounds: 10 ohms.
3. Excessive Ground Resistance: Where resistance to ground exceeds specified values, notify ENGINEER promptly and include recommendations to reduce ground resistance and to accomplish recommended work.
4. Report: Prepare certified test reports, of ground resistance at each test location. Include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

3.06 RESTORATION

- A. Restore surface features, including vegetation, at areas disturbed by work of this Section.
 1. Re-establish original grades, except as otherwise indicated.
 2. Where sod has been removed, replace it as soon as possible after backfilling is completed.
 3. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition.
 4. Include topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching.
 5. Maintain restored surfaces.
 6. Restore disturbed paving.

END OF SECTION

SECTION 26 05 29
HANGERS AND SUPPORTING FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Supports from building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

1.02 QUALITY ASSURANCE

A. Items provided under this section shall be listed and labeled by Underwriters Laboratories, Inc. (UL) or other Nationally Recognized Testing laboratory (NRTL).

1. Term "NRTL" shall be as defined in Occupational Safety and Health Administration (OSHA) Regulation 1910.7.
2. Terms "listed" and "labeled" shall be as defined in National Electrical Code (NEC), Article 100.

B. Regulatory requirements:

1. NEC: Components and installation shall comply with National Fire Protection Association (NFPA) 70.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Exposure: Dry, galvanized steel or 316 stainless steel
- B. Exposure: Wet, 316 stainless steel
- C. Exposure: Corrosive, fiberglass reinforced plastic (FRP) and/or non-metallic materials including fasteners and anchorments.

2.02 COATINGS

- A. Products for use outdoors.
- B. Use Polyvinyl Chloride (PVC) coating where indicated on Drawings.

2.03 MANUFACTURED SUPPORTING DEVICES

- A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.
- B. Fasteners: Types, materials, and construction to match support materials listed above.
- C. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.

- D. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers.
- E. U-Channel Systems: Channels, with 9/16-inch diameter holes, at minimum of 8 inch on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of same manufacture.

2.04 FABRICATED SUPPORTING DEVICES

- A. Shop- or field-fabricate supports or manufacture supports assembled from U-channel components.
- B. Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports. Comply with Section 05 50 00.
- C. Pipe Sleeves: Provide pipe sleeves of one of following:
 - 1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from following gage metal for sleeve diameter noted:
 - a. 3 inch and smaller: 20 gauge
 - b. 4 inch to 6 inch: 16 gauge
 - c. Over 6 inch: 14 gauge
 - 2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
 - 3. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe.

2.05 FIRE RESISTANT JOINT SEALERS

- A. Manufacturers:
 - 1. "Dow Corning Fire Stop Foam," Dow Corning Corp.
 - 2. "Pensil 851," General Electric Co.
 - 3. Or equal.
- B. Two-part, foamed-in-place, silicone sealant formulated for use in through-penetration fire-stopping around cables, conduit, pipes, and duct penetrations through fire-rated walls and floors.
- C. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with American Society for Testing and Materials (ASTM) E 814, by Underwriters' Laboratories, Inc., or other testing and inspection agency acceptable to authorities having jurisdiction.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.
- B. Coordinate with structural system and with other electrical installation.
- C. Raceway Supports: Comply with NEC and following requirements:

1. Conform to manufacturer's recommendations for selection and installation of supports.
 2. Strength of each support shall be adequate to carry present and future load multiplied by safety factor of at least four. Where this determination results in safety allowance of less than 200 pounds, provide additional strength until there is minimum of 200 pounds safety allowance in strength of each support.
 3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
 4. Support parallel runs of horizontal raceways together on trapeze-type hangers.
 5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1 inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4 inch diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.
 6. In vertical runs, arrange support so load produced by weight of raceway and enclosed conductors is carried entirely by conduit supports with no weight load on raceway terminals.
- D. Vertical Conductor Supports: Install simultaneously with installation of conductors.
- E. Miscellaneous Supports: Support miscellaneous electrical components as required to produce same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.
- F. Sleeves: Install in concrete slabs and walls and other fire-rated floors and walls for raceways and cable installations. For sleeves through fire rated-wall or floor construction, apply UL listed firestopping sealant in gaps between sleeves and enclosed conduits and cables.
- G. Conduit Seals: Install seals for conduit penetrations of slabs below grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.
- H. Conduit extending through roof shall pass through ceiling box at roof line.
1. Provide 14 gauge minimum copper box complete with watertight soldered seams and flanged to serve as pitch pocket for each conduit.
 2. Install conduit and pitch pocket in advance of roofing work.
- I. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with following:
1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.
 2. Holes cut in concrete shall not cut main reinforcing bars. Fill holes that are not used.
 3. Load applied to any fastener shall not exceed 25% of proof test load. Use vibration- and shock- resistant fasteners for attachments to concrete slabs.
- J. Light Fixture Supports:
1. Raceway system shall not be used to support equipment which includes light fixtures.

2. Conform to manufacturer's recommendations for selection and installation of supports.
3. Strength of each support shall be adequate to carry present and future load multiplied by safety factor of at least four. Where this determination results in safety allowance of less than 200 pounds, provide additional strength until there is minimum of 200 pounds safety allowance in strength of each support.
4. Fixture hangers shall be used to support suspended fixtures; hangers shall be supplemented with safety chains were shown on Fixture Schedule.

END OF SECTION

SECTION 26 05 33.13
CABINETS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Outlet and device boxes.
2. Pull and junction boxes.
3. Floor boxes and service fittings.
4. Cabinets.
5. Hinged door enclosures.
6. Boxes and fittings for hazardous locations.

B. Conduit-body-type electrical enclosures and wiring fittings are specified in Section 26 05 33.16.

1.02 DEFINITIONS

A. Cabinets: Enclosure designed either for surface or for flush mounting and having frame, or trim in which door or doors may be mounted.

B. Device Box: Outlet box designed to house receptacle device or wiring box designed to house switch.

C. Enclosure: Box, case, cabinet, or housing for electrical wiring or components.

D. Hinged Door Enclosure: Enclosure designed for surface mounting and having swinging doors or covers secured directly to and telescoping with walls of box.

E. Outlet Box: Wiring enclosure where current is taken from wiring system to supply utilization equipment.

F. Wiring Box: Enclosure designed to provide access to wiring systems or for mounting of indicating devices or of switches for controlling electrical circuits.

1.03 SUBMITTALS

A. Product Data: Submit for cabinets and enclosures with classification higher than National Electrical Manufacturers Association (NEMA) 1.

B. Submit in accordance with Section 01 33 00.

1.04 QUALITY ASSURANCE

A. Items provided under this section shall be listed or labeled by Underwriters Laboratories, Inc. (UL) or other Nationally Recognized Testing Laboratory (NRTL).

1. Term "NRTL" shall be as defined in Occupational Safety and Health Administration (OSHA) Regulation 1910.7.
2. Terms "listed" and "labeled" shall be as defined in National Electrical Code (NEC), Article 100.

B. Regulatory Requirements:

1. NEC: Components and installation shall comply with National Fire Protection Association (NFPA 70).

PART 2 – PRODUCTS

2.01 CABINETS, BOXES, AND FITTINGS, GENERAL

- A. Electrical Cabinets, Boxes, and Fittings: Of indicated types, sizes, and NEMA enclosure classes. Where not indicated, provide units of types, sizes, and classes appropriate for use and location. Provide items complete with covers and accessories required for intended use. Provide gaskets for units in corrosive and wet locations.

2.02 MISCELLANEOUS MATERIALS AND FINISHES

- A. Fasteners for General Use: Corrosion resistant screws and hardware including cadmium and zinc plated items.
- B. Fasteners for Wet Locations: Stainless steel screws and hardware.
- C. Fittings for Boxes, Cabinets, and Enclosures: Conform to UL 514B. Malleable iron or zinc plated steel for conduit hubs, bushings and box connectors.
- D. Finishes:
 1. Exterior Finish: Galvanized or Gray baked enamel for items exposed in finished locations except as otherwise indicated.
 2. Interior Finish: Where indicated, white baked enamel.
- E. Fastener style:
 1. Stainless steel door clamp assembly (Hoffman SS6LP series, Wiegmann SSN4 series or equal) for stainless steel boxes. Screw-down clamps are not acceptable.
 2. External quick-release or quarter turn semi-flush oil tight latch latches for galvanized boxes.
 3. Spring loaded, triple-thread, captive hex-head bolts for cast metal boxes.

2.03 METAL OUTLET, DEVICE, AND SMALL WIRING BOXES

- A. General:
 1. Conform to UL 514A and UL 514B.
 2. Boxes shall be of type, shape, size, and depth to suit each location and application.
- B. Steel Boxes: Conform to NEMA OS 1. Boxes shall be sheet steel with stamped knockouts, threaded screw holes and accessories suitable for each location including mounting brackets and straps, cable clamps, exterior rings and fixture studs.
- C. Galvanized Cast-Iron Boxes: Iron alloy, waterproof, with threaded raceway entries and features and accessories suitable for each location, including mounting ears, threaded screw holes for devices and closure plugs.
- D. Steel Floor Boxes: Flat rolled, code gauge, galvanized, sheet steel, concrete tight, fully adjustable, with stamped knockouts, adjusting rings, and brass floor plates. Where indicated, provide multi-section boxes with concealed individual section covers under common flush floor plate. Provide for duplex receptacle in one of concealed section covers and 1 inch diameter bushed opening in other.

- E. Service Fittings for Floor Outlet Boxes: Surface mounted horizontal, cast aluminum type 3 inch high, suitable for finished spaces and finished in satin aluminum, except as otherwise indicated. Provide duplex receptacle or 1 inch bushed opening for telephone or other communications service as indicated. Equip fitting for attaching flat to floor box cover.

2.04 PULL AND JUNCTION BOXES

- A. General: Comply with UL 50 for boxes over 100 cubic inch volume. Boxes shall have screwed or bolted on covers of material same as box and shall be of size and shape to suit application.
- B. Galvanized Steel Boxes: Flat rolled, code gauge, sheet steel with welded seams. Where necessary to provide rigid assembly, construct with internal structural steel bracing. Hot-dip galvanized after fabrication. Cover shall be gasketed.
- C. Stainless-Steel Boxes: Fabricate of stainless steel conforming to Type 304 of American Society for Testing and Materials (ASTM) A167. Where necessary to provide rigid assembly, construct with internal structural stainless steel bracing. Cover shall be gasketed.
- D. Boxes Approved for Classified Locations: Cast metal or cast nonmetallic boxes conforming to UL 886 listed and labeled for use in specific location classification, and with specific hazardous material encountered. Conduit entrances shall be integral threaded type.
- E. Cast Nonmetallic Boxes: Ultra-violet stabilized, nonconductive, high impact-resistant Polyvinyl Chloride (PVC) boxes with gasketed cover and integral mounting flanges.

2.05 CABINETS

- A. Comply with UL 50.
- B. Construction: Flat rolled, code gauge, galvanized, sheet steel, NEMA 1 class except as otherwise indicated. Cabinet shall consist of box and front consisting of 1 piece frame and hinged door. Arrange door to close against rabbet placed around inside edge of frame, with uniformly close fit between door and frame. Provide concealed fasteners, not over 24 inch apart, to hold fronts to cabinet boxes and provide for adjustment. Provide flush or concealed door hinges not over 24 inch apart and not over 6 inch from top and bottom of door. For flush cabinets, make front approximately 3/4 inch larger in each dimension. For surface mounted cabinets make front same height and width as box.
- C. Doors: Double doors for cabinets wider than 24 inch Telephone cabinets wider than 48 inch may have sliding or removable doors.
- D. Locks: Combination spring catch and key lock, with each lock for cabinets of same system keyed alike. Locks may be omitted on signal, power, and lighting cabinets located within wire closets and mechanical-electrical rooms. Locks shall be of type to permit doors to latch closed without locking.

2.06 FIBERGLASS ENCLOSURES WITH HINGED DOORS

- A. Molded, glass fiber reinforced high impact strength polyester with bolt or screw secured doors and solid neoprene gaskets.

2.07 STEEL ENCLOSURES WITH HINGED DOORS

- A. Comply with UL 50 and NEMA ICS 6.
- B. Construction:

1. Sheet steel, 16 gauge, minimum, with continuous welded seams. NEMA class as indicated; arranged for surface mounting.
 2. Stainless steel.
- C. Doors: Hinged directly to cabinet and removable, with approximately 3/4 inch flange around each edge, shaped to cover edge of box. Provide handle operated, key locking latch. Individual door width shall be no greater than 24 inch. Provide multiple doors where required.
- D. Mounting Panel: Provide painted removable internal mounting panel for component installation.
- E. Enclosure: NEMA 12 except as indicated. Where door gasketing is required, provide neoprene gasket attached with oil-resistant adhesive, and held in place with steel retaining strips. For enclosures of class higher than NEMA 1, use hubbed raceway entrances.
- 2.08 CAST METAL ENCLOSURES WITH HINGED DOORS
- A. Copper free aluminum with bolted, hinged doors. Where used at hazardous (classified) locations, enclosures shall conform to UL and shall be listed and labeled for classification of hazard involved.
- 2.09 MOLDED NONMETALLIC ENCLOSURES WITH HINGED DOOR
- A. Molded, glass fiber reinforced high impact strength polyester with bolt or screw secured doors and solid neoprene gaskets.
- 2.10 TERMINAL STRIPS
- A. Manufacturers:
1. Square D.
 2. Buchanan.
 3. Or equal.
- B. Channel mount snap-on type.
- C. Individual gangable with nylon bases.
- D. Solderless box lug type rated at 600 volts to accommodate No. 22 to 8 American Wire Gauge (AWG) wire or as otherwise indicated.
- E. Provide 50% spare terminals.

PART 3 – EXECUTION

3.01 INSTALLATION, GENERAL

- A. Locations: Install items where indicated and where required to suit code requirements and installation conditions.
- B. Cap unused knockout holes where blanks have been removed and plug unused conduit hubs.
- C. Support and fasten items in accordance with Section 26 05 29.
- D. Sizes shall be adequate to meet NEC volume requirements, but in no case smaller than sizes indicated.

- E. Remove sharp edges where they may come in contact with wiring or personnel.

3.02 APPLICATIONS

- A. Cabinets: Flush mounted, NEMA Type 1 enclosure except as otherwise indicated.
- B. Hinged Door Enclosures: Sheet steel, baked enamel finish, NEMA type 12 enclosure except as indicated.
- C. Hinged Door Enclosures Outdoors: Galvanized sheet steel with baked enamel finish, NEMA type 4X. Install drip hood, factory tailored to individual units.
- D. Hinged Door Enclosures in Corrosive Locations: Fiberglass Reinforced Epoxy (FRE) enclosure, or as indicated on Drawings.
- E. Outlet Boxes and Fittings: Install outlet and device boxes and associated covers and fittings of materials and NEMA types for each location in conformance with following requirements unless otherwise noted:
 - 1. Interior Dry Locations: Sheet steel, NEMA type 1 for flush mounting and ferrous Type FS or FD cast boxes with threaded conduit hubs for surface mounting.
 - 2. Wet Locations: 316 Stainless Steel, NEMA type 4X enclosures.
 - 3. Corrosive Locations: FRE, NEMA type 4X enclosures.
 - 4. Metal Door Jambs: Narrow partition boxes with internal ears.
- F. Pull and Junction Boxes: Install pull and junction boxes of materials and NEMA types for each location in conformance with following requirements unless otherwise noted:
 - 1. Interior Dry Locations: Sheet steel, NEMA type 1 for flush mounting and ferrous Type FS or FD cast boxes with threaded conduit hubs for surface mounting.
 - 2. Wet Locations: 316 Stainless Steel, NEMA type 4X enclosures.
 - 3. Corrosive Locations: FRE, NEMA type 4X enclosures.
 - 4. Hazardous (Classified) Locations: NEMA type listed and labeled for location and class of hazard indicated.
- G. Floor Boxes: In slabs on grade and wet locations use NEMA type 4 boxes. At other locations in slabs, use concrete-tight NEMA type 1 boxes.

3.03 INSTALLATION OF OUTLET BOXES

- A. Outlets at Windows and Doors: Locate close to window or door trim.
- B. Column and Pilaster Locations: Locate outlet boxes for switches and receptacles on columns or pilasters so centers of columns are clear for future installation of partitions.
- C. Locations in Special Finish Materials: For outlet boxes for receptacles and switches mounted in desks or furniture cabinets or in glazed tile, concrete block, marble, brick, stone or wood walls, use rectangular shaped boxes with square corners and straight sides. Install boxes without plaster rings. Saw cut recesses for outlet boxes in exposed masonry walls.
- D. Gasketed Boxes: At following locations use cast metal, threaded hub type boxes with gasketed weatherproof covers:
 - 1. Exterior locations.
 - 2. Where surface mounted on unfinished walls, columns or pilasters. (Cover gaskets may be omitted in dry locations).

3. Where exposed to moisture laden atmosphere.
 4. Where indicated.
- E. Mounting: Mount outlet boxes for switches with long axis vertical or as indicated. Mount boxes for receptacles vertically. Gang boxes shall be mounted with long axis horizontal. Locate box covers or device plates so they will not span different types of building finishes either vertically or horizontally. Locate boxes for switches near doors on side opposite hinges and close to door trim, even though electrical floor plans may show them on hinge side.
- F. Ceiling Outlets: For fixtures, where wiring is concealed, use outlet boxes 4 inch sq by 1-1/2 inch deep, minimum with raised plaster or tile cover. Provide 3/8 inch fixture stud.
- G. Cover Plates for Surface Boxes: Use plates sized to box front without overlap.
- H. Protect outlet boxes to prevent entrance of plaster, and debris. Thoroughly clean foreign material from boxes before conductors are installed.
- I. Concrete Boxes: Use extra deep boxes to permit side conduit entrance without interfering with reinforcing, but do not use such boxes with over 6 inch depth.
- J. Secure boxes rigidly to substrate upon which being mounted or solidly embed boxes in concrete or masonry. Do not support from conduit, mechanical ductwork or piping.
- K. Set boxes in concealed conduit runs, flush with wall surfaces, with or without covers as required.
- L. Do not install boxes back to back or through wall. Offset outlet boxes on opposite sides of wall minimum 12 inch
- M. Set outlet boxes parallel to construction, securely mounted and adjusted to set true and flush with finished surface.
- N. Do not burn holes, use knockout punches or saw.
- O. Use handy boxes only where specifically indicated.
- P. Provide outlet box divider barriers between 277/480 volt, 120/240 and 120/208 volt devices as required per NEC.
- Q. Where emergency switches occur adjacent to normal light switches, install in separate boxes in accordance with NEC and device plate color coding separation.
- R. Floor Boxes: Install in concrete floor slabs so they are completely enveloped in concrete except for top. Where normal slab thickness will not envelop box as specified above, provide increased thickness of slab. Provide each compartment of each floor box with grounding terminal consisting of washer-in-head machine screw, not smaller than no. 10-32, screwed into tapped hole in box. Adjust covers of floor boxes flush with finished floor.

3.04 OUTLET BOX LOCATIONS

- A. Locate flush mounted wall boxes in corner of nearest brick or block to keep cutting to minimum.
- B. Location of outlets and equipment as shown on Drawings is approximate and exact location to be verified and shall be determined by:
 1. Construction or code requirements.
 2. Conflict with equipment or other trades.

3. Equipment manufacturer's drawings.
- C. Minor modification in location of outlets and equipment considered incidental up to distance of 10 feet with no additional compensation, provided necessary instructions given prior to roughing in of outlet.
- D. Mounting heights for devices and equipment to be measured from finished floor to centerline of device and unless otherwise noted on Drawings as follows.
 1. Switches: 48 inch above floor.
 2. Alternating Current Receptacles and Telephone Outlets: 15 inch above floor or 6 inch above counters, counter backsplashes, and baseboard radiators in finished areas; 48 inch above floor in unfinished areas.
 3. Wall Bracket Lighting Fixtures: 8 inch above mirrors or 6 feet 6 inch above floor.
 4. Pushbuttons: 48 inch above floor.
 5. Motor Starters and Disconnect Switches: 60 inch above floor
 6. Thermostats: 60 inch above floor.

3.05 INSTALLATION OF PULL AND JUNCTION BOXES

- A. Box Selection: For boxes in main feeder conduit runs, use sizes not smaller than 8 inch sq by 4 inch deep. Do not exceed 6 entering and 6 leaving raceways in single box. Quantities of conductors (including equipment grounding conductors) in pull or junction box shall not exceed following:

Size of Largest Conductors in Box	Maximum No. of Conductors in Box
No. 4/0 AWG	30
250 Kcmil	20
500 Kcmil	15
Over 500 Kcmil	10

1. Cable Supports: Install clamps, grids, or devices to which cables may be secured. Arrange cables so they may be readily identified. Support cable at least every 30 inch inside boxes.
2. Mount pull boxes in inaccessible ceilings with covers flush with finished ceiling.
3. Size: Provide pull and junction boxes for telephone, signal, instrumentation, control, and other systems at least 50% larger than would be required by the NEC for boxes smaller than 24 inch by 24 inch, or as indicated. Locate boxes strategically and provide shapes to permit easy pulling of future wires or cables of types normal for such systems.

3.06 INSTALLATION OF CABINETS AND HINGED DOOR ENCLOSURES

- A. Mount with fronts straight and plumb.
- B. Install with tops 78 inch above floor.
- C. Set cabinets in finished spaces flush with walls.
- D. Terminate wires and cables on terminal strips.

3.07 GROUNDING

- A. Provide grounding connections for boxes and components as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torqueing requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL 486A.

3.08 CLEANING AND FINISH REPAIR

- A. Upon completion of installation, inspect components. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, abrasions and weld marks.
- B. Galvanized Finish: Repair damage using zinc-rich paint recommended by manufacturer.
- C. Painted Finish: Repair damage using matching corrosion inhibiting touch-up coating.

END OF SECTION

SECTION 26 05 33.16
CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.01 SUMMARY

A. Section includes:

1. Raceways:

- a. Galvanized rigid steel conduit (GRS).
- b. Fiberglass Reinforced Epoxy (FRE).
- c. Polyvinyl chloride (PVC) externally coated galvanized rigid steel conduit (CGRS).
- d. Liquidtight flexible metal conduit (LFMC).
- e. Hazardous Flexible Metal Conduit.
- f. Rigid nonmetallic polyvinyl chloride conduit (PVC).
- g. Wireway (WW).

1.02 DEFINITIONS

A. Underfloor Conduits.

1. Conduits which run underground within perimeter of building walls under building floor. This may consist of one conduit, or several conduits grouped together.

B. Duct Bank Conduits

1. Conduits which run under ground outside perimeter of building walls. This may consist of one conduit, or several conduits grouped together.

C. Underground Conduits

1. Underground conduits are both underfloor conduits and duct bank conduits.

1.03 SUBMITTALS

A. Submittals are not required if Contractor supplies materials or equipment as specified. If Contractor proposes substitutions to material or equipment submittals identified below are required.

1. Product data.
2. Submit in accordance with Section 01 33 00.

1.04 QUALITY ASSURANCE

A. Items provided under this section shall be listed or labeled by Underwriters Laboratories, Inc. (UL) or other Nationally Recognized Testing Laboratory (NRTL).

1. Term "NRTL" shall be as defined in Occupational Safety and Health Administration (OSHA) Regulation 1910.7.
2. Terms "listed" and "labeled" shall be as defined in National Electrical Code (NEC), Article 100.

B. Regulatory Requirements:

1. NEC: Components and installation shall comply with National Fire Protection Association (NFPA) 70.

- C. Comply with National Electrical Contractors Association (NECA) "Standard of Installation."

PART 2 – PRODUCTS

2.01 METAL CONDUIT

- A. Galvanized Rigid Steel Conduit: American National Standards Institute (ANSI) C80.1.
- B. Plastic-Coated Steel Conduit and Fittings: UL6 and National Electrical Manufacturers Association (NEMA) RN 1.
 - 1. ETL Verified Polyvinyl Chloride-001 Labeled or fully comply with UL adhesion Test.
- C. Liquidtight Flexible Metal Conduit: Flexible steel conduit with Polyvinyl Chloride jacket.
- D. Hazardous Flexible Metal Conduit: Brass or stainless steel braid.

2.02 NONMETALLIC CONDUIT

- A. Rigid Nonmetallic Polyvinyl Chloride (PVC) Conduit: NEMA TC 2, Schedule 40 PVC Chloride.
- B. Rigid Nonmetallic Polyvinyl Chloride (PVC) Conduit: NEMA TC 2, Schedule 80 PVC Chloride.
- C. PVC Conduit Fittings: NEMA TC 3; match to conduit type and material.

2.03 FITTINGS

- A. Fittings and conduit bodies for steel conduits:
 - 1. Steel or malleable iron, zinc galvanized or cadmium plated.
 - 2. Do not use set screw or indentor type fittings.
 - 3. Do not use aluminum or die cast fittings.
 - 4. GRS Connectors and Couplings:
 - a. Threaded.
 - b. Insulated throat.
 - c. Gland compression type.
 - d. Rain and concrete type.
 - 5. Comply with NEMA FB 1, compatible with conduit materials.
- B. Fittings for PVC Coated galvanized rigid steel conduits:
 - 1. PVC Coated Form 8 conduit bodies, 1/2 inch through 2 inch shall either be UL Listed Type 4X and NEMA 4X for wet or outdoor applications, including a PVC Coated cast cover with integral O-ring and stainless steel screws, secured to 15 inch-pounds of torque.
 - 2. Comply with NEMA FB 1, compatible with conduit materials.
- C. PVC Conduit Fittings:
 - 1. NEMA TC 3; match to conduit type and material.
- D. Expansion Joints:
 - 1. Conduit expansion fittings complete with copper bonding jumper, Crouse-Hinds Type XJ.
 - 2. Conduit expansion/deflection fittings with copper bonding jumper, Crouse-Hinds Type XD.

E. Seals:

1. Wall entrance, OZ/Gedney Type FSK or FSC.

F. Drain Fittings:

1. Automatic Drain Breather:

a. Explosionproof.

- 1) Safe for Class I Division 1, Groups C and D.

- b. Capable of passing minimum 25 cubic centimeters of water per minute and minimum 0.05 cubic feet of air per minute at atmospheric pressure.

2. Condensate Drain:

a. Conduit outlet body, Type T.

- b. Threaded, galvanized plug with 3/16 inch drilled holed through plug.

G. Hazardous Areas:

1. Explosionproof.
2. Horizontal seal fittings, Crouse-Hinds Type EYS.
3. Vertical seal fittings, Crouse-Hinds Type EYD.
4. Vertical seal fittings shall have drain plug.

2.04 WIREWAYS

- A. Wireways larger than 18" long by 6" deep by 6" high and used as anything but a below panelboard pull point is not allowed without prior approval by ENGINEER.
- B. Material: Sheet metal sized and shaped as indicated.
- C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireway as required for complete system.
- D. Select features where not otherwise indicated, as required to complete wiring system and to comply with NEC.
- E. Wireway Covers:
 1. Hinged type for dry locations.
 2. Bolted cover with gasket for wet locations.
- F. Finish: Manufacturer's standard enamel finish unless otherwise noted.

2.05 RACEWAY/DUCT SEALING COMPOUND

- A. Nonhardening, putty-like consistency workable at temperatures as low as 35°F.
- B. Compound shall not slump at temperature of 300 °F and shall readily adhere to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Examine surfaces to receive raceways, wireways, and fittings for compliance with installation tolerances and other conditions affecting performance of raceway system.
- B. Coordinate layout and installation of raceway and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

3.02 WIRING METHODS

- A. Wet Locations: Use following wiring methods unless otherwise noted on Drawings:
 - 1. Exposed: PVC-coated steel conduit.
 - 2. Concealed: Galvanized rigid steel.
 - 3. Underground Power and Control, Single Run: Rigid nonmetallic PVC conduit.
 - a. Concrete encased except for area lighting branch circuits or as otherwise noted on Drawings.
 - 4. Underground Power and Control, Grouped: Rigid nonmetallic PVC conduit.
 - a. Concrete encased.
 - 5. Underground Shielded Instrumentation Cables and Shielded Instrumentation Cables run in concrete slabs, Single Run or Grouped: Galvanized rigid steel.
 - a. Concrete encased.
 - 6. Connection to Vibrating Equipment (including transformers and hydraulic, pneumatic, or electric solenoid or motor-driven equipment): Liquidtight flexible metal conduit.
- B. Indoor Dry Locations: Use following wiring methods unless otherwise noted.
 - 1. Connection to Vibrating Equipment (including transformers and hydraulic, pneumatic, or electric solenoid or motor-driven equipment): Flexible metal conduit.
 - 2. Exposed: Galvanized rigid steel conduit
 - 3. Concealed: Galvanized rigid steel conduit.
- C. Hazardous classified locations: Use the following wiring methods unless otherwise noted on drawings.
 - 1. Exposed and concealed: PVC-coated steel conduit.
 - 2. Exposed flexible conduit: brass or stainless steel braid suitable for the hazardous classified location.
- D. Corrosive Environments: Use the following wiring methods unless otherwise noted on drawings.
 - 1. Exposed and concealed: Rigid nonmetallic Schedule 80 PVC conduit.
 - 2. Connection to Vibrating Equipment (including hydraulic, pneumatic, or electric solenoid or motor-driven equipment): Liquidtight flexible metal conduit.
- E. Use 3/4 inch minimum size unless otherwise noted except conduit runs to room light switches may be 1/2 inch.

- F. Unless specifically indicated otherwise, use galvanized rigid steel conduit for general wiring.
 - 1. IMC may be used for branch circuit wiring only in trade size 3/4 and 1 inch where conduit can be concealed in hollow spaces of walls inside vapor barrier, above suspended ceilings.
- G. Underground conduits:
 - 1. Encase galvanized rigid steel conduits installed underground in at least 3 inch of concrete.
 - 2. PVC conduit may be used without encasing in concrete for underfloor conduit or where specifically indicated on Drawings.
 - 3. Underground conduit shall be minimum of 1 inch, buried at depth of not less than 24 inch below grade.
 - 4. Provide conduits or ducts terminating below grade with means to prevent entry of dirt and moisture.
 - 5. When using concrete encased PVC conduit provide PVC coated galvanized rigid steel elbows.
- H. In precast areas, run conduits in insulation space or in floor topping without crossing conduits, using 3/4 inch maximum conduit size.
- I. Raceways Embedded in Slabs: Install in middle third of slab thickness where practical, and leave at least 1 inch (25 millimeter) concrete cover.
 - 1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
 - 2. Space raceways laterally to prevent voids in concrete.
 - 3. Run conduit larger than 1 inch trade size parallel to or at right angles to main reinforcement and spaced on center of at least 3 times conduit trade diameter with minimum 2 inch concrete covering. Conduits over 1 inch may not be installed in slab without approval of Engineer.
 - 4. When at right angles to reinforcement, place conduit close to slab support.
 - 5. Conduits embedded in concrete frame shall comply with applicable provisions of American Concrete Institute (ACI) 318.

3.03 WIREWAYS

- A. Use wireways only where indicated on drawings.
- B. Do not use wireways without prior approval from Engineer.
- C. Do not install wireways through walls or floors.

3.04 INSTALLATION

- A. Cap conduits after installation to prevent entry of debris.
- B. Conceal raceways by enclosing within finished walls, ceilings, and floors, unless otherwise indicated.
- C. Provide watertight conduit system where installed in wet places, underground or where buried in masonry or concrete.
 - 1. Use threaded hubs when entering top of enclosures.
 - 2. Use sealing type locknuts when entering sides or bottom of enclosures.
- D. Keep raceways at least 6 inch (150 millimeter) away from parallel runs of flues and steam or hot water pipes. Install horizontal raceway runs above water and steam piping.
- E. Install raceways level and square and at proper elevations. Provide adequate headroom.

- F. Complete raceway installation before starting conductor installation.
- G. Support raceway as specified in Section 26 05 09.
- H. Use temporary closures to prevent foreign matter from entering raceway.
- I. Run concealed raceways with minimum of bends in shortest practical distance considering type of building construction and obstructions, except as otherwise indicated.
- J. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow surface contours as much as practical.
 - 1. Mount exposed horizontal runs as high above floor as possible, and in no case lower than 7 foot above floors, walkways, or platforms in passage areas.
 - 2. Run parallel or banked raceways together, on common supports where practical.
 - 3. Make bends in parallel or banked runs from same center line to make bends parallel. Use factory elbows only where they can be installed parallel; otherwise, provide field bends for parallel raceways.
- K. Join raceways with fittings designed and approved for purpose and make joints tight.
 - 1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
 - 2. Use insulating bushings to protect conductors.
- L. Terminations: Where raceways are terminated with locknuts and bushings, align raceway to enter squarely, and install the locknuts with dished part against the box. Use two locknuts, one inside and one outside the box. Use insulating bushings. Provide insulated grounding bushings to terminate ground wire.
- M. Where terminating in threaded hubs, screw raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to box, and tighten chase nipple so no threads are exposed.
- N. Install pull wires in empty raceways. Use monofilament plastic line having not less than 200 pound (90 kilogram) tensile strength. Leave not less than 12 inch (300 millimeter) of slack at each end of pull wire.
- O. Telephone and Signal System Raceways 2 inch Trade Size and Smaller: In addition to above requirements, install in maximum lengths of 150 foot (45 meters) and with maximum of two 90 degree bends or equivalent. Install pull or junction boxes where necessary to comply with these requirements.
- P. Conduit runs extending through areas of different temperature or atmospheric conditions or partly indoors and partly outdoors shall be sealed, drained and installed in manner preventing drainage of condensed or entrapped moisture into cabinets, motors or equipment enclosures.
- Q. PVC Externally Coated Galvanized Rigid Steel Conduit: Use only fittings approved for use with that material. Field cuts on all male threads of conduit sections, elbows, and nipples shall be protected by application of a conductive, non-corrosive protection. Patch nicks and scrapes in PVC coating after installing conduit. All installers shall be field certified by the PVC Coated manufacturer for installation and provide proof of certification.

3.05 CONDUIT STUB-UPS

- A. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above finished slab.

- B. Transition under floor conduit to PVC coated galvanized rigid steel conduit before rising above floor. Under floor conduit elbows shall be PVC coated galvanized rigid steel conduit. Extend the PVC coated galvanized rigid steel conduit portion of the stub-up minimum 12 inch above floor or slab.

3.06 CONDUIT BENDS

- A. Make bends and offsets so inside diameter is not reduced. Unless otherwise indicated, keep legs of bend in same plane and straight legs of offsets parallel.
- B. Provide NEMA standard conduit bends, except for conduits containing medium voltage cable, fiber optic cable, or conductors requiring large radius bends.
- C. Provide large radius conduit bends for conduits containing 5 kilovolt and 15 kilovolt cables as follows:

Conduit Trade Size	Bend Radius
2 inch - 2-1/2 inch	24 inch
3 inch - 4 inch	36 inch
5 inch	48 inch

- 1. Where physical limitations do not permit use of above, conduit bends with radius of at 8 times diameter of largest cable passing through conduit may be used.

3.07 FLEXIBLE CONNECTIONS

- A. Use maximum of 6 foot (1830 millimeter) of flexible conduit for recessed and semi-recessed lighting fixtures.
- B. Terminate conduits at motor terminal boxes, motor operated valve stations or pipe-mounted instruments and other equipment subject to vibration with maximum of 3 foot (915 millimeter) liquidtight flexible metal conduit unless other wise indicated.
- C. Use liquidtight flexible conduit in wet or damp locations.
- D. Use flexible conduit and connections suitable for hazardous classified locations in hazardous classified locations.
- E. Install separate ground conductor inside flexible conduit connections.

3.08 FITTINGS

- A. Install raceway sealing fittings according to manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in flush steel box with blank cover plate having finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at following points and elsewhere as indicated:
 - 1. Where conduits enter or leave hazardous locations.
 - 2. Where conduits pass from warm locations to cold locations, such as boundaries of refrigerated spaces and air-conditioned spaces.
 - 3. Where otherwise required by NEC.
- B. Use raceway fittings compatible with raceway and suitable for use and location. For GRS use threaded conduit fittings, except as otherwise indicated.

- C. Install automatic breather drain fittings according to manufacturers written instructions. Locate fittings to drain conduit system and prevent condensate from entering device enclosures. Install automatic breather drain fittings at following points and elsewhere as indicated. Fittings shall be installed such that condensate is directed away from electrical and mechanical equipment and/or toward sump area or floor drain.
 - 1. Where vertical seals are installed.
 - 2. Low points in conduit system.
 - 3. Where conduits enter panels or junction boxes in damp locations.
 - 4. Where conduits pass from outside of building to inside.
 - 5. Where conduits pass between rooms that have significant temperature differences.
 - 6. Below field instruments at junction of flexible and rigid conduit.
 - 7. Where otherwise required by NEC.
- D. Install wall entrance seal as dictated by application where conduits pass through foundation walls below grade.
- E. Install conduit expansion fittings complete with bonding jumper in following locations.
 - 1. Conduit runs crossing structural expansion joint.
 - 2. Conduit runs attached to 2 separate structures.
 - 3. Conduit runs where movement perpendicular to axis of conduit may be encountered.
- F. Where conduit passes from inside of building to outdoors, it shall be firmly packed at fitting nearest wall line with Johns-Manville Duxseal to depth of at least 1 inch after wires and cables are pulled in; or, if conduit enters directly into equipment, it shall be fitted with seal and drain fitting to prevent water entering equipment.

3.09 GROUNDING

- A. Ground in accordance with Section 26 05 26.
- B. Provide grounding connections for raceway, boxes, and components as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL 486A.

3.10 PROTECTION

- A. Provide final protection and maintain conditions, in manner acceptable to manufacturer and Installer, to ensure that coatings, finishes, and cabinets are without damage or deterioration at 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 touch-up coating recommended by manufacturer.

3.11 CLEANING

- A. Upon completion of installation of system, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END OF SECTION

SECTION 26 05 43
UNDERGROUND DUCTS AND MANHOLES FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Ducts.
2. Duct banks.
3. Handholes.

1.02 DEFINITIONS

A. Duct: General term for electrical conduit and other raceway, either metallic or nonmetallic, specified for use underground, embedded in earth or concrete.

B. Duct Bank: Group of 2 or more ducts in continuous run between two points.

C. Underfloor Conduits.

1. Conduits which run underground within perimeter of building walls under building floor. This may consist of 1 conduit, or several conduits grouped together.

D. Duct Bank Conduits

1. Conduits which run under ground outside perimeter of building walls. This may consist of 1 conduit, or several conduits grouped together.

E. Underground Conduits

1. Underground conduits are both underfloor conduits and duct bank conduits.

F. Handhole: Below-the-surface enclosure in connection with ducts into which people reach, but do not enter, for purpose of installing, operating, or maintaining equipment or wiring.

1.03 SUBMITTALS

A. Submittals identified below are required.

1. Product data.
2. Submit in accordance with Section 01 33 00.
3. Duct entrances to buildings detailing conduit materials and a sketch showing elevations of conduits in relation to the building floor slabs, footings and frost walls.
4. A buoyancy calculation for each handhole documenting that buoyance is not a problem. Criteria for buoyancy are as follows:
 - a. Minimum safety factor 1.1.
 - b. Surface friction with backfill materials shall not be included.
 - c. Submerged soil weight of 55 pounds per cubic foot where soil is used to help hold down the handhole. Only soil above handhole or any anti-flotation devices may be included.
 - d. Water table to grade.
 - e. No water to be included inside structure.
 - f. Weight for castings, all precast components and any manufacturer supplied fillets in bottom of handhole may be included.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturers of precast handholes shall be firms regularly engaged in manufacturing factory-fabricated handholes, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Items provided under this section shall be listed or labeled by Underwriters Laboratories, Inc. (UL) or other Nationally Recognized Testing Laboratory (NRTL).
 - 1. Term "NRTL" shall be as defined in OSHA Regulation 1910.7.
 - 2. Terms "listed" and "labeled" shall be as defined in National Electrical Code (NEC), Article 100.
- C. Regulatory Requirements:
 - 1. NEC: Components and installation shall comply with National Fire Protection Association (NFPA) 70.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store precast concrete units at site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- B. Lift and support precast concrete units only at designated lifting or supporting points.

1.06 SEQUENCING AND SCHEDULING

- A. Coordination of Work:
 - 1. Coordinate layout and installation of handholes with final arrangement of ducts as influenced by actual final location of other utilities in field.
 - 2. Coordinate elevations of duct and raceway entrances into handholes with final profiles of ducts and raceways as determined by coordination with other utilities, underground obstructions, and buildings.
 - 3. Establish locations and elevations to suit field conditions and assure duct runs drain to handholes, or as shown on Drawings.

PART 2 – PRODUCTS

2.01 DUCTS AND FITTINGS

- A. Comply with Section 26 05 33.16.

2.02 CAST-IN-PLACE CONCRETE

- A. Comply with Section 03 30 00 for concrete and Section 03 20 00 for reinforcing.
- B. Aggregate For Duct Encasement: 3/8 inch maximum size.
- C. Strength: 3,000 psi minimum 28 day compressive strength.

2.03 DUCT BANK ACCESSORIES

- A. Duct Supports: Rigid Polyvinyl Chloride (PVC) spacers selected to provide minimum duct spacings and concrete cover depths indicated, while rigidly supporting ducts during concreting.

2.04 HANDHOLE HARDWARE AND ACCESSORIES

- A. Frames and Covers: Cast iron conforming to American National Standards Institute (ANSI) C2, Rule 323. Truck traffic rated. Furnish with cast-in legend, "Electric" or "Signal" as appropriate. Cover-to-frame bearing surfaces machined.
- B. Sump Frame and Grate: Comply with FS RR-F-621, Type VII for frame, Type I for cover.
- C. Pulling Eyes in Walls: Eyebolt with rebar fastening insert. 2 inch diameter eye, 1 inch by 4 inch long bolt. Working load embedded in 6-inch, 4,000 psi concrete: 13,000 pounds minimum tension.
- D. Pulling and Lifting Irons in Floor: 7/8 inch diameter hot-dipped galvanized, bent steel rod, stress relieved after forming, and fastened to reinforced rod. Exposed triangular shaped opening. Ultimate yield strength, 40,000 pounds shear, 60,000 pounds tension.
- E. Bolting Inserts for Cable Stanchions: Flared, threaded inserts of noncorrosive, chemical resistant, nonconductive thermoplastic material. 1/2 inch internal diameter by 2-3/4 inch deep, flared to 1-1/4 inch minimum at base. Tested ultimate pull-out strength: 12,000 pounds, minimum.
- F. Expansion Anchors for Installation after Concrete is cast: Zinc-plated carbon steel wedge type with stainless steel expander clip 1/2 inch bolt size, 5,300 pound rated pull-out strength, and 6,800 pound rated shear strength, minimum.
- G. Cable Stanchions: Hot-rolled, hot-dipped galvanized "T" section steel, 2-1/4 inch size, punched with 14 holes on 1-1/2 inch centers for cable arm attachment.
- H. Cable Arms: 3/16 gauge hot-rolled, hot-dipped galvanized sheet steel pressed to channel shape, approximately two 12 inch wide by 14 inch long and arranged for secure mounting in horizontal position at any position on cable stanchions.
- I. Cable Support Insulators: High glaze, wet process porcelain arranged for mounting on cable arms.
- J. Ground Rods: Solid copper clad steel, 3/4 inch diameter by 10 foot length.
- K. Ground Wire: Stranded bare copper, No. 6 American Wire Gauge (AWG), minimum.

2.05 PRECAST HANDHOLES

- A. Factory fabricated of reinforced concrete in conformance with ANSI C2 and applicable requirements of American Society for Testing and Materials (ASTM) C478. Design handhole structure in accordance with requirements of American Association of State Highway and Transportation Officials (AASHTO) publication "Standard Specifications for Highway Bridges." AASHTO H20 highway loading shall apply with 30% loading added for impact.
- B. Precast Units: Interlocking, mating sections, complete with accessory items, hardware, and features as indicated including concrete knockout panels for conduit entrance and sleeve for ground rod.
- C. Joint sealant for joints between precast sections shall be continuous extrusion of asphaltic butyl material compounded for adhesion, cohesion, flexibility, and durability properties required for permanent seal against maximum hydrostatic pressures theoretically attainable at installation location with ground water level at grade.

2.06 RACEWAY/DUCT SEALING COMPOUND

- A. Compound:
 - 1. Nonhardening, putty-like consistency workable at temperatures as low as 35 degrees Fahrenheit.
 - 2. Compound shall not slump at temperature of 300 degrees Fahrenheit and shall readily adhere to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

PART 3 – EXECUTION

3.01 WIRING METHOD

- A. General: Install ducts for wiring runs indicated. Provide sizes as indicated.
- B. Single Lighting Duct Runs: Rigid nonmetallic PVC conduit, Schedule 40, encased in concrete unless otherwise noted.
- C. Duct Banks:
 - 1. Power and Control Conduits: Rigid nonmetallic conduit, Schedule 40, encased in concrete.
 - 2. Instrumentation Conduits: Galvanized Rigid Steel conduit encased in concrete.

3.02 EXCAVATION AND BACKFILL

- A. Conform to Section 31 23 33 except as modified below:
 - 1. Do not use heavy-duty, hydraulic-operated compaction equipment.
 - 2. Excavation: Cut trenches neatly and uniformly, and slope uniformly to required pitch.
 - 3. For direct-buried, nonencased ducts prepare trench bottoms free from stones, soft spots, and sharp objects. Where necessary, add 3 inch layer of stone-free sand or earth to trench bottom and compact to density of adjacent undisturbed soil to provide suitable bearing for ducts. Backfill over and around ducts on bottom of trench with stone-free sand or earth to 6 inch minimum above tops of ducts and compact by hand or pneumatic tamper to density of adjacent undisturbed earth.
 - 4. For each additional layer of direct-buried ducts above bottom ducts, backfill over and around each layer of ducts with stone-free sand or earth to 12 inch minimum above tops of ducts and compact by hand or pneumatically to density of adjacent undisturbed earth.
 - 5. Separation Between Direct-Buried, Nonencased Ducts: 3 inch minimum for like services, and 6 inch minimum between power and signal ducts.

3.03 INSTALLATION OF DUCTS

- A. Slope: Pitch ducts to drain towards handholes and away from buildings and equipment unless otherwise shown on Drawings. Minimum slope shall be 4 inch in 100 foot Where necessary to achieve this between handholes, slope ducts from high point in run to drain in both directions.
- B. Curves and Bends: Use manufactured elbows for stub-ups at equipment and at building entrances. For other curves and bends, except as otherwise indicated, use manufactured long sweep bends with minimum radius of 36 inches in both horizontal and vertical directions. Conduit elbows in duct banks shall be PVC coated galvanized rigid steel.
- C. Make joints in ducts and fittings watertight in accordance with manufacturer's instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

- D. Duct Entrances to Handholes: End bells spaced approximately 10 inch center to center for 5 inch ducts and varied proportionately for other duct sizes. Change from regular spacing to end bell spacing shall start 10 foot from end bell and shall be made without reducing duct line slope and without forming trap in line. Grout end bells into handhole walls from both sides to provide watertight entrances. Provide groundable end bushings on metal ducts and connect to system grounding conductor.
- E. Duct Entrances to Buildings: Transformations from underground PVC duct to steel conduit shall be made 10 foot minimum unless otherwise indicated on drawings, outside building wall and shall use fittings manufactured for purpose. Install in accordance with following:
 - 1. Concrete-Encased Ducts: Install reinforcing in duct banks and coordinate duct bank with structural design at wall so duct bank is supported at wall without reducing structural or watertight integrity.
 - 2. Waterproof Entrances: Where ducts enter buildings through waterproofed floor or wall, watertight entrance-sealing device shall be installed with sealing gland assembly on inside. Anchor device securely into masonry construction with one or more integral flanges and membrane waterproofing secured to device in permanently watertight manner.
- F. Concrete-Encased Ducts: Support on plastic separators coordinated with duct size and required duct spacing, and install in accordance with following:
 - 1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, and secure separators to earth and to ducts to prevent floating during concreting. Do not use tie wires or reinforcing steel in such way as to form conductive or magnetic loops around ducts or duct groups.
 - 2. Reinforcing: Reinforce duct banks. Size and arrange reinforcing steel as indicated on Drawings.
 - 3. Concreting: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not use power-driven agitating equipment unless specifically designed for duct bank application. Pour each run of envelope between handholes or other terminations in one continuous operation unless approved by Engineer. Where more than one pour is necessary, terminate each pour in vertical plane and continue duct bank reinforcing minimum of 18 inch beyond termination of pour.
 - 4. Forms: Walls of trench may be used to form side walls of duct bank provided soil is self-supporting and concrete envelope can be poured without soil inclusions. Use forms where soil is not self-supporting.
 - 5. Minimum Clearances: 3 inch between ducts and exterior envelope wall, 3 inch between ducts for like services, and 6 inch between power and ducts for other systems.
 - 6. Depth: Except as otherwise indicated, top of duct bank shall be 24 inch below finished grade, minimum, in nontraffic areas, and 30 inch below finished grade, minimum, in vehicular traffic areas.
- G. Stub-ups: Duct stub-ups to equipment shall be PVC coated galvanized rigid steel. For equipment mounted on outdoor concrete pads, PVC coated rigid steel conduit shall extend minimum of 5 foot away from edge of pad. Install insulated grounding bushings on terminations. Couple steel conduits to ducts with adapters designed for purpose and encased concrete.
- H. Sealing: For ducts to be wired in this Project, provide temporary closure at terminations. For spare ducts, seal bore of ducts at terminations. Use sealing compound and plugs as required to withstand 15 psi minimum hydrostatic pressure.
- I. Pulling Cord: Provide 100 pound test nylon cord in ducts including spares.
- J. Marker Tape: Provide plastic marker tape over ducts at 12 inch below finished grade in accordance with Section 26 05 53.

3.04 INSTALLATION OF HANDHOLES, GENERAL

A. General:

1. Provide handholes of sizes, shapes, and locations as indicated.
2. Determine final elevation of ducts as influenced by possible adjustments in other utilities and surface features and discovery of underground obstructions before installing handholes. Obtain Engineer's approval for handhole installation adjustments necessitated by obstructions.
3. Install units plumb and level and with orientation and depth coordinated with arrangement of connecting ducts to minimize bends and deflections required for proper entrances.

B. Elevation:

1. Handholes: Install handholes with depth as indicated. Where indicated, cast handhole cover frame directly into roof of handhole and set roof surface 1 inch above grade. In roads install flush with road.

C. Access: Install access to handhole through cast-iron frame and cover. Use 30 inch cover for handholes, except use 24 inch covers for 2 foot by 2 foot handholes. Set frames in paved areas and traffic ways flush with finished grade. Set other frames 1 inch above finished grade.

D. Waterproofing: Apply waterproofing to exterior surfaces of units after concrete has cured at least 3 days. After ducts have been connected and grouted in, and prior to backfilling, waterproof joints and connections and touch up abrasions and scars.

E. Hardware: Install removable hardware including pulling eyes, cable stanchions, cable arms, and insulators as required for installation and support of cable and conductors and as indicated.

F. Field-Installed Bolting Anchors: Do not drill deeper than 3-7/8 inch for anchor bolts installed in field. Use minimum of 2 anchors for each cable stanchion.

G. Grounding: Install ground rod through floor of each handhole with top protruding 4 inch above floor. Seal floor opening against water penetration with waterproof nonshrink grout. Ground exposed metal components and hardware with bare copper ground conductor. Train conductors neatly around corners. Install on walls and roof using cable clamps secured with expansion anchors.

3.05 INSTALLATION OF CAST-IN-PLACE HANDHOLES

A. Comply with Section 03 30 00 and construct handholes as indicated.

B. Finish interior surfaces with smooth troweled finish.

C. Windows for future duct connections shall be concrete knock-out panels 1-1/2 to 2 inch thick, located as indicated.

3.06 INSTALLATION OF PRECAST HANDHOLES

A. Install in accordance with ASTM C891 and manufacturer's instructions.

B. Support units on level bed of crushed stone or gravel, graded from 1 inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. In addition to the mastic joint sealer, all joints between precast handhole sections shall be sealed with an exterior joint seal. Joint seals manufacturers:

1. NPC - External Joint Wrap by Bidco, Inc.
 2. MacWrap External Collar by Mac Wrap Construction Products Co. Inc.
 3. Cretex Wrap by Cretex Specialty Products
 4. EZ-wrap by Press Seal Gasket Corporation
- D. Install external chimney seal between the handhole flange and the top of the handhole cone. Chimney seal shall be Cretex External Chimney Seal by Cretex Specialty Products, or equal.
- E. Internal joint seals will not be allowed.
- 3.07 TESTING
- A. Field Quality Control:
1. Grounding: Test handhole grounding provisions to ensure electrical continuity of bonding and grounding connections. Make ground-resistance test at each ground rod and submit report of results. Use an instrument specifically designed for ground-resistance measurements.
 2. Duct Integrity: Rod ducts with mandrell 1/4 inch smaller in diameter than internal diameter of ducts. Where rodding indicates obstructions in ducts, remove obstructions and retest.
 3. Water Tightness: Make internal inspection of handholes three months after completion of construction for indications of water ingress. Where leakage is noted, remove water found and seal leakage sources. Reinspect after two months and reseal remaining leakage sources. Repeat process at two month intervals until leakage is corrected.

3.08 CLEANING AND RESTORATION

- A. Clean Ducts: Clean full length of ducts with round bristle brush with diameter 1/2 inch greater than internal diameter of duct.
- B. Clean Handholes: Clean internal surfaces of handholes and remove foreign material.

3.09 RESTORATION

- A. Restore surface features at areas disturbed by excavation and reestablish original grades except as otherwise indicated.
- B. Where sod has been removed, replace it as soon as possible after backfilling is completed.
- C. Restore all areas disturbed by trenching, storing of dirt, cable laying, and other work to their original condition.
- D. Include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, or mulching.
- E. Restore disturbed paving as indicated.

END OF SECTION

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Identification of electrical materials, equipment, and installations.

1.02 SUBMITTALS

A. Product Data:

1. Submit for each type of product specified.

B. Miscellaneous:

1. Schedule of identification nomenclature to be used for identification signs and labels.

C. Submit in accordance with Section 01 33 00.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:

1. National Electrical Code (NEC): Components and installation shall comply with National Fire Protection Association (NFPA) 70.

PART 2 – PRODUCTS

2.01 RACEWAY AND CONDUCTOR LABELS

A. Manufacturer's Standard Products: Where more than one type is listed for specified application, selection is Installer's option, but provide a single type for each application category. Use colors prescribed by American National Standards Institute (ANSI) A13.1, NFPA 70, or as specified elsewhere.

B. Conform to ANSI A13.1, Table 3, for minimum size of letters for legend and minimum length of color field for each raceway or cable size.

1. Color: Black legend on orange field.
2. Legend: Indicates voltage.

C. Adhesive Labels: Preprinted, flexible, self adhesive vinyl. Legend is over-laminated with clear, wear and chemical resistant coating.

D. Pre-tensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color coded, acrylic or latex bands sized to suit diameter of line it identifies and arranged to stay in place by pre-tensioned gripping action when placed in position.

E. Colored Adhesive Tape: Self adhesive vinyl tape not less than 3 mils thick by 1 to 2 inch wide (0.08 millimeter thick by 25 to 51 millimeter wide).

- F. Underground Line Warning Tape: Permanent, bright colored, continuous printed, vinyl tape with following features:
 - 1. Size: Not less than 6 inch wide by 4 mils thick (152 millimeter wide by 0.102 millimeter thick).
 - 2. Compounded for permanent direct burial service.
 - 3. Embedded continuous metallic strip or core.
 - 4. Printed Legend: Indicates type of underground line.
- G. Aluminum, Wraparound Marker Bands: Bands cut from 0.014 inch (0.4 millimeter) thick aluminum sheet, with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.
- H. Plasticized Card Stock Tags: Vinyl cloth with preprinted and field printed legends. Orange background, except as otherwise indicated, with eyelet for fastener.
- I. Aluminum Faced Card Stock Tags: Wear resistant, 18 point minimum card stock faced on both sides with embossable aluminum sheet, 0.002 inch (0.05 millimeter) thick, laminated with moisture resistant acrylic adhesive, and punched for fastener. Preprinted legends suit each application.
- J. Brass or Aluminum Tags: Metal tags with stamped legend, punched for fastener. Dimensions: 2 by 2 inch (51 by 51 millimeter) by 0.05 inch (1.3 millimeter).

2.02 ENGRAVED NAMEPLATES AND SIGNS

- A. Manufacturer's Standard Products: Where more than one type is listed for specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, or as specified elsewhere.
- B. Engraving stock, melamine plastic laminate, 1/16 inch (1.6 millimeter) minimum thick for signs up to 20 square inch (129 square cm), 1/8 inch (3.2 millimeter) thick for larger sizes.
 - 1. Engraved Legend: white letters on black face.
 - 2. Punched for mechanical fasteners.
- C. Baked Enamel Signs for Interior Use: Preprinted aluminum signs, punched for fasteners, with colors, legend, and size as indicated or as otherwise required for application. 1/4 inch (6.4 millimeter) grommets in corners for mounting.
- D. Exterior, Metal Backed, Signs: Wear resistant, non-fading, UV resistant ink, with reinforced UV, chemical, abrasion, and moisture resistant laminate layer. Aluminum substrate 0.04 inch (1 millimeter), with colors, legend, and size appropriate to application. 1/4 inch (6.4 millimeter) grommets in corners for mounting.
- E. Fasteners for Plastic Laminated and Metal Signs: Self tapping stainless steel screws or No. 10/32 stainless steel machine screws with nuts, flat washers and lock washers.

2.03 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self extinguishing, 1 piece, self locking, Type 6/6 nylon cable ties with following features:
 - 1. Minimum Width: 3/16 inch (5 millimeter).
 - 2. Tensile Strength: 50 pound (22.3 kilograms) minimum.
 - 3. Temperature Range: Minus 40 to 185 degrees Fahrenheit (Minus 4 to 85 degrees Celsius).
 - 4. Color: As indicated where used for color coding.
- B. Paint: Alkyd-urethane enamel. Primer as recommended by enamel manufacturer.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Install identification devices according to manufacturer's written instructions.
- B. Install labels where indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
- C. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and or designations used for electrical identification with corresponding designations used in Contract Documents or required by codes and standards. Use consistent designations throughout Project.
- D. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.
- E. Self Adhesive Identification Products: Clean surfaces of dust, loose material, and oily films before applying.
- F. Install painted identification as follows:
 - 1. Clean surfaces of dust, loose material, and oily films before painting.
 - 2. Prime Surfaces: For galvanized metal, use single component, acrylic vehicle coating formulated for galvanized surfaces. For concrete masonry units, use heavy duty, acrylic resin block filler. For concrete surfaces, use clear, alkali resistant, alkyd binder type sealer.
 - 3. Apply one intermediate and one finish coat of silicone alkyd enamel.
 - 4. Apply primer and finish materials according to manufacturer's instructions.
- G. Identify Raceways containing power, control and instrumentation conductors with adhesive labels identifying voltage and raceway contents. Locate labels at penetrations of walls and floors, at 50 feet (15 meter) maximum intervals in straight runs, and at 25 feet (7.6 meter) in congested areas.
- H. Identify Raceways and Exposed Cables of Certain Systems with Color Banding: Band exposed and accessible raceways of systems listed below for identification.
 - 1. Bands: Pre-tensioned, snap around, colored plastic sleeves; colored adhesive tape; or combination of both. Make each color band 2 inch (51 millimeter) wide, completely encircling conduit, and place adjacent bands of 2 color markings in contact, side by side.
 - 2. Locate bands at changes in direction, at penetrations of walls and floors, at 50 feet (15 meter) maximum intervals in straight runs, and at 25 feet (7.6 meter) in congested areas.
 - 3. Colors: As follows:
 - a. Fire Alarm System: Red.
 - b. Fire Suppression Supervisory and Control System: Red and yellow.
 - c. Combined Fire Alarm and Security System: Red and blue.
 - d. Security System: Blue and yellow.
 - e. Mechanical and Electrical Supervisory System: Green and blue.
 - f. Telecommunications System: Green and yellow.
- I. Install Circuit Identification Labels on Boxes: Label externally as follows:
 - 1. Exposed Boxes: Pressure sensitive, self adhesive plastic label on cover.
 - 2. Concealed Boxes: Plasticized card stock tags.
 - 3. Labeling Legend: Permanent, water proof listing of panel and circuit number or equivalent.

- J. Identify Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communications lines, install continuous underground plastic line marker located directly above line at 6 to 8 inch (150 to 200 millimeter) below finished grade. Where multiple lines installed in common trench or concrete envelope provide multiple underground line warning tapes, one for each 16 inches of width of lines. If lines do not exceed an overall width of 16 inch (400 millimeter), use single line marker.
1. Install line marker for underground wiring, both direct buried and in raceway.
- K. Color Code Conductors: Secondary service, feeder, and branch circuit conductors throughout secondary electrical system.
1. Field applied, color coding methods may be used in lieu of factory coded wire for sizes larger than No. 10 AWG.
 - a. Colored, pressure sensitive plastic tape in half lapped turns for distance of 6 inch (150 millimeter) from terminal points and in boxes where splices or taps are made. Apply last 2 turns of tape with no tension to prevent possible unwinding. Use 1 inch (25 millimeter) wide tape in colors as specified. Adjust tape bands to avoid obscuring cable identification markings.
 - b. Colored cable ties applied in groups of 3 ties of specified color to each wire at each terminal or splice point starting 3 inch (76 millimeter) from terminal and spaced 3 inch (76 millimeter) apart. Apply with special tool or pliers, tighten to snug fit, and cut off excess length.
 2. 208/120 Volt System: As follows:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White.
 - e. Ground: Green.
 3. 480/277 Volt System: As follows:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - d. Neutral: White with non-green stripe.
 - e. Ground: Green.
- L. Power Circuit Identification: Use metal tags or aluminum wraparound marker bands for cables, feeders, and power circuits in vaults, pull boxes, junction boxes, manholes, and switchboard rooms.
1. Legend: 1/4 inch (6.4 millimeter) steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.
 2. Fasten tags with nylon cable ties; fasten bands using integral ears.
- M. Apply identification to conductors as follows:
1. Conductors to Be Extended in Future: Indicate source and circuit numbers.
 2. Multiple Power or Lighting Circuits in Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color coding for voltage and phase indication of secondary circuit.

3. Multiple Control and Communications Circuits in Same Enclosure: Identify each conductor by its system and circuit designation. Use consistent system of tags, color coding, or cable marking tape.
- N. Apply warning, caution, and instruction signs and stencils as follows:
1. Install warning, caution, and instruction signs where indicated or required to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved, plastic laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.
 2. Emergency Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8 inch (9 millimeter) high lettering for emergency instructions on power transfer, load shedding, and or emergency operations.
- O. Install identification as follows:
1. Apply equipment identification labels of engraved plastic laminate on each major unit of equipment, including central or master unit of each system. This includes communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Except as otherwise indicated, provide single line of text with 1/2 inch (13 millimeter) high lettering on 1-1/2 inch (38 millimeter) high label; where 2 lines of text are required, use lettering 2 inch (51 millimeter) high. Use white lettering on black field. Apply labels for each unit of following categories of equipment.
 - a. Panelboards, electrical cabinets, and enclosures.
 - b. Access doors and panels for concealed electrical items.
 - c. Motor control centers.
 - d. Push button stations.
 - e. Power transfer equipment.
 - f. Contactors.
 - g. Remote controlled switches.
 - h. Dimmers.
 - i. Control devices.
 - j. Transformers.
 - k. Frequency converters.
 - l. Television/audio monitoring master station.
 - m. Fire alarm master station or control panel.
 - n. Security monitoring master station or control panel.
 2. Apply designation labels of engraved plastic laminate for disconnect switches, breakers, push buttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.

END OF SECTION

SECTION 26 05 73
POWER SYSTEM STUDIES

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Short circuit study, protective device evaluation study, protective device coordination study, and arc flash study on a portion of the electrical power distribution system; see Drawing 007-E-3 for new electrical equipment.
 2. Portions of electrical distribution system from normal and alternate sources of power throughout distribution system. Normal system operating method, alternate operation, and operations which could result in maximum fault conditions and maximum incident energy shall be covered in study.
- B. Contractor shall engage services of independent engineering firm for purpose of performing electric power system studies as specified.
- C. The Electrical Power System Studies shall be performed and the shop drawing shall be submitted and approved prior to submitting the shop drawings for the electrical equipment.

1.02 SUBMITTALS

A. Study Report:

1. Provide summary of results of power system study in final report. Submit 5 bound copies of final report.
 2. Include:
 - a. Description, purpose, basis, and scope of study and single line diagram of power system.
 - b. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short circuit duties and commentary regarding same.
 - c. Protective device time versus current color coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.
 - d. Fault current calculations including definition of terms and guide for interpretation of computer printout.
 - e. Tabulation of appropriate tap settings for relay units.
 - f. Arc flash calculations and tabulation of incident energy level calories /square centimeter (cal/cm^2) for each equipment location and recommended personal protective equipment (PPE).
- B. Submit in accordance with Section 01 33 00.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:

1. National Electric Code (NEC): Components and installation shall comply with National Fire Protection Association (NFPA) 70.
2. National Electric Safety Code (NESC): Components and installation shall comply with American National Standards Institute (ANSI) C2.

3. Standard for Electrical Safety in the Work Place: National Fire Protection Association (NFPA) 70E.
- B. Qualifications of engineering firm.
1. Corporately and financially independent engineering organization which can function as unbiased engineering authority, professionally independent of manufacturers, suppliers and installers of equipment or systems studied as specified.
 2. Study report shall be signed and sealed by Professional Engineer registered in same State as project location.
 3. Engineering organization may be same as testing organization.

PART 2 – PRODUCTS

(Not Used)

PART 3 – EXECUTION

3.01 STUDIES

- A. Studies include following – See Drawing 007-E-3 for new equipment.
1. Power Transformer (T-3).
 2. Existing Switchgear (SWGR-1)
 3. New motor control centers.
 4. New power and lighting distribution panels.
 5. New and existing cable, wire, and conduit systems involved with contract.
- B. Studies do not include equipment as shown on Drawings indicated as future.
- C. Contractor and company performing the power system studies are responsible for gathering information on the equipment and conductors required to perform the power system studies.

3.02 SHORT CIRCUIT STUDY

- A. Provide complete report with printout data sheets using digital computer type program as part of study.
- B. Include utilities' short circuit contribution, resistance and reactance components of branch impedances, X/R ratios, base quantities selected, and other source impedances.
- C. Calculate short circuit momentary duty values and interrupting duty values based on assumed 3-phase bolted short circuit at switch gear base medium voltage controller, switchboard, low voltage Motor Control Center (MCC), distribution panelboard, pertinent branch circuit panel, and other significant locations through system. Include short circuit tabulation of symmetrical fault currents and X/R ratios. List with respective X/R ratio each fault location, total duty on bus, and individual contribution from each connected branch.

3.03 EQUIPMENT DEVICE EVALUATION STUDY

- A. Provide protective device evaluation study to determine adequacy of circuit breakers, molded case switches, automatic transfer switches, knife switches, controllers, surge arresters, busways, and fuses by tabulating and comparing short circuit ratings of these devices with calculated fault currents. Apply appropriate multiplying factors based on system X/R ratios and protective device rating standards. Notify Engineer of problem areas or inadequacies in equipment due to short circuit currents and provide suggested alternate equipment.

3.04 EQUIPMENT DEVICE COORDINATION STUDY

- A. Provide protective device coordination study with necessary calculations and logic decisions required to select or check selection of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated current transformers, and low voltage breaker trip characteristics and settings. Objective of study to obtain optimum protective and coordination performance from these devices.
- B. Include as part of coordination study, medium and low voltage classes of equipment from utility's incoming line protective device down to and including largest rated device in 480 volt MCCs and panelboards. Include phase and ground overcurrent protection as well as settings of other adjustable protective devices.
- C. Draw time-current characteristics of specified protective devices in color on log-log paper or computer printout. Include with plots complete titles, representative one-line diagram and legends, associated Power Company's relays or fuse characteristics, significant motor starting characteristics, complete parameters of transformers, complete operating bands of low voltage circuit breaker trip curves and fuses. Indicate types of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, transformer magnetizing in-rush and ANSI transformer withstand parameters, cable thermal overcurrent withstand limits, and significant symmetrical and asymmetrical fault currents. Provide coordination plots for phase and ground protective devices on system basis. Provide sufficient number of separate curves to indicate coordination achieved.
- D. Provide separate selection and settings of protective devices in tabulated form listing circuit identification, Institute of Electrical and Electronics Engineers (IEEE) device number, current transformer ratios and connection, manufacturer and type, range of adjustment, and recommended settings. Tabulate recommended power fuse selection for medium voltage fuses where applied in system. Notify Engineer of discrepancies, problem areas or inadequacies and provide suggested alternate equipment ratings and/or settings.

3.05 ARC FLASH STUDY

- A. Provide Incident Energy Study – An incident energy study shall be done in accordance with the IEEE 1584, "IEEE Guide for Performing Arc Flash Hazard Calculations" as referenced in NFPA 70E, "Standard for Electrical Safety in the Workplace", in order to quantify the hazard for selection of personal protective equipment (PPE).
- B. Adjust system design to optimize the results of the study as it relates to safety and reliable electrical system operation (e.g. overcurrent device settings, current limiting devices). This includes mitigation, where possible, of incident energy levels that exceed 40 cal/cm². Provide suggested alternate equipment and settings to minimize incident energy levels.
- C. Provide incident energy level (cal/cm²) for each equipment location and recommended PPE.
- D. Based on the results of the incident energy study provide and install a warning label (orange <40 cal/cm²) or danger label (red > 40 cal/cm²) for each piece of equipment. The label must be readable in both indoor and outdoor environments and contain the following information:
 - 1. Arc hazard boundary (feet and inches)
 - 2. Working distance (feet and inches)
 - 3. Arc flash incident energy at the working distance (cal/cm²)
 - 4. PPE category and description including the glove rating
 - 5. Voltage rating of the equipment
 - 6. Limited approach distance (feet and inches)
 - 7. Restricted approach distance (feet and inches)

8. Prohibited approach distance (feet and inches)
 9. Equipment/bus name
 10. Date prepared
- E. Provide one day of arc flash safety training, travel time excluded and at jobsite or classroom designated by Owner, that contains the requirements referenced in Occupational Safety and Health Administration (OSHA) 1910.269, OSHA 1910 Subpart S and NFPA 70E. Training shall include but not be limited to the following:
1. Proper use of the system analysis data
 2. Interpretation of hazard labels
 3. Selection and utilization of personal protective equipment
 4. Safe work practices and procedures

END OF SECTION

SECTION 26 05 84
ELECTRIC MOTORS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Electric motors for use on ac power systems up to 600 Volts.
2. Motors that are factory-installed as part of equipment.

B. Motors furnished under other sections of these Specifications as part of equipment items shall conform to requirements of this section except as noted otherwise in that section or indicated otherwise on Drawings or schedules.

C. Section does not include manufacturer's definite purpose, direct current, synchronous or wound rotor motors.

1.02 SUBMITTALS

A. General:

1. Include motor submittal as part of equipment submittal for equipment specified in other sections.
2. Include identification of equipment by name and tag number as indicated in Specifications or on Drawings.

B. Product Data:

1. Complete nameplate data in accordance with National Electrical Manufacturers Association (NEMA) standards.
2. Full load power factor and maximum recommended correction capacitor kilovoltamp (kVA) rating for motors 5 horsepower and larger.
3. Nominal efficiency in accordance with Institute of Electrical and Electronics Engineers (IEEE) 112.
4. Motor dimensions and frame size.
5. Manufacturer's printed data on each motor type being provided to indicate compliance with specified performance and construction.
6. Service manual to include storage and alignment instructions.

C. Submit in accordance with Section 01 33 00.

D. Operation and Maintenance (O&M) Data:

1. Operating instructions, maintenance requirements and parts list.
2. Submit with specification section of equipment of which motor is a part.
3. Submit in accordance with Section 01 78 23.

1.03 QUALITY ASSURANCE

A. Items provided under this section shall be listed or labeled by Underwriters Laboratories, Inc. (UL) or other Nationally Recognized Testing Laboratory (NRTL).

1. Terms "NRTL" shall be as defined in OSHA Regulation 1910.7.
2. Terms "listed" and "labeled" shall be as defined in National Electrical Code, Article 100.

- B. Comply with National Electrical Manufacturers Association (NEMA) MG 1, "Motors and Generators."
- C. Comply with UL 1004, "Motors, Electric".

PART 2 – PRODUCTS

2.02 MANUFACTURERS

- A. Siemens
- B. General Electric
- C. U.S. Motors
- D. Toshiba

2.03 GENERAL

- A. Requirements below apply to motors covered by this Section except as otherwise indicated.
- B. Motors 1/2 horsepower and Larger: Polyphase.
- C. Motors Smaller Than 1/2 horsepower: Single-phase.
- D. Frequency Rating: 60 Hertz.
- E. Voltage Rating: Determined by voltage of circuit to which motor is connected for following motor voltage ratings (utilization voltages):
 - 1. 120 volt Circuit: 115 volt - motor rating.
 - 2. 208 volt Circuit: 200 volt - motor rating.
 - 3. 240 volt Circuit: 230 volt - motor rating.
 - 4. 480 volt Circuit: 460 volt - motor rating.
- F. Service factors indicated for motors are minimum values and apply at frequency and utilization voltage at which motor is connected. Provide motors which will not operate in service factor range when supply voltage is within 10% of motor voltage rating.
- G. Capacity: Sufficient to start and operate connected loads at designated speeds in indicated environment, and with indicated operating sequence, without exceeding nameplate ratings. Provide motors rated for continuous duty at 100% of rated capacity.
- H. Temperature Rise: Based on 40 degrees Celsius ambient except as otherwise indicated.
- I. Enclosure: Totally Enclosed Fan Cooled (TEFC) unless otherwise indicated in other sections and as required by NEC.
 - 1. Explosion proof motors approved for specific hazard classifications covered by NEC.
 - 2. Weather proof motors designed for outdoors and in wet areas.
 - 3. Chemical resistant motors designed for severe duty applications, including high humidity, corrosive, dirty or salty atmospheres.
- J. Copper Windings.

2.04 POLYPHASE MOTORS

- A. Squirrel-cage induction-type conforming to following requirements except as otherwise indicated.
- B. NEMA Design Letter Designation: "B"
- C. Bearings: Double-shielded, prelubricated ball bearings suitable for radial and thrust loading for application.
- D. Motor Efficiencies:
 - 1. General purpose motors (not inverter duty/vector duty or explosion proof): NEMA Premium Energy Efficient Motors with nominal efficiency equal to or greater than that stated in NEMA MG 1 for NEMA Premium Energy Efficient Motors for that type and rating of motor.
 - 2. Inverter Duty and/or Vector Duty Motors: NEMA Energy Efficient/High Efficiency Motors with nominal efficiency equal to or greater than that stated in NEMA MG 1 for NEMA Energy Efficient/High Efficiency Motors for that type and rating of motor.
 - 3. Explosion proof motors: : NEMA Energy Efficient/High Efficiency Motors with nominal efficiency equal to or greater than that stated in NEMA MG 1 for NEMA Energy Efficient/High Efficiency Motors for that type and rating of motor
- E. Inverter Duty and/or Vector Duty Motors with Manufacturer's Premium Insulation System that is Specifically for Use with Solid-State Drives/ Variable Frequency Drives (VFD): Squirrel-cage induction, NEMA Design B units with ratings, characteristics, and features coordinated with and approved by drive manufacturer conforming to or exceeding the requirements of NEMA MG 1, Part 31.
 - 1. Include adequate thermal capacity for continuous operation under worst case temperature conditions with motor operating at rated torque, without reduction in insulation life of motor, under the range of conditions specified.
 - 2. Suitable for operation with inverters specified in Section 26 26 23.
 - 3. Provide factory installed motor shaft grounding ring:
 - a. AEGIS SGR grounding ring bolted to motor frame.
 - b. Sized for motor shaft.
 - c. Provide AEGIS SGR colloidal silver coating on motor shaft to increase conductivity and reduce resistance of motor shaft.
- F. Internal Thermal Overload Protection for Motors: For motors so indicated, protection automatically opens control circuit arranged for external connection. Protection operates when winding temperature exceeds safe value calibrated to temperature rating of motor insulation.
- G. Motors for Reduced Inrush Starting: Coordinate with indicated reduced inrush controller type and with characteristics of driven equipment load. Provide required wiring leads in motor terminal box to suit control method.
- H. Torque:
 - 1. Breakdown torque shall be 200% or more of maximum torque load placed on motor shaft.
 - 2. Provide necessary WK2 curves for special loads to coordinate with motors.
 - 3. Supply special motors where load requirements exceed standard design.
- I. Open Drip Proof (ODP).
 - 1. Energy Efficient.
 - 2. Protected Openings.
 - 3. Class B Insulation.
 - 4. 1.15 Service Factor.

5. Cast iron construction.
- J. Totally Enclosed Fan Cooled (TEFC) and Totally Enclosed Non Ventilated (TENV).
1. Energy Efficient.
 2. 1.15 service factor, Class "F" insulation.
 3. Cast iron construction; frame, conduit box, end shields, fan cover, inner caps for 182T frames and larger.
 4. Positive lubrication systems.
 5. Removable eyebolt.
 6. Suitable for indoor and outdoor installations.
 7. Diagonally split, neoprene gasketed, rotatable oversized conduit box with NPT threaded lead hole.
 8. Conduit box mounted, UL approved clamp type grounding lug.
 9. Permanently numbered non-wicking leads.
 10. Rust inhibitive non-washing lubricant.
 11. Stainless steel nameplate with.
 - a. NEMA nominal efficiency.
 - b. Anti Friction Bearing Manufacturers Association (AFBMA) bearing numbers.
 - c. Lubrication instructions.
- K. Corrosion Resistant (Mill and Chemical Duty).
1. Same features as TEFC, except as noted below.
 2. Neoprene lead seal separator gasket mounted between motor frame and conduit box.
 3. Anti-static corrosion resistant fan.
 4. Zinc plated hex head hardware.
 5. Stainless steel T drains and breather fittings.
 6. Stator and rotor completely epoxy coated for corrosion protection.
 7. Non-metallic V-ring shaft slinger.
 8. Double shielded bearings.
 9. Double-coated epoxy enamel exterior finish.
 10. Stainless steel nameplate.
- L. Explosion Proof.
1. Same features as TEFC.
 2. Approved for NEC hazardous classified location as noted in equipment specification or as indicated on Drawings.
 3. Automatic explosion proof breather drains.
- M. Submersible pump and mixer motors.
1. As specified in equipment specification sections.
 2. 1.10 service factor, unless otherwise indicated in equipment specification sections.

2.05 SINGLE-PHASE MOTORS

- A. One of following types as selected to suit starting torque and other requirements of specific motor application:
1. Permanent Split Capacitor.
 2. Split-Phase Start, Capacitor-Run.
 3. Capacitor-Start, Capacitor-Run.
- B. Shaded-Pole Motors: Use only for motors smaller than 1/20 horsepower.

- C. Internal Thermal Overload Protection for Motors: For motors so indicated, protection automatically opens power supply circuit to the motor, or control circuit arranged for external connection. Protection operates when winding temperature exceeds safe value calibrated to temperature rating of motor insulation. Provide device that automatically resets when motor temperature returns to normal range except as otherwise indicated.
- D. Bearings, belt connected motors and other motors with high radial forces on motor shaft shall be ball bearing type. Sealed, prelubricated sleeve bearings may be used for other single phase motors.

2.06 SOURCE QUALITY CONTROL

A. Testing:

1. Perform individual motor test on motors over 1 horsepower.
2. Test shall be standard NEMA routine production test in accordance with NEMA MG 1.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Field install motors in accordance with manufacturer's instructions and following:

1. Direct Connected Motors: Mount securely in accurate alignment.
2. Belt Drive Motors: Use adjustable motor mounting bases. Align pulleys and install belts. Use belts furnished by manufacturer and tension belts in accordance with manufacturer recommendations.

3.02 COMMISSIONING

- A. Check operating motors, both factory and field-installed, for unusual conditions during normal operation. Coordinate with commissioning of equipment for which motor is part.
- B. Report unusual conditions.
- C. Correct deficiencies of field-installed units.

3.03 ALIGNMENT

- A. Installer of motor is responsible for alignment.
- B. Check alignment of motors prior to startup.
- C. Motors over 50 horsepower: Laser alignment and balance check using test equipment specially designed for this purpose.

3.04 FIELD QUALITY CONTROL

- A. Inspect wire and connections for physical damage and proper connection.
- B. Conduct insulation resistance (megger) test on each motor 25 horsepower and larger before energizing. Conduct test with 500 or 1,000 volts direct current megger. Test each phase separately and follow procedures listed below.
 1. Disconnect voltage sources, lightning arrestors, capacitors, and other potential low insulation sources from motor before connecting megger to motor.

2. When testing phase, connect phases not under test to ground.
 3. Apply test voltage, phase to ground on each phase being tested. Record resistance reading at 30 sec and at 1 min after test voltage is applied. Divide 1 minute reading by 30 second reading to obtain dielectric absorption ratio (DAR). DAR shall be 1.25 or greater for phase to pass test.
 4. If phases have DAR of 1.25 or greater, attach tag to motor and mark tag "Insulation Resistance Test OK" and sign.
 5. If phases have DAR of less than 1.25, attach tag to motor and mark tag "Insulation Resistance Test Failed" and sign. Provide new motor and retest. Notify Engineer of failure and actions taken to correct.
 6. Connect equipment removed in Item 1 above.
- C. Before energizing motor, record motor's nameplate current on record drawing line diagrams. Size motor starter overload heaters with starter manufacturer's recommendation for given motor nameplate current, service factor, and power factor correcting capacitors, if provided.
- D. Check rotation of motor before connecting to driven equipment; before couplings are bolted or belts installed. Before motor is started to check rotation, determine that motor is lubricated. When rotation is correct, mark insulation resistance test tag "Rotation OK". Sign or initial test tag by person who checked motor rotation.
- E. Supplier or manufacturer shall direct services to system and equipment operation, maintenance, troubleshooting, and equipment and system-related areas other than wastewater treatment process. See Section 01 61 00.
- F. In addition to the services specified above, provide manufacturer's services as required to successfully complete systems demonstration as specified in Section 01 79 10.

END OF SECTION

SECTION 26 22 00
LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Product Data: Include data on features, components, ratings, and performance for each type of transformer specified. Include dimensioned plans, sections, and elevation views. Show minimum clearances and installed devices and features.
- B. Shop Drawings:
 - 1. Wiring Diagrams: Detail wiring and identify terminals for tap changing and connecting field-installed wiring.
- C. Test Results:
 - 1. Reports on transformer tests.
- D. Submit in accordance with Section 01 33 00.

1.02 QUALITY ASSURANCE

- A. Items provided under this section shall be listed or labeled by Underwriters Laboratories, Inc. (UL) or other Nationally Recognized Testing Laboratory (NRTL).
 - 1. Term "NRTL" shall be as defined in Occupational Safety and Health Administration (OSHA) Regulation 1910.7.
 - 2. Terms "listed" and "labeled" shall be as defined in National Electrical Code (NEC), Article 100.
- B. Regulatory Requirements:
 - 1. NEC: Components and installation shall comply with National Fire Protection Association (NFPA) 70.
- C. Comply with Institute of Electrical and Electronics Engineers (IEEE) C2.
- D. Comply with NFPA 70.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within enclosure of each ventilated-type unit throughout periods during which equipment is not energized and is not in space that is continuously under normal control of temperature and humidity.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Square D.
- B. Eaton/Cutler-Hammer

2.02 TRANSFORMERS, GENERAL

- A. Factory-assembled and -tested, air-cooled units of types specified, designed for 60 Hz service.
- B. Cores: Grain-oriented, nonaging silicon steel.
- C. Coils: Continuous copper windings without splices, except for taps.
- D. Internal Coil Connections: Brazed or pressure type.
- E. Enclosure: Class complies with National Electrical Manufacturers Association (NEMA) 250 for environment in which installed.

2.03 GENERAL-PURPOSE DISTRIBUTION AND POWER TRANSFORMERS

- A. Comply with NEMA ST 20 and list and label as complying with UL 1561.
- B. Efficiency: Efficiency equal to or greater than that stated in Department of Energy (DOE) 10 CFR Part 431 (2016), for that type and rating of transformer.
- C. Cores: 1 leg per phase.
- D. Windings: One coil per phase in primary and secondary.
- E. Enclosure: Indoor, ventilated.
- F. Insulation Class: 220°C class 115 degrees Celsius maximum rise above 40°C for transformers 15 Kilovoltamps (kVA) or smaller; 220°C class 80°C maximum rise above 40°C for transformers larger than 15 kVA.
- G. Taps: For transformers 3 kVA and larger, full-capacity taps in high-voltage windings are as follows:
 - 1. Taps, 15 through 500 kVA: Six 2.5% taps, 2 above and 4 below rated high voltage.
- H. K-Factor Rating: Transformers indicated to be K-factor rated are listed to comply with UL 1561 requirements for non-sinusoidal load current handling capability to degree defined by designated K-factor.
 - 1. Transformer design prevents overheating when carrying full load with harmonic content corresponding to designated K-factor.
 - 2. Nameplate states designated K-factor of transformer.
- I. Electrostatic Shielding: Each winding is independently single shielded with full-width copper electrostatic shield arranged to minimize interwinding capacitance.
 - 1. Coil leads and terminal strips are arranged to minimize capacitive coupling between input and output connections.
 - 2. Shield Terminal: Separate; marked "Shield" for grounding connection.
 - 3. Capacitance: Shield limits capacitance between primary and secondary to maximum of 33 picofarads over frequency range of 20 Hertz (Hz) to 1 MegaHertz (MHz).
 - 4. Common-Mode Noise Attenuation: Minus 120 Decibels (dB) minimum, 0.5 to 1.5 KiloHertz (kHz); minus 65 dB minimum, 1.5 to 100 kHz.
 - 5. Normal-Mode Noise Attenuation: Minus 52 dB minimum, 1.5 to 10 kHz.
- J. Wall-Mounting Brackets: Manufacturer's standard brackets for transformers up to 75 kVA.

2.04 FINISHES

- A. Indoor Units: Manufacturer's standard paint over corrosion-resistant pretreatment and primer.
- B. Outdoor Units: Comply with ANSI C57.12.28.

2.05 SOURCE QUALITY CONTROL

- A. Factory Tests: Design and routine tests comply with referenced standards.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Comply with safety requirements of IEEE C2.
- B. Arrange equipment to provide adequate spacing for access and for circulation of cooling air.
- C. Identify transformers and install warning signs according to Section 16075.
- 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.

3.02 GROUNDING

- A. Comply with NFPA 70 requirements separately derived systems for connecting to grounding electrodes and for bonding to metallic piping near transformer.
- B. Comply with Section 26 05 26 for materials and installation requirements.

3.03 FIELD QUALITY CONTROL

- A. Testing: Perform field quality-control testing.
 - 1. Test Objectives: To ensure transformer is operational within industry and manufacturer's tolerances, is installed according to Contract Documents, and is suitable for energizing.
 - 2. Report: Submit written report of observations and tests. Report defective materials and installation.
 - 3. Tests: Include following minimum inspections and tests according to manufacturer's written instructions. Comply with IEEE C57.12.91 for test methods and data correction factors.
 - a. Inspect accessible components for cleanliness, mechanical and electrical integrity, and damage or deterioration. Verify that temporary shipping bracing has been removed. Include internal inspection through access panels and covers.
 - b. Inspect bolted electrical connections for tightness according to manufacturer's published torque values or, if not available, those specified in UL 486A.
 - c. Insulation Resistance: Perform megohmmeter tests of primary and secondary winding to winding and winding to ground.
 - 1) Minimum Test Voltage: 1000 Volts, Direct Current (DC).
 - 2) Minimum Insulation Resistance: 500 megohms.
 - 3) Duration of Each Test: 10 minutes.
 - 4) Temperature Correction: Correct results for test temperature deviation from 20 degrees Celsius standard.

4. Test Failures: Compare test results with specified performance or manufacturer's data. Correct deficiencies identified by tests and retest. Verify that transformers meet specified requirements.
5. Supplier or manufacturer shall direct services to specific system and equipment operation, maintenance, field tests, and troubleshooting. See Section 01 61 00.
6. In addition to the services specified above, provide manufacturer's services as required to successfully complete systems demonstration as specified in Section 01 79 10.

3.04 CLEANING

- A. On completion of installation, inspect components. Remove paint splatters and other spots, dirt, and debris. Repair scratches and mars on finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

3.05 ADJUSTING

- A. After installing and cleaning, touch up scratches and mars on finish to match original finish.
- B. Adjust transformer taps and connections to provide optimum voltage conditions at utilization equipment throughout normal operating cycle of facility. Record primary and secondary voltages and tap settings or connections and submit with test results.

END OF SECTION

SECTION 26 24 16
PANELBOARDS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Lighting and power panelboards and associated auxiliary equipment rated 600 Volts and less.

1.02 SUBMITTALS

A. Product Data: For each type of panelboard, accessory item, and component specified.

B. Shop Drawings: For panelboards. Include dimensioned plans, sections, and elevations. Show tabulations of installed devices, major features, and voltage rating. Include following:

1. Enclosure type with details for types other than National Electrical Manufacturers Association (NEMA) 250, Type 1.
2. Bus configuration and current ratings.
3. Short-circuit current rating of panelboard.
4. Features, characteristics, ratings, and factory settings of individual protective devices and auxiliary components.

C. Test Results:

1. Indicate and interpret field test results for compliance with performance requirements.

D. Operation and Maintenance Manuals:

1. Instruction books and leaflets.
2. Recommended renewal parts list.
3. Drawings and information.
4. Submit in accordance with Section 01 78 23.

E. Submit in accordance with Section 01 33 00.

F. Approval of equipment specified in this section is contingent upon approval of coordination study specified in Section 26 05 73.

1.03 QUALITY ASSURANCE

A. Items provided under this section shall be listed or labeled by Underwriters Laboratories, Inc. (UL) or other Nationally Recognized Testing Laboratory (NRTL).

1. Term "NRTL" shall be as defined in Occupational Safety and Health Administration (OSHA) Regulation 1910.7.
2. Terms "listed" and "labeled" shall be as defined in National Electrical Code (NEC), Article 100.

B. Regulatory Requirements:

1. NEC: Components and installation shall comply with National Fire Protection Association (NFPA) 70.

C. Comply with National Electrical Manufacturers Association (NEMA) PB 1.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Square D Co.
- B. Eaton/Cutler-Hammer

2.02 PANELBOARD FABRICATION

- A. Enclosures: Flush- or surface-mounted cabinets as indicated. NEMA PB 1, Type 1, unless otherwise indicated to meet environmental conditions at installed location.
 - 1. Outdoor and Corrosive Locations: NEMA 250, Type 4X, 316 stainless steel.
- B. Front: Secured to box with concealed trim clamps, unless otherwise indicated. Front for surface-mounted panelboards shall be same dimensions as box. Fronts for flush panelboards shall overlap box, unless otherwise indicated.
- C. Directory Frame: Metal, mounted inside each panelboard door.
- D. Bus: Hard drawn copper of 98% conductivity.
- E. Main and Neutral Lugs: Compression type.
- F. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors. Bonded to box.
- G. Service Equipment Approval: Listed for use as service equipment for panelboards with main service disconnect.
- H. Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances, for overcurrent protective device ampere ratings indicated for future installation of devices.
- I. Special Features: Include following features for panelboards as indicated:
 - 1. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors; insulated from box.
- J. Extra Gutter Space: Dimensions and arrangement as indicated.
 - 1. Subfeed: Overcurrent protective device or lug provision as indicated.
- K. Feed-through Lugs: Sized to accommodate feeders indicated.

2.03 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- B. Doors: In panelboard front, with concealed hinges. Secure with flush catch and tumbler lock, keyed alike.

2.04 DISTRIBUTION PANELBOARDS

- A. Branch-Circuit Breakers: Where overcurrent protective devices are indicated to be circuit breakers, use bolt-on circuit breakers, except circuit breakers 225-Amp frame size and greater may be plug-in type where individual positive-locking device requires mechanical release for removal.

2.05 OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: NEMA AB 1, handle lockable.
 - 1. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting capacity rating to meet available fault current.
 - 2. Application Listing: Appropriate for application, including Type SWD for switching fluorescent lighting loads, Type HACR for heating, air-conditioning, and refrigerating equipment and Class B GFCI for pipeline and vessel fixed electrical heating equipment unless otherwise indicated.
 - 3. Circuit Breakers, 400 Amp and Larger: Field-adjustable short-time and continuous current settings.
 - 4. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.
 - 5. Series rated circuit breakers not acceptable.

2.06 SURGE PROTECTION DEVICES – Panelboard (125-LP-1)

- A. Provide with dedicated disconnecting means to isolate device from system without interrupting service.
- B. IEEE C62.41, selected to meet requirements for service entrance.
- C. Protection modes and UL 1449, third edition or latest edition, clamping voltages coordinated with circuit system and circuit voltage.
- D. Factory mounted with UL listed and labeled mounting device.
- E. 200 kiloamp (kA) per phase surge current capacity minimum.
- F. Door mounted diagnostic lights.
- G. Audible alarm, with silencing switch, to indicate when protection has failed. Switch shall be accessible from outside of enclosure and not require enclosure door to be opened to access.
- H. Replaceable modular design.
- I. Mounted within main circuit breaker section.
- J. One Form C contact to indicate suppressor is operational.
- K. Minimum of 10 year warranty.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install panelboards and accessory items according to NEMA PB 1.1.
- B. Mounting Heights: Top of trim 74 inch (1880 millimeter) above finished floor, unless otherwise indicated.
- C. Mounting: Plumb and rigid without distortion of box. Mount flush panelboards uniformly flush with wall finish.
- D. Circuit Directory: Type directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing.
- E. Install filler plates in unused spaces.
- F. Wiring in Panelboard Gutters: Arrange conductors into groups, and bundle and wrap with wire ties after completing load balancing.

3.02 IDENTIFICATION

- A. Identify field-installed wiring and components and provide warning signs as specified in Section 26 05 53.
- B. Panelboard Nameplates: Label each panelboard with engraved laminated-plastic or metal nameplates mounted with corrosion-resistant screws.

3.03 GROUNDING

- A. Make equipment grounding connections for panelboards.
- B. Provide ground continuity to main electrical ground bus.

3.04 CONNECTIONS

- A. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.

3.05 FIELD QUALITY CONTROL

- A. Make insulation-resistance tests of each panelboard bus, component, and connecting supply, feeder, and control circuits.
- B. Make continuity tests of each circuit.
- C. Visual and Mechanical Inspection.
 - 1. Check circuit breaker for proper mounting and compare nameplate data to drawings and specifications.
 - 2. Operate circuit breaker to ensure smooth operations.
 - 3. Inspect case for cracks or other defects.
- D. Balancing Loads: After Substantial Completion, conduct load-balancing measurements and make circuit changes as follows:
 - 1. Perform measurements during period of normal working load as advised by Owner.
 - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of facility. Make special arrangements with Owner to avoid disrupting critical 24 hr services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 3. Recheck loads after circuit changes during normal load period. Record all load readings before and after changes and submit test records.
 - 4. Tolerance: Difference exceeding 20% between phase loads, within panelboard, is not acceptable. Rebalance and recheck as required to meet this minimum requirement.

3.06 ADJUSTING

- A. Set field-adjustable pick-up and time-sensitivity ranges in accordance with Section 26 05 73.

3.07 CLEANING

- A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

END OF SECTION

SECTION 26 24 19
MOTOR-CONTROL CENTERS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Motor-control centers for use on ac circuits rated 600 Volts and less.

1.02 SUBMITTALS

A. Product Data:

1. Include dimensions, ratings, and data on features and components.

B. Shop Drawings: For each motor-control center specified in this Section. Include dimensioned plans, elevations, and component lists. Show ratings, including short-time and short-circuit ratings, and horizontal and vertical bus ampacities.

1. Schedule of features, characteristics, ratings, and factory settings of individual motor-control center units.
2. Wiring Diagrams: Interconnecting wiring diagrams pertinent to class and type specified for motor-control center. Schematic diagram of each type of controller unit indicated.

C. Motor Control Center Layout

1. Motor control center submitted shall include future spaces matching or exceeding the future spaces shown on drawings. Future spaces shall be grouped together as shown on drawings. If future spaces are shown as groups larger than 12 inches vertically, it is not acceptable to replace with multiple 6 inch or 12 inch spaces throughout motor control center. Provide additional motor control center section(s) as required to match or exceed total future vertical spaces as shown on drawings.
2. Motor control center layout submitted shall match as close as possible the motor control center layout shown on the drawings. Identical equipment and motors shown grouped together shall be grouped together with the tag numbers ascending from top to bottom or left to right.

D. Test Results:

1. Certified reports of field tests and observations.

E. Operation and Maintenance Data (O&M):

1. Maintenance data for Motor Control Center (MCC).
2. Submit in accordance with Section 01 78 23.

F. Miscellaneous: 0

1. 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.

G. Submit in accordance with Section 01 33 00.

- H. Approval of equipment specified in this section is contingent upon approval of coordination study specified in Section 26 05 73.

1.03 QUALITY ASSURANCE

- A. Source Limitations: Obtain similar motor-control devices through one source from single manufacturer.
- B. Items provided under this section shall be listed or labeled by Underwriters Laboratories, Inc. (UL) or other Nationally Recognized Testing Laboratory (NRTL).
 - 1. Term "NRTL" shall be as defined in OSHA Regulation 1910.7.
 - 2. Terms "listed" and "labeled" shall be as defined in National Electrical Code (NEC), Article 100.
- C. Regulatory Requirements:
 - 1. NEC: Components and installation shall comply with National Fire Protection Association (NFPA) 70.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver in shipping splits of lengths that can be moved past obstructions in delivery path.
- B. Store so condensation will not occur on or in motor-control centers. Provide temporary heaters as required to prevent condensation.
- C. Handle motor-control centers according to NEMA ICS 2.3. Use factory-installed lifting devices.

1.05 COORDINATION

- A. Coordinate features of controllers and accessory devices with pilot devices and control circuits to which they connect.
- B. Coordinate features, accessories, and functions of each motor controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.06 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
 - 1. Spare Fuse and Indicating Lamps: Furnish 1 spare for every 5 installed units, but not less than 1 set of 3 of each kind.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Allen-Bradley Co.
- B. ABB.
- C. No Substitutions allowed.

2.02 COORDINATION STUDY

- A. Where coordination study specified in Section 26 05 73 recommends changes in types, classes, features or ratings of equipment or devices from those indicated, make written request for instruction. Obtain instructions from Engineer before ordering equipment or devices recommended to be changed.

2.03 MOTOR-CONTROL CENTERS

- A. Wiring: NEMA ICS 3, Class I, Type B. Factory wiring shall be labeled at each end with markers which correspond to the approved shop drawing wiring diagrams.
- B. Enclosures: Surface-mounted cabinets as indicated. NEMA 250, Type 1 gasketed, unless otherwise indicated to meet environmental conditions at installed location.
 - 1. Compartments: Modular; individual doors have concealed hinges and quick-captive screw fasteners. Interlocks on combination controller units require disconnect means in off position before door can be opened or closed, except by consciously operating permissive release device.
 - 2. Interchangeability: Compartments are constructed to remove units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in control center. Units requiring same size compartment are interchangeable, and compartments are constructed to permit ready rearrangement of units, such as replacing 3 single units with unit requiring 3 spaces, without cutting or welding.
 - 3. Wiring Spaces: Each vertical section of structure with horizontal and vertical wiring has spaces for wiring to each unit compartment in each section, with supports holding wiring in place.
- C. Short-Circuit Current Rating for Each Section: Equal to or greater than indicated available fault current in symmetrical amperes at motor-control center location.

2.04 BUSES

- A. Material: Tin Plated copper.
- B. Ampacity Ratings:
 - 1. As indicated for horizontal buses.
 - 2. 300 amp minimum for vertical main buses or larger as required for installed units.
- C. Equipment Ground Bus: Noninsulated, horizontal copper bus 2 by 1/4 inch (50 by 6 millimeter), minimum.
- D. Horizontal Bus Arrangement: Main phase and ground buses extended with same capacity entire length of motor-control center, with provision for future extension at both ends by bolt holes and captive bus splice sections.
- E. Short-Circuit Withstand Rating: Same as short-circuit current rating of section.

2.05 FUNCTIONAL FEATURES

- A. Description: Modular arrangement of motor controllers, control devices, overcurrent protective devices, transformers, panelboards, instruments, indicating panels, blank panels, and other items mounted in compartments of motor-control center as indicated.
- B. Motor-Controller Units: Combination controller units of types and with features, ratings, and circuit assignments indicated.

1. Units with full-voltage, across-the-line, magnetic controllers up to and including Size 3 are installed on drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
 2. Units have short-circuit current ratings equal to or greater than short-circuit current rating of motor-control center section.
 3. Units in motor-control centers with Type B wiring are equipped with pull-apart terminal strips or drawout terminal boards for external control connections.
- C. Overcurrent Protective Devices: Types of devices with features, ratings, and circuit assignments indicated. Individual feeder-tap units through 225-Amp rating shall be installed on drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
- D. Spaces and Blank Units: Compartments fully bused and equipped with guide rails or equivalent, ready for insertion of drawout units.
- E. Spare Units: Type, sizes, and ratings as indicated, and installed in compartments indicated "spare."
- F. Key Interlocks: Arranged so keys are attached at devices indicated as shown on Drawing 007-E-10.

2.06 MAGNETIC MOTOR CONTROLLERS

- A. Description: NEMA ICS 2, Class A, full voltage, non-reversing, across-the-line, unless otherwise indicated.
- B. Control Circuit: 120 Volts; obtained from integral control power transformer, unless otherwise indicated. Include control power transformer with adequate capacity to operate connected pilot, indicating and control devices, plus 100% spare capacity.
- C. Combination Controller: Factory-assembled combination controller and disconnect switch with or without overcurrent protection as indicated.
1. Circuit-Breaker Disconnect: NEMA AB 1, motor-circuit protector with field-adjustable short-circuit trip coordinated with motor locked-rotor amperes.
- D. Overload Relay:
1. Enhanced Protection Overload Relay: Provide overload relays with NEMA Class 10 or better tripping characteristics for submersible equipment or where indicated. Select to protect motor against voltage unbalance and single phasing.

2.07 VARIABLE-FREQUENCY CONTROLLERS

- A. Provide in accordance with Section 26 29 33

2.08 OVERCURRENT PROTECTION

- A. Molded-Case Circuit Breaker: NEMA AB 1, handle lockable.
1. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting capacity rating to meet available fault current.
 2. Application Listing: Appropriate for application, including Type HACR for heating, air-conditioning, and refrigeration equipment.
 3. Circuit Breakers, 200 Amp and Larger: Trip units interchangeable within frame size.
 4. Circuit Breakers, 400 Amp and Larger: Field-adjustable, short-time, long-time, instantaneous, and continuous-current settings.

5. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.
6. Shunt Trip: Where indicated or required for ground fault protection trip.
7. Series rated circuit breakers not acceptable.

2.09 ACCESSORIES

- A. Factory install on controller enclosure, unless otherwise indicated.
 1. Green "Run" and Amber "Fault" Pilot Lights, push-to-test: NEMA ICS 2, heavy-duty type
 2. Indicating Lights, 30.5mm:
 - a. LED Lamp
 - b. Transformer type.
 - c. Colored lens as specified.
 - d. Transformer rated for 120vac.
 - e. Push to test.
 3. Manual overload reset button on all motor starter buckets.
 4. Hand-Off-Auto selector switch: NEMA ICS 2, heavy-duty type as specified on 009 drawings.
 5. Elapsed Time Meters: Heavy duty with digital readout in hours.
- B. Furnish following devices when indicated on Drawings.
 1. Push-Button Stations and Selector Switches: NEMA ICS 2, heavy-duty type.
 2. Stop and Lockout Push-Button Station: Momentary-break push-button station with factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
 3. Control Relays: Auxiliary and adjustable time-delay relays.
 4. Elapsed Time Meters: Heavy duty with digital readout in hours.
 5. Multifunction Digital-Metering Monitor: UL-listed or -recognized, microprocessor-based unit suitable for three- or four-wire systems and with following features:
 - a. Phase Currents, Each Phase: Plus or minus 1%.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1%.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1%.
 - d. Three-Phase Real Power: Plus or minus 2%.
 - e. Three-Phase Reactive Power: Plus or minus 2%.
 - f. Power Factor: Plus or minus 2%.
 - g. Frequency: Plus or minus 0.5%.
 - h. Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2%.
 - i. Accumulated energy, in megawatt hours (joules), plus or minus 2%; stored values unaffected by power outages for up to 72 hours.

PART 3 - EXECUTION

3.01 APPLICATIONS

- A. Select features of each motor controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, drive, and load; and configuration of pilot device and control circuit affecting controller functions.
- B. Select horsepower rating of controllers to suit motor controlled.

- C. Push-Button Stations: In covers of magnetic controllers for manually started motors where indicated, start contact connected in parallel with sealing auxiliary contact for low-voltage protection.
- D. Hand-Off-Automatic Selector Switches: Where Indicated.
- E. Pilot Lights: Push to test "Run" and "Stopped" pilot lights.

3.02 INSTALLATION

- A. Install motor-control centers according to NEMA ICS 2.3 and manufacturer's written instructions.
- B. Install motor-control centers on concrete housekeeping bases.

3.03 IDENTIFICATION

- A. Identify field-installed wiring and components and provide warning signs according to Section 26 05 53.

3.04 CONTROL WIRING INSTALLATION

- A. Install wiring between motor-control devices according to Section 26 05 19.
- B. Bundle, train, and support wiring in enclosures.
- C. Connect hand-off-automatic switch and other automatic control devices according to indicated wiring diagram or one that is manufacturer approved, where available.
 - 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 motor-control 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.

3.05 CONNECTIONS

- A. Tighten motor-control center bus joint, electrical connector, and terminal bolts according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.

3.06 COORDINATION STUDY

- A. Where coordination study specified in Section 26 05 73 recommends changes in types, classes, features or ratings of equipment or devices from those indicated, make written request for instructions. Obtain instructions from Engineer before ordering equipment or devices recommended to be changed.

3.07 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services:
 - 1. Supplier's or manufacturer's representative for equipment specified herein shall be present at jobsite or classroom designated by Owner for minimum workdays indicated, travel time excluded, for assistance during plant construction, plant startup, and training of Owner's personnel for plant operation. Include:
 - a. 1 man-day for Installation Services.
 - b. 1/2 man-day for Instructional Services.

2. Supplier or manufacturer shall direct services to system and equipment operation, maintenance, troubleshooting, and equipment and system-related areas other than wastewater treatment process. See Section 01 61 00.
3. In addition to the services specified above, provide manufacturer's services as required to successfully complete systems demonstration as specified in Section 01 79 00.

B. Testing:

1. Reports: Notify Engineer in writing indicating defective materials and workmanship and unsatisfactory test results. Include record of repairs and adjustments made.
2. Perform following tests:
 - a. Test insulation resistance of MCC buses; components; and of connecting supply, feeder, and control circuits. For components with solid-state devices or other sensitive components, perform tests in accordance with manufacturer's instructions.
 - b. Make continuity tests of circuits.
 - c. Inspect MCCs for defects and physical damage, testing laboratory labels, circuit connections, and nameplate compliance with up-to-date system drawings.
 - d. Perform operational test and exercise of mechanical components and other operable devices in accordance with manufacturer's instruction manual.
 - e. Check MCC anchorage, external clearances, and alignment and fit of components including internal elements.
 - f. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
 - g. Device Ratings and Settings: Verify ratings and settings of overload relays, motor circuit protectors, and overcurrent protective devices.
3. Quality Control Testing Program: Assure MCC installation meets specified requirements, is operational within specified tolerances, and provides appropriate protection for systems and equipment.
 - a. Test and inspect MCC' in accordance with manufacturer's recommendations and these specifications.
 - b. Schedule tests and provide notification at least 7 days in advance of test commencement.
 - c. Reports: Prepare written reports of test results and observations. Report defective materials and workmanship. Include complete records of adjustments and corrective action taken.
 - d. Labeling: On satisfactory completion of tests and related effort, apply label to tested components indicating results, person responsible, and date.
 - e. Test insulation resistance of buses and portions of control wiring that disconnect from solid-state devices through normal disconnecting features. Insulation resistance less than 100 megohms is not acceptable.
 - f. Verify appropriate capacity, overcurrent protection, and operating voltage of control power elements including control power transformers and control power wiring.
 - g. Check phasing of supply source to bus.
4. Perform following tests (Overcurrent Protection Devices):
 - 1) Make insulation resistance tests of circuit breaker buses, components, and connecting supply, feeder, and control circuits.
 - 2) Make continuity tests of circuits.
 - 3) Include full updating on final system configuration and parameters where they supplement or differ from those indicated in original Contract Documents.
 - 4) Comply with manufacturer's instructions for installation and testing of circuit breaker.
 - b. Visual and mechanical inspection: Include following inspections and related work.

- 1) Overcurrent-Protective-Device Ratings and Settings: Verify indicated ratings and settings to be appropriate for final system arrangement and parameters. Where discrepancies are found, Engineer shall recommend final protective device ratings and settings. Use accepted revised ratings or settings to make final system adjustments.
 - 2) Inspect for defects and physical damage, NRTL labeling, and nameplate compliance with current single line diagram.
 - 3) Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer's instruction manual.
 - 4) Check tightness of electrical connections of circuit breaker with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
 - 5) Clean circuit breaker using manufacturer's approved methods and materials.
 - 6) Verify installation of proper fuse types and ratings in fusible circuit breaker.
- c. Electrical Tests: Include following items performed in accordance with manufacturer's instructions:
- 1) Insulation resistance test of circuit breaker conducting parts. Insulation resistance less than 100 megohms is not acceptable.
 - 2) Verify trip unit reset characteristics for insulated-case circuit breakers.
 - 3) Make adjustments for final settings of adjustable-trip devices.
 - 4) Activate auxiliary protective devices such as ground fault or undervoltage relays, to verify operation of shunt-trip devices.
 - 5) Check key and other interlock and safety devices for operation and sequence. Make closing attempts on locked-open and opening attempts on locked-closed devices including moveable barriers and shutters.
5. Perform the following tests (Motor Controllers):
- 1) Test insulation resistance of conducting parts of motor control components; and of connecting supply, feeder, and control circuits. For devices containing solid-state components, use test equipment and methods recommended by manufacturer.
 - 2) Make continuity tests of circuits.
 - 3) Review updating of final system configuration and parameters where they supplement or differ from those indicated in original Contract Documents.
 - 4) Review manufacturer's written instructions for installation and testing of motor control devices.
- b. Visual and Mechanical Inspection: Include following inspections and related work.
- 1) Motor Control Device Ratings and Settings: Verify ratings and settings as installed are appropriate for final loads and final system arrangement and parameters. Recommend final protective device ratings and settings where differences found. Use accepted revised ratings or settings to make final system adjustments.
 - 2) Inspect for defects and physical damage and nameplate compliance with Drawings.
 - 3) Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer's written instructions.
 - 4) Check tightness of electrical connections of devices with calibrated torque wrench. Use manufacturer's recommended torque values.
 - 5) Clean devices using manufacturer's approved methods and materials.
 - 6) Verify proper fuse types and ratings in fusible devices.
- c. Electrical Tests: Perform following in accordance with manufacturer's written instructions.

- 1) Insulation resistance test of motor control devices conducting parts to extent permitted by manufacturer's written instructions. Insulation resistance less than 100 megohms not acceptable.
- 2) Make adjustments for final settings of adjustable trip devices.
- 3) Test auxiliary protective features such as loss of phase, phase unbalance, and undervoltage to verify operation.
- 4) Check for improper voltages at terminals in controllers having external control wiring when controller disconnect opened. Voltage over 30 volts unacceptable.

6. Retesting: Correct deficiencies and retest. Verify by retests that specified requirements are met.

3.08 ADJUSTMENTS

A. Set field-adjustable pick-up and time-sensitivity ranges in accordance with Section 26 05 73.

3.09 CLEANING

A. Inspect interior and exterior of motor-control centers. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean devices internally, using methods and materials recommended by manufacturer.

END OF SECTION

SECTION 26 27 26
WIRING DEVICES

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Receptacles, connectors, switches, and finish plates.

1.02 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

1.03 SUBMITTALS

A. Submittals are not required if one of named manufacturers is furnished. If named manufacturer is not furnished submit Product Data and Samples.

B. Product Data:

1. For each product specified that is not one of the named manufacturers.

C. Samples:

1. For devices and device plates for color selection and evaluation of technical features.

D. Submit in accordance with Section 01 33 00.

1.04 QUALITY ASSURANCE

A. Items provided under this section shall be listed or labeled by Underwriters Laboratories, Inc. (UL) or other Nationally Recognized Testing Laboratory (NRTL).

1. Term "NRTL" shall be as defined in OSHA Regulation 1910.7.
2. Term "listed" and "labeled" shall be as defined in National Electrical Code (NEC), Article 100.

B. Regulatory Requirements:

1. NEC: Components and installation shall comply with National Fire Protection Association (NFPA) 70.

C. Comply with National Electrical Manufacturers Association (NEMA) WD 1.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Wiring Devices:

1. Bryant Electric, Inc.
2. GE Company; GE Wiring Devices.
3. Hubbell, Inc.; Wiring Devices Div.
4. Killark Electric Manufacturing Co.
5. Pass & Seymour/Legrand; Wiring Devices Div.

6. Pyle-National, Inc.; an Amphenol Co.
- B. Wiring Devices for Hazardous (Classified) Locations:
1. Crouse-Hinds Electrical Co.; Distribution Equipment Div.
 2. Killark Electric Manufacturing Co.
 3. Pyle-National, Inc.; an Amphenol Co.
- C. Multioutlet Assemblies:
1. Airey-Thompson Co.
 2. Wiremold.
- D. Poke through, Floor Service Outlets and Telephone/Power Poles:
1. Hubbell, Inc.; Wiring Devices Div.
 2. Pass & Seymour/Legrand; Wiring Devices Div.
 3. Square D Co.
 4. Wiremold.

2.02 RECEPTACLES

- A. Straight Blade and Locking Receptacles: Heavy Duty specification grade.
- B. GFCI Receptacles: Termination type, with integral NEMA WD 6, Configuration 5-20R duplex receptacle. Design units for installation in 2-3/4 inch (70 millimeter) deep outlet box without an adapter.
- C. Isolated Ground Receptacles: Equipment grounding contacts connected only to green grounding screw terminal of device with inherent electrical isolation from mounting strap.
1. Devices: Listed and labeled as isolated ground receptacles.
 2. Isolation Method: Integral to receptacle construction and not dependent on removable parts.
- D. Industrial Heavy Duty Receptacle: Comply with International Electrotechnical Commission (IEC) 309-1 and 309-2.
- E. Color: Type 302, satin finished stainless steel unless otherwise indicated or required by Code.

2.03 PENDANT CORD/CONNECTOR DEVICES

- A. Matching, locking type, plug and receptacle body connector, NEMA WD 6, Configurations L5-20P and L5-20R, Heavy Duty grade.
1. Body: Nylon with screw open cable gripping jaws and provision for attaching external cable grip.
 2. External Cable Grip: Woven wire mesh type made of high strength galvanized steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.04 CORD AND PLUG SETS

- A. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
1. Cord: Rubber insulated, stranded copper conductors, with type SOW-A jacket. Green insulated grounding conductor, and equipment rating ampacity plus minimum of 30%.

2. Plug: Nylon body and integral cable clamping jaws. Match cord and receptacle type for connection.

2.05 SWITCHES

- A. Snap Switches: Heavy duty, quiet type.
- B. Dimmer Switches: Modular, full wave, solid state units with integral, quiet on/off switches and audible and electromagnetic noise filters.
 1. Control: Continuously adjustable slide, toggle, or rotary knob. Single pole or three way switch to suit connections.
- C. Telephone Jack: 8-position, modular, latching-plug type, flush in face of wall plated.
- D. Color: Type 302, satin finished stainless steel unless otherwise indicated or required by Code.

2.06 WALL PLATES

- A. Single and combination types match corresponding wiring devices.
 1. Plate Securing Screws: Metal with head color to match plate finish.
 2. Dry Locations: 0.04 inch (1 millimeter) thick, Type 302, satin finished stainless steel.
 3. Wet locations: Weatherproof plates and covers suitable for wet locations while in use.
 - a. Hinged and gasketed cover/enclosure to maintain weather tight seal while the equipment is plugged into it. TayNac or equal.

2.07 FLOOR SERVICE FITTINGS

- A. Type: Modular, flush type, dual service units suitable for wiring method used.
- B. Compartmentation: Barrier separates power and signal compartments.
- C. Housing Material: Die cast aluminum, satin finished.
- D. Power Receptacle: NEMA WD 6, Configuration 5-20R, gray finish, unless otherwise indicated.
- E. Signal Outlet: Blank cover with bushed cable opening, unless otherwise indicated.

2.08 POKE-THROUGH ASSEMBLIES

- A. Factory fabricated and wired assembly of below floor junction box unit with multichanneled, through floor raceway/firestop unit and detachable matching floor service outlet assembly.
 1. Size: Selected to fit nominal 3 inch (75 millimeter) cored holes in floor and matched to floor thickness.
 2. Fire Rating: Unit is listed and labeled for fire rating of floor ceiling assembly.
 3. Closure Plug: Arranged to close unused 3 inch (75 millimeter) cored openings and reestablish fire rating of floor.
 4. Wiring: Three No. 12 American Wire Gauge (AWG) power and ground conductors, one 75 ohm coaxial telephone/data cable, and one four-pair, telephone/data cable.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Mounting height as follows unless otherwise shown on Drawings:
 - 1. Switches: 48 inch above floor.
 - 2. AC Receptacles and Telephone Outlets: 15 inch above floor or 6 inch above counters, counter back-splashes, and baseboard radiators in finished areas; 48 inch above floor in unfinished areas.
- B. Install devices and assemblies plumb and secure.
- C. Install wall plates when painting is complete.
- D. Install wall dimmers to achieve indicated rating after derating for ganging as instructed by manufacturer.
- E. Do not share neutral conductor on load side of dimmers.
- F. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.
- G. Protect devices and assemblies during painting.
- H. Adjust locations at which floor service outlets and telephone/power service poles are installed to suit arrangement of partitions and furnishings.

3.02 IDENTIFICATION

- A. Comply with Section 26 05 53.
 - 1. Switches: Where three or more switches are ganged, and elsewhere as indicated, identify each switch with approved legend engraved on wall plate.
 - 2. Receptacles: Identify panelboard and circuit number from which served. Use machine printed, pressure sensitive, abrasion resistant label tape on face of plate and durable wire markers or tags within outlet boxes.

3.03 CONNECTIONS

- A. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.
- B. Isolated Ground Receptacles: Connect to isolated ground conductor routed to designated isolated equipment ground terminal of electrical system.
- C. Tighten electrical connectors and terminals according to manufacturers published torque-tightening values. If manufacturers torque values are not indicated, use those specified in UL 486A.

3.04 FIELD QUALITY CONTROL

- A. Test wiring devices for proper polarity and ground continuity. Operate each device at least six times.
- B. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.
- C. Replace damaged or defective components.

3.05 CLEANING

- A. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION

SECTION 26 28 00
LOW-VOLTAGE CIRCUIT PROTECTION DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Feeder and equipment disconnects.

1.02 SUBMITTALS

A. Product Data:

1. Submit for switches, circuit breakers, and accessories.

B. Shop Drawings:

1. Wiring diagrams detailing power and control wiring and differentiating clearly between manufacturer-installed wiring and field-installed wiring.

C. Test Results:

1. Report of Field Tests and Observations certified by Contractor.

D. Operating and Maintenance Data (O&M):

1. Maintenance data for tripping devices.
2. Submit in accordance with Section 01 78 23.

E. Submit in accordance with Section 01 33 00.

F. Approval of equipment specified in this section is contingent upon approval of coordination study specified in Section 26 05 73.

1.03 QUALITY ASSURANCE

A. Items provided under this section shall be listed or labeled by UL or other Nationally Recognized Testing Laboratory (NRTL).

1. Term "NRTL" shall be as defined in OSHA Regulation 1910.7.
2. Terms "listed" and "labeled" shall be as defined in National Electrical Code (NEC), Article 100.

B. Regulatory Requirements:

1. NEC: Components and installation shall comply with National Fire Protection Association (NFPA) 70.

C. Single-Source Responsibility: Enclosed switches, fuses and circuit breakers shall be product of single manufacturer.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Feeder and Equipment Disconnects:

1. Square D Co.
2. Eaton/Cutler-Hammer.

2.02 FEEDER AND EQUIPMENT DISCONNECTS

A. Safety Switches:

1. NEMA heavy duty Type HD.
2. Dual cover interlock.
3. Visible blades.
4. Provisions for control circuit interlock.
5. Pin type hinges.
6. Tin plated current carrying parts.
7. Quick make and break operator mechanism.
8. Handle attached to box, not cover.
9. Handle position indication, ON in up position and OFF in down position.
10. Padlock provisions for up to 3 padlocks in OFF position.
11. UL listed lugs for type and size of wire specified.
12. Spring reinforced fuse clips for Class R fuses.
13. Provisions for insulated or groundable neutral.
14. UL listed short circuit rating 200,000 RMS amp with Class R fuses.
15. Auxiliary contacts as specified on drawings.

B. Enclosures:

1. NEMA 1 in electrical equipment rooms.
2. NEMA 12 in other indoor locations.
3. NEMA 4X 316 stainless steel with watertight hubs for outdoor and wet locations.
4. NEMA 7 in hazardous classified locations.
5. As otherwise indicated and as required by NEC.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine utilization equipment nameplates and installation instructions to verify proper fuse locations, sizes, and characteristics.
- B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install enclosed switches in locations as indicated, according to manufacturer's written instructions.
- B. Install enclosed switches level and plumb.
- C. Connect enclosed switches and circuit breakers and components to wiring system and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts according to equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL Standard 486A.

3.03 IDENTIFICATION

- A. Install typewritten labels on inside door of each fused switch to indicate fuse replacement information.

3.04 COORDINATION STUDY

- A. Where coordination study recommends changes in types, classes, features or ratings of equipment or devices specified in Section 26 05 73 from those indicated, make written request for instructions. Obtain instructions from Engineer before ordering equipment or devices recommended to be changed.

3.05 ADJUSTING

- A. Set field-adjustable pick-up and time-sensitivity ranges as indicated.

3.06 CLEANING

- A. Upon completion of installation, inspect over current protection devices. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

END OF SECTION

SECTION 26 29 23
VARIABLE FREQUENCY DRIVE EQUIPMENT

PART 1 – GENERAL

1.01 SUMMARY

- A. Specifications for Variable Frequency Drive Equipment including Schedule 1 attached to this section.
- B. Variable Frequency Drive Equipment for project shall be from the same manufacturer and shall be the same model and type.

1.02 REFERENCES

- A. ANSI: American National Standards Institute
- B. IEEE: Institute of Electrical and Electronics Engineers
- C. UL: Underwriters Laboratory

1.03 SYSTEM DESCRIPTION

- A. Unless otherwise specified, run signals shall be derived from motor starter normally open auxiliary contacts or from variable frequency drive.
- B. References to “selector switch” refer to maintained contact type switch functions. Loss and return of control power to circuit does not change control mode or requirement as per switch position.
- C. References to “push-button” refer to momentary contact type switch functions.

1.04 SUBMITTALS

- A. Shop Drawings:
 - 1. Panel fabrication and dimensions drawings.
 - 2. Front of panel layout drawings.
 - 3. Interior panel layout drawings.
 - 4. Nameplate legend.
 - 5. Component specification sheets.
 - 6. Instruction manuals.
 - 7. Parts list.
 - 8. Recommended spare parts list.
 - 9. Include Engineer’s tag number or description when available on each drawing, specification sheet, and manufacturer’s catalog cut in submittal for each component included in system.
- B. Operation and Maintenance (O&M) Data:
 - 1. Submit manufacturer’s standard O&M data indicating safety and periodic maintenance data.
- C. Submit shop drawings and operation and maintenance data in accordance with the requirements of Section 01 33 00 and Section 01 78 23.

1.05 QUALITY ASSURANCE

- A. Review equipment motor submittal for compatibility with drive system and to assure 20-year motor insulation design life and drive sizing.
- B. Drive equipment shall conform to requirements of IEEE 519.
- C. VFDs and options shall be UL listed as a complete assembly. The VFD package shall have a UL listed short circuit current rating (SCCR) of 35,000 amps and this rating shall be indicated on the UL data label

PART 2 – PRODUCTS

2.01 PULSE WIDTH MODULATED (PWM) VARIABLE FREQUENCY DRIVE (VFD)

A. Manufacturers.

- 1. Allen Bradley: PowerFlex 753 Series.
- 2. ABB ACS 880 Series.
- 3. No substitutions allowed.

B. General:

- 1. Ambient temperature: 0 TO 40°C.
- 2. Humidity: 5 to 95%, non-condensing.
- 3. cUL/UL approved or CSA certified and UL listed.
- 4. Factory wiring shall be labeled at each end with markers which correspond to the approved shop drawing wiring diagrams.

C. Input Power.

- 1. 460 Volts Alternating Current (VAC) (+8%, -10%).
- 2. 3-phase, 3-wire, any phase sequence.
- 3. 60 Hertz (+/-5%).
- 4. Drive shall include surge protection. The surge protective device shall be listed per UL 1449 Third Edition (Sept 2009), Type 1 SPD (In=10kA), 200 kiloAmps (kA) short circuit current rating (SCCR) and have a voltage protection rating (VPR) of 3000Volts per UL 1449.
- 5. Capable of withstanding line voltage transients up to 3000 volts in accordance with ANSI 37.90.1 and ANSI C62.41.
- 6. Drive shall be constructed to limit line noise generated due to voltage distortion and line notch. Include as required to meet IEEE 519:
 - a. Insulated Gate Bipolar Transistor (IGBT) switching.
 - b. Direct Current (DC) Link Inductor.
 - c. 3% Line Reactor.

D. Output Power.

- 1. Match to motor.
- 2. 3-phase, 3-wire.
- 3. Sinusoidal wave, pulse width modulated wave form.
- 4. Maximum output: 460 VAC.
- 5. 6 to 60 Hertz, adjustable.
- 6. Frequency accuracy: +/- 1% of setting.

7. Rate full load output current in excess of motor nameplate current and increase motor current due to harmonics.
8. Output open and short circuit protection.
9. Power transistors shall be IGBT's with Peak Inverse Voltage (PIV) ratings of 1200 volts minimum.

E. Motor Performance.

1. 0.5% speed regulation in manual or automatic speed control mode.
2. 150% starting torque.
3. 100% rated torque from 60 Hertz to specified turndown over 10:1 speed range.

F. Drive features.

1. Selectable library of routines for 4-20 milliamps direct current (mAdc) follower circuitry to include output proportional to current, offset, slope, minimum clamp, and separate acceleration and deceleration adjustments.
2. Design circuit to accept 4-20 mAdc positive or negative signal, grounded or ungrounded.
3. Automatic restart on nuisance shutdown for up to 5 successive attempts.
4. Minimum Efficiency for constant torque applications.
 - a. 100% rated speed and load – 95% or better.
 - b. 70% rated speed and 100% load – 94% or better.
 - c. 50% rated speed and 100% load – 93% or better.
 - d. 30% rated speed and 100% load – 91% or better.
 - e. 20% rated speed and 100% load – 87% or better.
5. Include PI (proportional, integral) control function integral to drive.
6. 110% overload capacity for 60 seconds.

G. Short Circuit and Drive Input Protection:

1. Instantaneous over-current trip shutdown set at 180% and 150% overload capacity for 60 seconds.
2. Under-voltage protection with automatic restart.
3. Input power circuit breaker with 65,000 amps interrupting capacity (AIC), labeled in accordance with UL Standard 489 with through the door operator.
 - a. Provisions to lock in "OFF" position.
 - b. Mechanical interlock to prevent opening cabinet door with disconnect in the "ON" position, or moving disconnect to the "ON" position with the door open.
 - c. Auxiliary contact on main disconnect to isolate control power when control power fed from an external source.
 - d. Barriers and warning signs on terminals that are energized with power disconnect "OFF".

H. Internal Protective Features:

1. Output phase sequence independent of input phase sequence.
2. Phase loss protection.
3. High or low sustained voltage shutdown.
4. 120 vac or 24 volts direct current (vdc) grounded control circuits.
5. Anti-regenerative circuit to protect inverter during deceleration.
6. Transistor over-current and over-temperature protection.
7. Electrically isolated low voltage logic.

8. DC bus fuse protection.
9. MOV (metal oxide varistor) surge protection.

I. Inverter Adjustments

1. Maximum Speed: 50 to 100% rated.
2. Minimum Speed: 6 to 70% rated.
3. Current limit: 10% to 150%.
4. Linear Acceleration: 3 to 300 seconds.
5. Linear Deceleration: 3 to 300 seconds.
6. Torque boost.
7. Maximum voltage level.
8. Electronic thermal overload: 10 to 100% of drive current.
9. Carrier frequency: 2.2 to 8.0 kilohertz (kHz) adjustable.
10. Up to three adjustable skip frequencies.
11. Selectable volts/Hertz patterns to include general purpose, variable torque, constant torque, constant horsepower, and programmable.
12. Fault Recovery: Auto Restart.
13. Loss of Power: Auto Restart.
14. I/O Assignments: Field Adjustable.

J. Inverter Diagnostic and Shutdown Protective Features:

1. External fault.
2. Low line voltage.
3. High line voltage.
4. Instantaneous current overload.
5. Internal over-temperature.
6. Over-current stall.
7. Over-voltage stall.
8. Ground fault.
9. Blown input fuse.
10. Control power supply failure.

K. Inverter construction:

1. Modular construction for ease of maintenance.
2. Easily accessible from front.
3. Construct boards of fire retardant materials in accordance with NEMA Grade FR4 specifications.

L. External Signals – Provide as described below and as shown on Drawings 009-N-6 and 009-N-7.

1. Provide communications module with EtherNet/IP protocol for data communications with plant supervisory control and data acquisition (SCADA) system.
2. Capable of accepting two-wire or three-wire start/stop control contacts in the automatic mode.
3. Accept 4-20 mAdc input speed reference with adjustable bias and gain.
4. Accept 0-10,000 ohm potentiometer input speed reference.
5. Accept external safety shutdown signals as specified or shown on drawings.
6. Accept motor overtemp signal as specified or shown on drawings.
7. Provide dry contact for remote indication of drive run status.
8. Provide dry contact for remote indication of common equipment fault alarm.
9. Provide isolated 4-20 mAdc powered signal for remote indication of drive speed.

M. Operator interface:

1. Provide front of panel multifunction display/keypad, capable of controlling drive and setting drive parameters. Provide as a minimum with the following functions:
 - a. Start
 - b. Stop
 - c. Reset
 - d. Increase/Decrease Speed Control
 - e. Manual or Remote Mode.
2. Display shall indicate following parameters:
 - a. Control mode – manual or automatic.
 - b. Output frequency.
 - c. Output voltage.
 - d. Output current.
 - e. Motor RPM.
 - f. Alarms and Faults.
3. Keypad functions shall include:
 - a. Menu driven.
 - b. Parameters stored in non-volatile memory.
 - c. Password or code protected.

N. Accessories

1. Indicating Lights:
 - a. LED Lamp.
 - b. Transformer type.
 - c. Colored lens as specified.
 - d. Transformer rated for 120vac.
 - e. Push to test.
2. Factory install on front of overall motor control center bucket, as shown on Drawings 009-N-6 and 009-N-7
 - a. Green "RUN" and Amber "FAULT" pilot lights, push to test: NEMA ICS 2, heavy-duty type.
 - b. Manual overload reset button for Motor Protection Relay.
 - c. Digital speed indicator (displays in Hertz)
 - d. Elapsed Time Meters: Heavy duty with digital readout in hours.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Manufacturer's Field Services:

1. Supplier's or manufacturer's representative for equipment specified herein shall be present at job site or classroom designated by Owner for minimum workdays indicated, travel time excluded, to supervise final adjustment of system after installation is complete, system startup, and training of Owner's personnel for system operation. Include minimum of:

- a. 1 workday for Installation Services.
 - b. 1/2 workday for Instructional Services.
 - c. 1/2 workday for Post Startup Services.
2. Supplier or manufacturer shall direct services to system and equipment operation, maintenance, troubleshooting, and equipment and system related areas. See Section 01 61 00.
 3. In addition to the services specified above, provide manufacturer's services as required to successfully complete systems demonstration as specified in Section 01 79 00.
- D. Installation and wiring of drive shall be by construction contractor.

SCHEDULE 1 TO SECTION 26 29 33

VARIABLE FREQUENCY DRIVES (VFD)

Enclosure Tag Number	Associated Equipment Description and Tag Number	Encl. Rating**	Hp*	Equip. Spec.	Mode	Torque
600-VFD-0601	Thickened Sludge Pump No. 1 600-P-0601	**	20	43 23 57	Volt/ Hertz	Constant
600-VFD-0602	Thickened Sludge Pump No. 2 600-P-0602	**	20	43 23 57	Volt/ Hertz	Constant
600-VFD-0701	Process Drain Pump No. 1 605-P-0701	**	5	43 25 13	Volt/ Hertz	Variable
600-VFD-0702	Process Drain Pump No. 2 605-P-0702	**	5	43 25 13	Volt/ Hertz	Variable

* Verify Motor Horsepower and Full Load Current with Equipment Supplied.

** Variable Frequency Drive located within Motor Control Center; see one-line diagrams.

END OF SECTION

SECTION 26 32 09
PORTABLE GENERATOR CONNECTION CABINET

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Portable generator connection cabinet for standby power service from Owner's portable engine-generator set.

1.02 SUBMITTALS

A. Product Data:

1. Receptacles.

B. Shop Drawings:

1. Dimension drawings including materials of construction.

C. Operation and Maintenance (O&M) Data:

1. Submit in accordance with Section 01 78 23.

D. Submit in accordance with Section 01 33 00.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Owner will deliver generator set to site for testing by Contractor. Notify Owner at least 2 weeks prior to when generator set is needed.

1.04 QUALITY ASSURANCE

- A. Items provided under this section shall be listed or labeled by Underwriters Laboratories, Inc. (UL) or other Nationally Recognized Testing Laboratory (NRTL).

1. Term "NRTL" shall be as defined in Occupational Safety and Health Administration (OSHA) Regulation 1910.7.
2. Terms "listed" and "labeled" shall be as defined in National Electrical Code (NEC), Article 100.

B. Regulatory Requirements:

1. NEC: Components and installation shall comply with National Fire Protection Association (NFPA 70).

PART 2 - PRODUCTS

2.01 CABINET

A. Manufacturers:

1. Berthold Electric.
2. ESL Power Systems.

B. Ratings:

1. Solids Processing Building (Structure 600) – 480 volt, 3 phase 3 wire, 400 amp
 2. Administration Building (Structure 900) – 480 volt, 3 phase, 3 wire, 250 amp.
 3. Dewatering Centrifuge – 480 volt, 3 phase, 3 wire, 150 amp.
- C. Construct exterior doors with two 90 degree bends on edges so as to present flat surface to door gasket. Interior dead front panels shall be constructed with one 90 degree bend and secured with captive screws.
- D. Hinge portion of cabinet bottom to allow room for portable power cables to pass with front cabinet door in closed position.
- E. Access panel below access door for 480 v power cables. Panel shall be standardized with cover plate for weather-proofing and designed by cabinet manufacturers. Panel shall be held closed by cabinet door when not in use.
- F. Accessories:
1. Drip hood and pad-lockable front door.
- G. Label devices and connections with white engraved laminated bakelite plates with black letters which shall be engraved as follows:
1. Portable cable connector: 400 AMP EACH CONNECTOR
 480 VOLTS
 3 phase 3W
 2. Ground connector: GROUND CONNECTOR

2.02 CONNECTIONS

- A. Permanent Bus in Cabinet:
1. Compression lugs.
 2. Capable of accepting 1 – #3/0 to 600KCMIL cable/phase and 1 – #6 to #3 AWG ground.
- B. Generator Connections in Cabinet:
1. Leviton Series 16 Male Panel Receptacles.
 2. Phase and ground receptacle receptacles shall be sized based on ampacity of bus connection assuming one cable per phase from the generator or centrifuge.
 3. Provide color coded insulating sleeves for receptacles.

2.03 ACCESSORIES

- A. Provide female-female adaptors that have the ability to mate with the Leviton Male Panel Receptacles installed in the cabinet.
- a. One adaptor per installed receptacle.

PART 3 - EXECUTION

3.01 CONNECTIONS

- A. Terminate power cables with high-pressure crimp connectors.

3.02 IDENTIFICATION

A. See Section 26 05 53 for color coded insulating sleeve requirements.

3.03 FIELD QUALITY CONTROL

A. Schedule and conduct test of phase rotation on Owner's portable generator set.

B. Correct generator connection cabinet wiring if required for proper phase rotation.

END OF SECTION

SECTION 26 36 00
TRANSFER SWITCHES

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Non Automatic Transfer Switch (NATS).

1.02 SUBMITTALS

A. Product Data:

1. Submit for each transfer switch, including dimensioned plans, sections, and elevations showing minimum clearances; conductor entry provisions; gutter space; installed features and devices; and materials lists.
2. Wiring diagrams, elementary or schematic, differentiating between manufacturer-installed and field-installed wiring.

B. Test Results:

1. Certified reports of field tests and observations.

C. Miscellaneous:

1. Manufacturer's certificate of compliance to referenced standards and tested short-circuit closing and withstand ratings applicable to protective devices and current ratings used in this Project, as indicated and as specified in this section.

D. Operation and Maintenance (O&M) Data:

1. Include features and operating sequences, both automatic and manual.
2. List factory settings of relays and provide relay setting and calibration instructions.
3. Submit in accordance with Section 01 78 23.

E. Submit in accordance with Section 01 33 00.

1.03 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms experienced in manufacturing equipment of types and capacities indicated and having record of successful in-service performance.

B. Emergency Service: Manufacturer maintains service center capable of providing emergency maintenance and repairs at Project site with 4 hour maximum response time.

C. Items provided under this section shall be listed or labeled by Underwriters Laboratories, Inc. (UL) or other Nationally Recognized Testing Laboratory (NRTL).

1. Term "NRTL" shall be as defined in Occupational Safety and Health Administration (OSHA) Regulation 1910.7.
2. Terms "listed" and "labeled" shall be as defined in National Electrical Code (NEC), Article 100.

D. Regulatory Requirements:

1. NEC: Components and installation shall comply with National Fire Protection Association (NFPA) No. 70.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. ASCO.
- B. Russelectric, Inc.
- C. Cummins Power Generation.
- D. Kohler Co.

2.02 TRANSFER SWITCH PRODUCTS, GENERAL

- A. Number of Poles and Current and Voltage Ratings: As indicated.
- B. Solid-State Controls: Repetitive accuracy setting of within 2% or better over an operating temperature range of -20 to 70 degrees Celsius.
- C. Resistance to Damage by Voltage Transients: Components meet or exceed voltage surge withstand capability requirements when tested according to American National Standards Institute (ANSI) C37.90.1. Components meet or exceed voltage impulse withstand test of National Electrical Manufacturers Association (NEMA) ICS 1.
- D. Neutral Terminal: Where 2- or 3-pole switches are indicated, provide fully rated, solid, unswitched neutral terminal except as indicated.
- E. Enclosures: General purpose, NEMA 1, conforming to UL 508, except as otherwise indicated.
- F. Factory Wiring: Train and bundle factory wiring and identify consistently with Shop Drawings, by color code or by numbered or lettered wire and cable tape markers at terminations.
 1. Designated terminals accommodate field wiring.
 2. Power Terminals Arrangement and Field Wiring Space: Suitable for top, side or bottom entrance of feeder conductors as indicated.
 3. Terminals: Pressure type, suitable for copper or aluminum conductors of sizes indicated.
 4. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
- G. Electrical Operation: Accomplish by nonfused, momentarily energized solenoid or electric motor-operated mechanism, mechanically and electrically interlocked in both directions. Switches using components of molded case circuit breakers or contactors not designed for continuous duty, repetitive switching between active power sources are not acceptable.
- H. Switch Action: Mechanically held in both directions for double-throw switches.
- I. Switch Contacts: Use silver composition for switching load current. Provide separate arcing contacts for units rated 225 amps and more.
- J. Overcurrent devices are not part of switch products.

2.03 FINISHES

- A. Enclosures: Manufacturer's standard enamel over corrosion-resistant pretreatment and primer.

2.04 SOURCE QUALITY CONTROL

- A. Factory test components, assembled switches, and associated equipment to ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for conformance with specified requirements. Perform dielectric strength test conforming to NEMA ICS 1.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Wall Mounting of Transfer Switches: Mount on wall as indicated.
- B. Identify components in accordance with Section 26 05 53.

3.02 CONNECTIONS

- A. Tighten factory-made connections and field connections including connectors and terminals, screws and bolts, according to equipment manufacturer's published torque tightening values.
- B. When manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A.

3.03 GROUNDING

- A. Make equipment grounding connections for transfer switch units as indicated and as required by NEC.

3.04 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services:
 - 1. Supplier's or manufacturer's field technician for equipment specified herein shall be present at job site for minimum workdays indicated, travel time excluded, for service during plant construction, plant startup, and training of Owner's personnel for plant operation. Include minimum of:
 - a. 1/2 workday for Instructional Services.
 - b. 1/2 workday for Post Startup Services.
 - 2. Supplier or manufacturer shall direct services to specific system and equipment operation, maintenance, field tests, and troubleshooting. See Section 01 61 00.
 - 3. In addition to the services specified above, provide manufacturer's services as required to successfully complete systems demonstration as specified in Section 01 79 10.
- B. Preliminary Tests: Perform electrical tests as recommended by manufacturer and as follows.
 - 1. Measure phase-to-phase and phase-to-ground insulation resistance levels with insulation resistance tester, including external control circuits. Use test voltages and procedure recommended by manufacturer. Meet manufacturer's specified minimum resistance.
 - 2. Check for electrical continuity of circuits and for short circuits.
- C. Field Tests: Give 7 day advance notice of tests and perform tests in presence of Owner and Engineer.
- D. Tests: As recommended by manufacturer and as follows.

1. Contact Resistance Test: Measure resistance of power contacts for ATSs. Resolve values in excess of 500 micro-ohms and differences between adjacent poles exceeding 50%.
 2. Ground Fault Tests: Coordinate with testing specified in Section 26 28 00 to ensure sensors are properly selected and located to optimize ground-fault protection where power is being delivered from either source.
 - a. Verify grounding points and sensor ratings and locations.
 - b. Apply simulated fault current at sensors and observe reaction of circuit interrupting devices.
 3. Operational Tests: Demonstrate interlock, sequence, and operational function for each switch at least 3 times.
 - a. Simulate power failures of normal source to ATSs and of standby source with normal source available.
 - b. Simulate low phase-to-ground voltage for each phase of normal source of ATSs.
 - c. Verify time-delay settings and pick-up and drop-out voltages.
- E. Test Failures: Correct deficiencies identified by tests and prepare for retest. Verify equipment meets specified requirements.
- F. Reports: Maintain written record of observations and tests. Report defective materials and workmanship, and retest corrected items. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach label or tag to each tested component indicating satisfactory completion of tests.

END OF SECTION

SECTION 26 43 13
SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRIC POWER CIRCUITS

PART 1 – GENERAL

1.01 DESCRIPTION

- A. Provide effective high energy transient voltage surge suppression, surge current diversion and high frequency noise attenuation in all electrical modes for equipment connected downstream from the facility's meter or load side of the main overcurrent device. Unit shall provide protection against both transient surges under 100 microseconds (μ s) and temporary over voltages (TOV) and swells up to 2 minutes. Connect in parallel with the facility's wiring system.
- B. Designed and manufactured in the USA by qualified manufacturer of suppression filter system equipment engaged in commercial design and manufacture of such products for minimum of five (5) years.

1.02 SUBMITTALS

- A. Product Data:
 - 1. Include rated capacities; shipping, installed and operating weights; furnished specialties; and accessories for each model indicated.
- B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- C. Operation and Maintenance Data:
 - 1. Surge Protective Devices (SPD).
 - 2. Submit in accordance with Section 01 78 23.
- D. Warrantees: Special warrantees specified in this Section.
- E. Submit in accordance with Section 01 33 00.

1.03 ENVIRONMENTAL REQUIREMENTS

- A. Storage Temperature. Storage temperature range shall be -40°C to $+85^{\circ}\text{C}$ (-40°F to $+185^{\circ}\text{F}$).
- B. Operating Temperature. Operating temperature range shall be -40°C to $+60^{\circ}\text{C}$ (-40°F to $+140^{\circ}\text{F}$).
- C. Relative Humidity: Operation shall be reliable in an environment with 5% to 95% non-condensing relative humidity.
- D. Audible Noise: The unit shall not generate any audible noise.
- E. Magnetic Field: No appreciable magnetic fields shall be generated.

1.04 QUALITY ASSURANCE

- A. Systems shall be designed, manufactured, tested and installed in accordance with the following applicable documents and standards:

1. Underwriters Laboratories, Inc. (UL1449 4th edition and UL 1283 5th edition)
2. Canadian Standard Association (CSA)
3. National Electrical Manufacturers Association (NEMA LS1 - 1992)
4. American National Standards Institute / Institute of Electrical and Electronics Engineers ANSI/IEEE (C62.41 – 1991, C62.45 – 1992, and C62.34)
5. Military Standards (MIL-STD 220B)
6. National Electric Code (NEC)
7. National Fire Protection Association (NFPA 70 [NEC], 75 and 78)
8. Federal Information Processing Standards Publication 94 (FIPS PUB 94)
9. Underwriter's Laboratories 248-1

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Current Technology, Inc.

2.02 SURGE PROTECTIVE DEVICE (SPD)

- A. Surge suppressor shall have UL 1449 suppression ratings for each mode of protection, as follows:
 1. 480/277 volt, 3 phase "WYE" – 1200 volts.
 2. 120/208 volt, 3 phase "WYE" – 800 volts.
 3. 480 volt 3 phase "Delta" – 1800 volts
- B. Provide protection in all modes. Seven discrete modes for "WYE" systems, Line-to-Neutral (L-N), Line-to-Ground (L-G) and Neutral-to-Ground (N-G), and six modes for "Delta" systems, Line-to-Line (L-L) and Line-to-Ground (L-G). (See NEMA 2.2.7 & IEEE Std. 1100-1992).
- C. Include a predetermined number of Selenium cells in parallel with arrays of non-linear voltage dependent metal oxide varistors (MOV) to protect against system voltage swells.
- D. The Catastrophic Protection System shall provide TOV and voltage swell protection to the following:
 1. TOV – should be capable of surviving and continue to protect critical loads against multiple TOV events (described as 200% nominal voltage by 8 milliseconds (ms)).
 2. Swell – should be capable of protection against swells up to 180% nominal for 0.7 ohms load for greater than 18,000 cycles.
- E. MOVs tested per ANSI/IEEE C62.33-1982.
- F. Minimum Single Pulse Surge Current Capacity per ANSI/IEEE C62041-1991's standard 8 X 20 μ s current waveform, shall not be less than as follows:

Selenium Select SPD (without disconnect) – MCC & Power Panel

150,000 amps, L-N

150,000 amps, L-G min. amps per phase 300,000 (L-N plus L-G)

150,000 amps, N-G

150,000 amps, L-L

TransGuard SPD (without disconnect) – Lighting Panels

50,000 amps, L-N

50,000 amps, L-G min. amps per phase 100,000 (L-N plus L-G)
50,000 amps, N-G
50,000 amps, L-L

- G. Test system for repetitive sequential ANSI/IEEE C62.41 Category C3 waveforms. Minimum repetitive strikes of $1.2 \times 50 \mu\text{s}$, 20 kilovolt (KV) open circuit voltage and $8 \times 20 \mu\text{s}$, 10 kiloampere (KA) short circuit current with no more than 10% degradation of clamping voltage at the specified surge current.
- H. Provide an extended range noise tracking filter system between 50 kilohertz (kHz) and 100 megahertz (MHz) with a minimum insertion loss ratio of 50:1 or 34 db over the entire range per NEMA LS-1, 1992, Section 2.2.11. UL 1283 Listed as an Electromagnetic Interference Filter. (Standard insertion loss data obtained utilizing MIL-STD-220B 50 ohm insertion loss methodology).
- I. Minimum continuous operating voltage (MCOV) of any component shall not be less than 115% of nominal operating voltage. MCOV shall be a tested value per section 37.7.3 of UL 1449 3rd Edition.
- J. The primary suppression path shall be Line to Neutral.
- K. All surge current devices shall incorporate low impedance plated busbars. No small gauge round wire, printed circuit boards, silicon avalanche diodes or plug-in connections are acceptable.
- L. Each individual Selenium cell, MOV and capacitor shall be fused so that the failure of any component does not affect the operation or protection of the entire unit.
- M. Provide in metal enclosure NEMA rated suitable for the installed location.

2.03 ACCESSORIES

A. SELENIUM SELECT SPD ON-LINE MONITORING

- 1. **MasterMIND Monitoring.** One set of status monitoring lights, that will provide visual indication of voltage present to the SPD. The lights shall also indicate when any value of less than 50% suppression protection is available from the SPD.
 - a. An audible alarm, a surge counter categorized into three industry recognizable categories, and two sets of Form C contacts for remote monitoring.
 - b. Monitoring system shall include a local graphics (M6E option) display to provide a time, date, magnitude, and duration stamp for when the following power quality events occur:
 - 1) Sags (voltage < 90% of nominal)
 - 2) Swells (voltage > 110% of nominal)
 - 3) Surges (voltage > 130% of peak voltage)
 - 4) Dropouts and Outages (power interruptions > 1 cycle)
 - c. System shall be capable of communicating remotely via Modbus-TCP over Ethernet and a web interface via Ethernet.

B. TRANSGUARD SPD ON-LINE MONITORING

1. **Basic Monitoring.** One set of status monitoring lights, that will provide visual indication of voltage present to the SPD. The lights shall also indicate when any value of less than 50% suppression protection is available from the SPD. Alarm output contacts and a surge counter.

PART 3 - EXECUTION

3.01 SYSTEM TESTING

A. Factory test before shipment.

1. Testing shall include, but not be limited to production-line tests, quality assurance checks, MCOV, and benchmark clamping voltage tests.
2. A copy of the benchmark clamping tests for each individual SPD shall be included with each unit.

B. Manufacturer's Field Services:

1. Supplier's or manufacturer's representative for equipment specified herein shall be present at jobsite or classroom designated by Owner for minimum workdays indicated, travel time excluded, for assistance during plant construction, plant startup, and training of Owner's personnel for plant operation. Include:
 - a. 1/2 workday for Installation and Testing Services.
 - b. 1/2 workday for Instructional Services.
2. Supplier or manufacturer shall direct services to system and equipment operation, maintenance, troubleshooting, and equipment and system-related areas other than wastewater treatment process. See Section 01615.
3. Obtain the services of a factory-authorized local service representative to provide the following tests:
 - a. Voltage measurements from L-G, L-N, L-L and N-G (as applicable).
 - b. Impulse injection to verify the system suppression voltage tolerances for all suppression paths. (Note: This testing is separate from any switchgear or other system tests. Completely disconnect the SPD from the switchgear prior to any switchgear or other system tests, including any hi pot testing.)
 - c. Record and compare test results to factory benchmark test parameters supplied with each individual unit.
 - d. Submit a copy of the start-up test results and the factory benchmark testing results to the engineer and the owner for confirmation of proper system function.

3.02 INSTALLATION

A. Selenium SPDs

1. SPDs shall be installed on load side of the main disconnects.
2. SPDs 150KA per mode and below shall have a dedicated circuit breaker disconnect at the connection point in the electrical distribution equipment. SPDs above 150KA per mode shall be connected directly to the equipment bus. Low impedance (HPI) cable shall be used to connect the SPD to the electrical distribution equipment. The total cable length between the SPD and the motor control centers and panelboards shall not exceed 10 feet.

3.03 SYSTEM WARRANTY

- A. The SPD system manufacturer shall warranty the entire system against defective materials and workmanship for a period of twenty years for the Selenium Select SPDs and fifteen years for the TransGuard SPDs.

END OF SECTION

SECTION 26 51 00
INTERIOR LIGHTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Interior lighting fixtures
2. Ballasts
3. Emergency lighting units
4. Accessories.

1.02 DEFINITIONS

- A. Emergency Lighting Unit: Fixture with integral emergency battery-powered supply and means for controlling and charging battery. Also known as an emergency light set.
- B. Fixture: Complete lighting unit, exit sign, or emergency lighting unit. Fixtures include lamps and parts required to distribute light, position and protect lamps, and connect lamps to power supply. Internal battery-powered exit signs and emergency lighting units also include battery and means for controlling and recharging battery. Emergency lighting units include ones with and without integral lamp heads.
- C. Average Life: Time after which 50% fails and 50% survives under normal conditions.

1.03 SUBMITTALS

A. Product Data

1. Describe fixtures, lamps, ballasts, and emergency lighting units. Arrange Product Data for fixtures in order of fixture designation.
2. Include data on features and accessories and following:
 - a. Outline drawings indicating dimensions and principal features of fixtures.
 - b. Electrical Ratings and Photometric Data: Certified results of laboratory tests for fixtures and lamps.
 - c. Battery and charger data for emergency lighting units.

B. Maintenance and Operating Data (O&M):

1. Maintenance data for fixtures to include operation and maintenance information.

C. Submit in accordance with Section 01 33 00.

1.04 QUALITY ASSURANCE

A. Items provided under this section shall be listed or labeled by UL or other Nationally Recognized Testing Laboratory (NRTL).

1. Term "NRTL" shall be as defined in OSHA Regulation 1910.7.
2. Terms "listed" and "labeled" shall be as defined in National Electrical Code, Article 100.

3. Special Listing and Labeling: Provide fixtures for use in damp or wet locations, underwater, and recessed in combustible construction that are specifically listed and labeled for such use. Provide fixtures for use in hazardous (classified) locations that are listed and labeled for specific hazard.
- B. Regulatory Requirements:
1. National Electrical Code (NEC): Components and installation shall comply with National Fire Protection Association (NFPA) 70.
- C. Coordinate fixtures, mounting hardware, and trim with ceiling system and other items, including work of other trades, required to be mounted on ceiling or in ceiling space.
- 1.05 WARRANTY
- A. Special Warranty for Batteries: Submit written warranty executed by manufacturer agreeing to replace rechargeable system batteries that fail in materials or workmanship within the specified warranty period.
- 1.06 EXTRA MATERIALS
- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
1. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least 1 of each type.
 2. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least 1 of each type.
 3. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least 1 of each type.

PART 2 - PRODUCTS

2.01 FIXTURES AND FIXTURE COMPONENTS

- A. Metal Parts: Free from burrs, sharp corners, and edges.
- B. Sheet Metal Components: Steel, except as indicated. Form and support to prevent warping and sagging.
- C. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position.
- D. Reflecting Surfaces: Minimum reflectance as follows, except as otherwise indicated:
1. White Surfaces: 85%.
 2. Specular Surfaces: 83%.
 3. Diffusing Specular Surfaces: 75%.
 4. Laminated Silver Metallized Film: 90%.
- E. Lenses, Diffusers, Covers, and Globes: 100% virgin acrylic plastic or water white, annealed crystal glass, except as otherwise indicated.
1. Plastic: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

2. Lens Thickness: 0.125 inch (3 millimeter) minimum; except where greater thickness is indicated.
- F. Fixture Support Components: Comply with Section 26 05 29.
1. Single-Stem Hangers: 1/2 inch (12 millimeter) steel tubing with swivel ball fitting and ceiling canopy. Finish same as fixture.
 2. Twin-Stem Hangers: Two, 1/2 inch (12 millimeter) steel tubes with single canopy arranged to mount a single fixture. Finish same as fixture.
 3. Rod Hangers: 3/16 inch (5 millimeter) minimum diameter, zinc-plated, threaded steel rod.
 4. Hook Hanger: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.
- G. Light Emitting Diodes (LED):
1. Recessed Fixtures
 - a. LEDs rated for 50,000 hour life minimum.
 - b. Embedded controls shall allow fixture to communicate with other nLight enabled controls included but not limited to dimmers, switches, occupancy sensors, and photocontrols.
 - c. Lumen Management system (N80) provides onboard intelligence that actively manages the LED light source so that constant lumen output is maintained over the system life.
 - d. LED AccuDrive: driver delivers full-range dimming from 0-10V control signal.
 - e. CSA Certified.
 - f. Tested to LM80 standards.
 - g. UL listed driver.
 2. Non-recessed Fixtures
 - a. LED rated for 100,000 hour life.
 - b. Embedded controls shall allow fixture to communicate with other nLight enabled controls included but not limited to dimmers, switches, occupancy sensors, and photocontrols
 - c. 0-10V dimming.
 - d. Damp rated.
 - e. CSA Certified.
 - f. UL listed driver.
- H. Exit Signs: Conform to UL 924 and following:
1. Light Emitting Diodes.
 2. Sign Colors: Conform to local code.
 3. Minimum Height of Letters: Conform to local code.
 4. Arrows: Include as indicated.
- I. Emergency Lighting Units: Conform to UL 924. Provide self-contained units with following features:
1. Two attached LED lamp heads.
 2. Battery: Sealed, maintenance-free, lead-acid type with minimum 10 year nominal life and special warranty.
 3. Charger: Minimum 2-rate, fully automatic, solid-state type, with sealed transfer relay.
 4. Operation: Relay automatically turns lamp on when supply circuit voltage drops to 80% of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. Relay disconnects lamps and battery and automatically recharges and floats on trickle charger when normal voltage is restored.

2.02 FINISHES

- A. Manufacturer's standard, except as otherwise indicated, applied over corrosion-resistant treatment or primer, free of streaks, runs, holidays, stains, blisters, and similar defects.

2.03 INDOOR CONTROLS (Structure 120 & 900)

A. MANUFACTURERS

- 1. Acuity Brands (Sensor Switch & nLight)

- a. Provide all lighting controls from same manufacturer.

- B. Dual technology sensors contain both passive infrared and Microphonics.

- C. Sensors shall operate at low voltage.

- D. Sensors shall have field adjustable time delay to turn off fixtures, 1 to 20 minute delay minimum range.

- E. System shall be compatible with a web-based software management program that enables remote system control, status monitoring, and creation of lighting control profiles.

- F. All switching and dimming for a specific lighting zone shall take place within the devices located in the zone itself (i.e. not in a remotely located devices such as panels) to facilitate system robustness and minimize wiring requirements. Specific applications that require centralized or remote switching shall be capable of being accommodated.

- G. Passive infrared wall/corner mount sensor

- 1. 90 to 130 degree coverage, minimum 100 foot detection range at mounting height of 10 ft.

- H. Dual technology wall switch

- 1. Minimum 15 foot detection range at wall switch mounting height of 44 inches.

- 2. Features

- a. Configurable to 3-way or 4-way switch as required.

- I. Dimmable Wall Switch

- 1. Pushbutton wall switch to control 0-10VDC dimmable fixtures.

- J. Dual technology extended range ceiling sensor

- 1. Circular coverage, minimum 28 foot detection range at mounting height of 10 ft.

- K. Dual technology standard range ceiling sensor

- 1. Circular coverage, minimum 12 foot detection range at mounting height of 10 ft.

- L. Dual technology wall/corner mount sensor

- 1. 90 to 130 degree coverage, minimum 50 foot detection range at mounting height of 10 ft.

- M. Daylight Control Sensors

1. Occupancy sensors with on/off and dimming photocell sensors shall enable nLight to monitor daylight conditions in a zone, and then adjust lighting to appropriate levels as needed to save energy.
2. On/off photocell sensor shall turn lights completely off when adequate daylight is present by switching relays within the sensor, power/relay pack or wall pod.
3. Dimming photocell sensors shall closely track daylight contribution and raise/lower level of dimmable lighting accordingly. Dimming shall be smooth and continuous.
4. Automatic set-point programming.
5. Calibration shall be capable of being done at any time of day.
6. Integrated foot-candle measurement.
7. Push-button digital programming of settings; no tools or analog adjustments shall be required.
8. Remote control via software.

N. Wall Pod

1. Push button digital light switch composed of traditional tactile buttons and LED user feedback.
2. Wall pod provides one, two, or four scene control.
 - a. Scene control includes step dimming capabilities (50% or 100%) and time override commands.
 - b. Operating temperature 14 degrees Fahrenheit to 160 degrees Fahrenheit

O. Power packs and dimming packs.

1. Remote power packs mounted adjacent to fixtures used to interface multiple ceiling sensors or wall switches to fixtures are required.
2. Sensors shall operate on 5 to 24 VAC or VDC. Up to 12 sensors may be connected to a single power pack. Low voltage for sensors shall be provided by power pack.
3. Contractor shall coordinate quantity and location of power packs required to complete system installation.
4. Dimming packs shall provide 0-10V dimming for LED fixtures.
5. Power packs shall be capable of providing occupancy signals to HVAC components.

P. Graphic Wallpod

1. Graphic wallpod model no. (nPOD GFX) shall be installed in Conference/Training Room of Administrative Building, Structure 900.
2. All lighting control profiles created in graphic wallpod shall be stored.
3. All zones shall be controlled and monitored from graphic wallpod.
4. Remotely upgradeable.
5. Finger touch screen.
6. Menu driven interface.
7. Backlit LCD screen.
8. 4-digit pin security code.
9. Provides 16 scene controls.

- Q. Contractor shall use Cat-5e cables to connect all lighting controls to power packs throughout structure.

PART 3- EXECUTION

3.01 INSTALLATION

- A. Set units plumb, square, and level with ceiling and walls, and secure according to manufacturer's written instructions and approved Shop Drawings. Support fixtures according to Section 26 05 29.
- B. Support for Recessed and Semi-recessed Grid-Type Fluorescent Fixtures: Support Units from suspended ceiling support system. Install ceiling support system rods or wires at minimum of 4 rods or wires for each fixture, located not more than 6 inch (150 millimeter) from fixture corners.
 - 1. Install support clips for recessed fixtures, securely fastened to ceiling grid members, at or near each fixture corner.
 - 2. Fixtures Smaller than Ceiling Grid: Install minimum of 4 rods or wires for each fixture and locate at corner of ceiling grid where fixture is located. Do not support fixtures by ceiling acoustical panels.
 - 3. Fixtures of Sizes Less than Ceiling Grid: Center in acoustical panel. Support fixtures independently with at least two 3/4 inch (20 millimeter) metal channels spanning and secured to ceiling tees.
- C. Support for Suspended Fixtures: Brace pendants and rods over 48 inch (1200 millimeter) long to limit swinging. Support stem-mounted, single-unit, suspended fluorescent fixtures with twin-stem hangers. For continuous rows, use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of chassis, including one at each end.
- D. Lamping: Where specific lamp designations are not indicated, lamp units according to manufacturer's instructions.
- E. Ceiling mounted occupancy sensors:
 - 1. Center in tiles of ceiling grid.
 - 2. Align with overhead fixtures suspended below ceiling or surface mounted to ceiling at same elevation as fixtures unless otherwise shown.
 - 3. Install to provide coverage of working areas and access doorways.
 - 4. Install clear of piping, ductwork, and other overhead obstructions.
 - 5. Verify operation after installation.
- F. Wall mounted occupancy sensors:
 - 1. Mount 10 feet above finished floor.
 - 2. Align with overhead fixtures suspended below ceiling or surface mounted to ceiling unless otherwise shown.
 - 3. Install to provide coverage of working areas and access doorways.
 - 4. Install clear of piping, ductwork, and other overhead obstructions.
 - 5. Verify operation after installation.

3.02 CONNECTIONS

- A. Ground lighting units. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.

3.03 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
 - 1. Verify normal operation of each fixture after fixtures have been installed and circuits have been energized with normal power source.
 - 2. Give advance notice of dates and times for field tests.
 - 3. Provide instruments to make and record test results.

B. Replace fixtures that show evidence of corrosion during Project warranty period.

3.04 ADJUSTING AND CLEANING

A. Clean fixtures after installation. Use methods and materials recommended by manufacturer.

B. Adjust aimable fixtures to provide required light intensities.

END OF SECTION

SECTION 26 56 00
EXTERIOR LIGHTING

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Exterior lighting fixtures.
2. Lamps.
3. Ballasts.
4. Pole standards.
5. Accessories.

1.02 DEFINITIONS

- A. Fixture: Complete lighting device. Fixtures include lamp or lamps and parts required to distribute light, position and protect lamps, and connect lamps to power supply.
- B. Lighting Unit: Fixture or assembly of fixtures with common support, including pole or bracket plus mounting and support accessories.
- C. Luminaire: Fixture.

1.03 SUBMITTALS

A. Product Data:

1. Describe fixtures, lamps, ballasts, poles, and accessories. Arrange Product Data for fixtures in order of fixture designation. Include data on features, poles, accessories, finishes, and following:
 - a. Outline drawings indicating dimensions and principal features of fixtures and poles.
 - b. Electrical Ratings and Photometric Data: Certified results of laboratory tests for fixtures and lamps.

B. Shop Drawings:

1. Detail nonstandard fixtures and poles and indicating dimensions, weights, method of field assembly, components, and accessories.
2. Wiring diagrams detailing wiring for control system showing both factory-installed and field-installed wiring for specific system of this Project, and differentiating between factory-installed and field-installed wiring.
3. Anchor-Bolt Templates: Keyed to specific poles and certified by manufacturer.

C. Test Results:

1. Indicate and interpret test results.

D. Operating and Maintenance Data (O&M):

1. Maintenance data for products to include operation and maintenance information.
2. Submit in accordance with Section 01785.

E. Submit in accordance with Section 01 33 00.

1.04 QUALITY ASSURANCE

- A. Comply with American National Standards Institute (ANSI) C2.
- B. Items provided under this section shall be listed or labeled by Underwriters Laboratories, Inc. (UL) or other Nationally Recognized Testing Laboratory (NRTL).
 - 1. Term "NRTL" shall be as defined in Occupational Safety and Health Administration (OSHA) Regulation 1910.7.
 - 2. Terms "listed" and "labeled" shall be as defined in National Electrical Code, Article 100.
- C. Regulatory Requirements:
 - 1. National Electrical Code (NEC): Components and installation shall comply with National Fire Protection Association (NFPA) 70.

1.05 STORAGE AND HANDLING OF POLES

- A. Store poles on decay-resistant treated skids at least 12 inch (300 millimeter) above grade and vegetation. Support pole to prevent distortion and arrange to provide free air circulation.
- B. Metal Poles: Retain factory-applied pole wrappings until just before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.06 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
 - 1. Glass and Plastic Lenses, Covers, and Other Optical Parts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 3. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 – PRODUCTS

2.01 FIXTURES AND FIXTURE COMPONENTS

- A. Metal Parts: Free from burrs, sharp edges, and corners.
- B. Sheet Metal Components: Corrosion-resistant aluminum, except as otherwise indicated. Form and support to prevent warping and sagging.
- C. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed fixtures.
- D. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position. Provide for door removal for cleaning or replacing lens. Arrange for door opening to disconnect ballast.
- E. Exposed Hardware Material: Stainless steel.

- F. Reflecting Surfaces: Minimum reflectances as follows, except as otherwise indicated:
 - 1. White Surfaces: 85%
 - 2. Specular Surfaces: 83%
 - 3. Diffusing Specular Surfaces: 75%
- G. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UltraViolet (UV) radiation.
- H. Lenses and Refractors: Materials as indicated. Use heat- and aging-resistant, resilient gaskets to seal and cushion lens and refractor mounting in fixture doors.
- I. Photoelectric Relays: Conform to UL 773.
 - 1. Contact Relays: Single throw, arranged to fail in ON position and factory set to turn light unit on at 1.5 to 3 foot-candles (16 to 32 lumen per square meter (lux)) and off at 4.5 to 10 foot-candles (48 to 108 lux) with 15 sec minimum time delay.
 - 2. Relay Mounting: In fixture housing.
- J. Light Emitting Diodes (LED)
 - 1. Driver shall be accessible for easy replacement.
 - 2. Weatherproof fixture housing shall be sealed completely against moisture and environment contaminants.
 - 3. 5100K temperature, Color rendering index (CRI) greater than 70.
 - 4. LED driver shall have power factor greater than 90% and THD less than 20%.
 - 5. CSA Certified to US standards for 40°C ambient.
- K. Lamps: Comply with ANSI C78 series that is applicable to each type of lamp. Provide fixtures with indicated lamps of designated type, characteristics, and wattage. Where lamp is not indicated for fixture, provide medium wattage lamp recommended by manufacturer.
- L. Lighting Contactors & Enclosure (Located in Structure 900 Electrical Room)
 - 1. Manufacturer: Square D Model 8903LXG30V02CR6 or equal.
 - 2. Description: NEMA ICS 2, magnetic lighting contactor, 100% rated.
 - 3. Configuration: Mechanically held.
 - 4. Coil Voltage: 120VAC, 60HZ
 - 5. Poles: Three.
 - 6. Contact Rating 30 amperes.
 - 7. Enclosure: ANSI/NEMA ICS 6, Type 1.
 - 8. Accessories:
 - a. Selector Switch: HAND/OFF/AUTOMATIC
 - b. Pushbuttons and Selector Switches: NEMA ICS 2, general duty type.

2.02 FIXTURE SUPPORT COMPONENTS

- A. Pole-Mounted Fixtures: Conform to American Association of State Highway and Transportation Officials (AASHTO) LTS-3.
- B. Wind-load strength of total support assembly, including pole, arms, appurtenances, base, and anchorage, is adequate to carry itself plus fixtures indicated at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of 100 Miles per Hour (mph) (160 Kilometers per Hour (km/h)) with gust factor of 1.3.
- C. Arm, Bracket, and Tenon Mount Materials: Match poles' finish.

- D. Mountings, Fastenings, and Appurtenances: Corrosion-resistant items compatible with support components. Use materials that will not cause galvanic action at contact points. Use mountings that correctly position luminaire to provide indicated light distribution.
- E. Pole Shafts: Square, tapered.
- F. Pole Bases: Anchor type with galvanized steel hold-down or anchor bolts, leveling nuts, and bolt covers.
- G. Poles: Steel tubing conforming to American Society for Testing and Materials (ASTM) A500, Grade B, carbon steel with minimum yield of 46,000 Pounds per Square Inch (PSI) (317 MegaPascals (MPa)). Poles are 1-piece construction up to 40 feet (12 meters) in length and have access handhole in wall.
- H. Metal Pole Grounding Provisions: Welded 1/2 inch (12 millimeter) threaded lug, accessible through handhole.
- I. Metal Pole Brackets: Designed to match pole metal. Provide cantilever brackets without underbrace, in sizes and styles indicated, with straight tubular end section to accommodate fixture.
- J. Pole-Top Tenons: Fabricated to support fixture or fixtures and brackets indicated and securely fastened to pole top.
- K. Concrete for Pole Foundations:
 - 1. Comply with Section 03300.
 - 2. Use 3000 psig strength, 28 day concrete.

2.03 FINISHES

- A. Metal Parts: Manufacturer's standard finish, except as otherwise indicated, applied over corrosion-resistant primer, free of streaks, runs, holidays, stains, blisters, and similar defects.
- B. Other Parts: Manufacturer's standard finish, except as otherwise indicated.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Set units plumb, square, level, and secure according to manufacturer's written instructions and approved submittals.
- B. Concrete Foundations: Construct according to Section 03 30 00.
 - 1. Comply with details and manufacturer's recommendations for reinforcing, anchor bolts, nuts, and washers. Verify anchor-bolt templates by comparing with actual pole bases furnished.
 - 2. Finish: Trowel and rub smooth parts exposed to view.
- C. Pole Installation: Use web fabric slings (not chain or cable) to raise and set poles.
- D. Fixture Attachment: Fasten to indicated structural supports.
- E. Lamp fixtures with indicated lamps according to manufacturer's written instructions. Replace malfunctioning lamps.

3.02 GROUNDING

A. Ground fixtures and metal poles according to Section 26 05 26.

1. Poles: Install 10 feet (3 meters) driven ground rod at each pole.
2. Nonmetallic Poles: Ground metallic components of lighting unit and foundations. Connect fixtures to grounding system with No. 6 AWG conductor.

3.03 FIELD QUALITY CONTROL

A. Inspect each installed unit for damage. Replace damaged fixtures and components.

B. Tests and Observations:

1. Give advance notice of dates and times for field tests.
2. Provide instruments to make and record test results.
3. Replace or repair damaged and malfunctioning units, make necessary adjustments, and retest. Repeat procedure until units operate properly.

3.01 ADJUSTING AND CLEANING

A. Clean units after installation. Use methods and materials recommended by manufacturer.

B. Adjust aimable fixtures to provide required light intensities.

END OF SECTION

DIVISION 28

ELECTRONIC SAFETY AND SECURITY

SECTION 28 15 00
ACCESS CONTROL SYSTEMS

PART 1 – GENERAL

1.01 SUMMARY

- A. Access control equipment and requirements for key FOB reader access control system.
- B. Call box intercom/video and control equipment.
- C. Raised arm plant gate access and control equipment.

1.02 ABBREVIATIONS AND DEFINITIONS

- A. SACSS Security Access Control System Supplier.
- B. FOB Electronically encoded device generally used as a security credential.

1.03 SUBMITTALS

A. General:

- 1. Submit Product Data in sufficient detail to confirm compliance with requirements of this Section.
- 2. Submit Product Data and Shop Drawings in one complete submittal package.
- 3. Partial submittals are not acceptable.

B. Product Data:

- 1. Catalog cuts and product specifications for devices and equipment specified.

C. Shop Drawings:

- 1. Installation and assembly drawings and specifically prepared technical data for control devices and equipment specified.
- 2. Comprehensive point to point wiring and schematic diagrams for all wiring components.
- 3. Electrical panel drawings including panel layout, schematic, and bill of materials cross referenced to panel layout drawings.
- 4. Submit in accordance with Section 01 33 00.

D. Operation and Maintenance (O&M) Data:

- 1. Operating instructions and maintenance data for materials, products and equipment for inclusion in O&M Manual.
- 2. Manufacturer's written instructions for periodic test/calibration/cleaning for equipment and controls in service.
- 3. Submit in accordance with Section 01 78 23.

1.04 SECURITY ACCESS CONTROL SYSTEM SUPPLIER

- A. Advent Systems, Inc.
- B. No Substitutions Permitted

- C. SACSS shall have on-staff personnel assigned to this Project.
- D. Contractor shall utilize a SACSS having the experience and knowledge, as defined herein, to undertake the work specified in Sections 28 15 00. The SACSS shall be an organization having the following organizational and individual experience, knowledge, and capability:
 - 1. SACSS shall be regularly engaged in the design, installation, and servicing of Plant Security Systems.
 - 2. SACSS shall demonstrate the ability to produce system documentation in the level of detail required by this specification.
 - 3. SACSS shall have previously executed a minimum of five (5) Plant Security System projects of similar size and complexity to this Project.
 - 4. The person(s) performing the field network setup and configuration functions as required by the Contract Documents shall have a minimum of five (5) years experience on Plant Security Systems.
 - 5. SACSS shall provide, on-site personnel to commission the functional testing, start-up and training as required by the Contract Documents. The individual shall have authored and commissioned Plant Security Systems for no fewer than three (3) projects of similar or greater complexity.
 - 6. Upon request of Owner, and in addition to other specified requirements, Contractor shall provide a minimum of five (5) SACSS references to confirm compliance with these requirements.

PART 2 – PRODUCTS

2.01 GENERAL

- A. Like items of equipment shall be end products of single manufacturer to achieve standardization for maintenance, spare parts, operation, service, and training.
- B. Equipment shall be latest and most modern design that is fully compatible, and will operate with City's current key FOB's.

2.02 ACCESS CONTROL SYSTEM

- A. Provide keyless access control equipment for the Plant Entrance and Exit Arm Gates and Building 900 as described and as shown on the Drawings. System shall identify the vehicle or person by FOB device distributed by the City. Equipment shall be compatible with other City security equipment.
- B. Security Access Control System Supplier (SACSS) shall provide all work included under this Specification consisting of but limited to the provision of all labor, equipment, materials, supplies, and performing all operations necessary to complete installation of the Security Access Control in compliance with Specifications and Drawings under the direction of the Contractor.
- C. The Work shall include, but not be limited to, the following:
 - 1. Furnish and install 2" square stainless steel pedestal for mounting card reader and intercom equipment.
 - 2. Furnish and install outdoor extended range HID proximity reader at Entrance Arm Gate as shown on Drawings.
 - 3. Furnish and install outdoor call box, two-way voice intercom with video at Entrance Arm Gate as shown on Drawings.
 - 4. Furnish and install two outdoor Gate Arm Operators for Plant entry and exit as shown on Drawings.
 - 5. Furnish and install ground loops for entry and exit as shown on Drawings.

6. Furnish and install one IP camera (Axis P3225) on existing pole northeast of entrance, and as shown on Drawings.
7. Furnish and install IP camera software with PTZ capability accessible to a minimum of 5 workstation clients (workstation hardware by Owner).
8. Furnish and install indoor and outdoor HID proximity readers at Building 900 adjacent the exterior entrances, and interior doors as shown on Drawings.
9. Proximity readers on the exterior of Building 900 shall be mounted adjacent the entrances.
10. Furnish and install mounting hardware, power supplies, surge protection, amplifiers, interface modules, specialty cabling, media converters, and other appurtenances as required for a complete operating system.
11. Furnish and install Main Gate Intercom-Video Master Station (900-ICM-1), and Main Gate Intercom-Video Sub-Master Station (120-ISM-1) at locations shown on Drawings.
12. All access control cabling not plenum rated shall be installed in conduit.
13. Access control cabling that is plenum rated may be installed above drop ceiling in Building 900 if supported with J-hooks as per cable manufacturer and in accordance with Division 26.
14. Door proximity switches in Building 900 for each door using HID proximity reader.
15. IR motion detectors (exit request) for doors in Building 900 at locations shown on Drawings
16. Software, hardware, and programming as required for a complete operating system.

D. Work under other Sections:

1. Conduit, power, fiber optic cable. Coordinate requirements with Division 26 – Electrical, and Division 40 – Process Integration.
2. 24Vdc electric door strikes and door crash bar exit hardware in Building 900. Coordinate requirements with Section 08 71 00.
3. Video images recording and review of stored data. Coordinate requirements with the City.

E. Equipment Operation:

1. Each authorized person has been issued an HID compatible device (badge or FOB) that is unique to that individual.
2. The HID card readers located at the Entrance Arm Gate and Building 900 identifies the person and allows secure access to site or Building based on acceptable credentials.
3. Security Access Control System shall maintain time/date/ID/location stamp of each HID access for a period not less than 30 days.
4. Non-authorized personnel will request access to the site at the Entrance Arm Gate call box intercom. Access will be granted or denied from Main Gate Intercom-Video Master Station (900-ICM-1), or Main Gate Intercom-Video Sub-Master Station (120-ISM-1) depending on time of day and staffing.
5. Leaving the site will be free-exit initiated by ground loops.
6. The HID system will communicate a signal (hardwired or networked) to the local PLC (SCC-900), for each instance that access is granted to the site (at Entrance Arm Gate) automatically via card reader or manually via Master Stations.

PART 3 – EXECUTION

3.01 GENERAL

- A. All work shall be performed in a neat, workmanlike manner and to comply with acknowledged industry and professional standards and practices.
- B. Security Access Control System Supplier shall coordinate with Owner to confirm reader provided is compatible with City's current security systems.

3.02 EQUIPMENT LOCATION

- A. Placement of devices shall be as shown on Drawings. Verify locations with Engineer before installation. Owner reserves the right to relocate any or all devices within a close proximity (10 feet) to the originally requested locations. All system components and related wiring shall be located with due regard for termination of induced electromagnetic and electrostatic noise, for the minimization of wiring length, and to provide reasonable safety for plant personnel.

3.03 QUALITY ASSURANCE

- A. All equipment shall conform to appropriate U.L. Listings and be installed in accordance with National Electric Code (NEC) and local code requirements.
- B. Coordination:
 - 1. SACSS shall attend Monthly Progress Meetings and Weekly Meetings specified in specifications, when requested by Owner, Contractor, System Integrator, or Engineer.

3.04 TRAINING

- A. Upon completion of the system, an authorized representative of the SACSS shall thoroughly instruct the Owner's personnel for a period of not less than four (4) hours in complete and proper operation of the system.

END OF SECTION

SECTION 28 46 00
FIRE ALARM SYSTEMS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Manual stations.
2. Detectors.
3. Signal equipment.
4. Controls and devices.

1.02 DEFINITION

A. FACP: Fire Alarm Control Panel.

1.03 SYSTEM DESCRIPTION

- A. Zoned, noncoded fire-detection and alarm system with manual and automatic alarm initiation.
- B. Signal Transmission: Hard wired, using separate individual circuits for each zone of alarm initiation and alarm device operation.
- C. Audible Alarm Indication: By sounding of horns and bells.
- D. Audible Alarm Indication: By sounding of horns and bells for alarm zones indicated and by voice alarm messages and tone signals on loudspeakers for remaining zones.
- E. Visual Alarm Indication: By xenon-strobe-type units.
- F. System connections for alarm-initiating and alarm-indicating circuits. Class B wiring.

1.04 SUBMITTALS

A. Product Data:

1. Each type of system component specified including dimensioned plans and elevations showing minimum clearances and installed features and devices. Include list of materials and Nationally Recognized Testing Laboratory (NRTL) listing data.

B. Shop Drawings:

1. Show details of graphic annunciator.
2. Wiring diagrams from manufacturer differentiating clearly between factory- and field-installed wiring. Include diagrams for equipment and for system with terminals and interconnections identified. Make diagrams specific to this Project and distinguish between field and factory wiring.
3. Floor Plans: Indicate final outlet locations and routings of raceway connections.

C. Miscellaneous:

1. System operation description covering this specific Project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are unacceptable.
2. Submission to Authorities Having Jurisdiction: In addition to routine submission of above material, make an identical submission to authorities having jurisdiction. Include copies of annotated Contract Drawings as needed to depict component locations to facilitate review. Upon receipt of comments from authorities having jurisdiction, submit them for review. Resubmit if required to make clarifications or revisions to obtain approval.

D. Test Reports:

1. Record of field tests of system.

E. Operating and Maintenance Data:

1. Operating instructions: Mount at Fire Alarm Control Panel (FACP).
2. Include data for each type of product, including features and operating sequences, both automatic and manual. Include recommendations for spare parts to be stocked at site. Provide names, addresses, and telephone numbers of service organizations that carry stock of repair parts for system to be furnished.

F. Submit in accordance with Section 01 33 00.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Engage experienced factory-authorized Installer to assist in performing work of this Section.
- B. Single-Source Responsibility: Obtain fire alarm components from single source who assumes responsibility for compatibility of system components.
- C. Compliance with Local Requirements: Comply with applicable building code, local ordinances, and regulations, and requirements of authorities having jurisdiction.
- D. Items provided under this section shall be listed or labeled by Underwriters Laboratories, Inc. (UL) or other Nationally Recognized Testing Laboratory (NRTL).
 1. Term "NRTL" shall be as defined in Occupational Safety and Health Administration (OSHA) Regulation 1910.7.
 2. Terms "listed" and "labeled" shall be as defined in National Electrical Code, Article 100.
- E. Regulatory Requirements:
 1. National Electrical Code (NEC): Components and installation shall comply with National Fire Protection Association (NFPA) 70.
 2. Comply with NFPA 72.

1.06 EXTRA MATERIALS

- A. Furnish extra materials before installation begins, that match products installed, are packaged with protective covering for storage, and are identified with labels clearly describing contents.
 1. Glass Rods for Manual Stations: Quantity equal to 15% of number of manual stations installed; minimum of 6 rods.

2. Lamps for Remote Indicating Lamp Units: Quantity equal to 10% of number of units installed, but not less than 1.
3. Lamps for Strobe Units: Quantity equal to 10% of number of units installed, but not less than 1.
4. Smoke Detectors, Fire Detectors, and Flame Detectors: Quantity equal to 10% of number of units of each type installed, but not less than 1 of each type.
5. Detector Bases: Quantity equal to 2% of number of units of each type installed, but not less than 1 of each type.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Edwards Systems Technology; General Signal Unit.
- B. No substitutions allowed.

2.02 FUNCTIONAL DESCRIPTION OF SYSTEM

- A. Include following system functions and operating features plus those additional functions and features required by authorities having jurisdiction:
 1. Priority of Signals: Accomplish automatic response functions by first zone initiated. Alarm functions resulting from initiation by first zone are not altered by subsequent alarms. highest priority is alarm signal. Supervisory and trouble signals have second- and third-level priority. Higher-priority signals take precedence over signals of lower priority, even though lower-priority condition occurred first. Annunciate alarm signals regardless of priority or order received.
 2. Noninterfering: Zone, power, wire, and supervise system so signal on 1 zone does not prevent receipt of signals from any other zone. All zones are manually resettable from FACP after initiating device or devices are restored to normal. Systems that require batteries or battery back-up for programming function are unacceptable.
 3. Fire Alarm Control Panel Response: Manual or automatic operation of alarm-initiating or supervisory-operating device causes FACP to transmit appropriate signal including following:
 - a. General alarm.
 - b. Fire-suppression system operation alarm.
 - c. Smoke or heat detector alarm.
 - d. Valve tamper supervisory.
 - e. Door release.
 - f. System trouble.
 - g. Fan shutdown.
 - h. Smoke-control initiation.
 4. Transmission to Remote Central Station: Automatically route alarm, supervisory, and trouble signals to remote central station service.
 5. Silencing at FACP: Switches provide capability for acknowledgment of alarm, supervisory, trouble, and other specified signals at FACP; and capability to silence local audible signal and light light-emitting diode (LED). Subsequent zone alarms cause audible signal to sound again until silenced by switch operation. Restoring alarm, supervisory, and trouble conditions to normal extinguishes associated LED and causes audible signal to sound again until restoration is acknowledged by switch operation.
 6. Loss of primary power at FACP sounds trouble signal at FACP and annunciator. Emergency power light is illuminated at both locations when system is operating on alternate power supply.

7. Annunciation: Manual and automatic operation of alarm- and supervisory-initiating devices is annunciated both on FACP and on annunciator, indicating location and type of device.
8. FACP Alphanumeric Display: Displays plain-English-language descriptions and addresses of initiating devices, alarms, trouble signals, supervisory signals, monitoring actions, system and component status, and system commands.
9. General Alarm:
 - a. Indicating general alarm condition at FACP and annunciator.
 - b. Identifying device that is source of alarm (or its zone) at FACP and annunciator.
 - c. Initiating audible and visible alarm signals through outbuilding.
 - d. Stopping supply and return fans serving zone where alarm is initiated.
 - e. Initiating transmission of alarm signal to remote central station.
10. Manual station alarm operation initiates general alarm.
11. Water-flow alarm switch operation:
 - a. Initiates general alarm.
 - b. Causes flashing of device location-indicating lamp for device that has operated.
12. Smoke detection for zones with alarm verification causes following:
 - a. Audible and visible indication of an "alarm verification" signal at FACP.
 - b. Activation of listed and approved "alarm verification" sequence at FACP and detector.
 - c. Recording of event on system printer.
 - d. General alarm initiation if alarm is verified.
 - e. FACP indication cancellation and system reset if alarm is not verified.
13. Sprinkler valve tamper switch operation causes or initiates following:
 - a. Supervisory, audible, and visible "valve tamper" signal indication at FACP and annunciator.
 - b. Location-indicating light to flash for device that has operated.
 - c. Printed record of event on system printer.
 - d. Transmission of supervisory signal to remote central station.
14. Low-air-pressure switch operation on dry pipe or preaction sprinkler system causes or initiates following:
 - a. Supervisory, audible, and visible "sprinkler trouble" signal indication at FACP and annunciator.
 - b. Location-indicating light to flash for device that has operated.
 - c. Printed record of event on system printer.
 - d. Transmission of trouble signal to remote central station.
15. Permissible Signal Time Elapse: maximum permissible elapsed time between actuation of any fire alarm or fire-detection system alarm-initiating device and its indication at FACP is 2 seconds.
16. Independent System Monitoring: Supervise each independent smoke- or heat-detection system, duct detector, and elevator smoke-detection system for both normal operation and trouble.
17. Circuit Supervision: Indicate circuit faults by both zone and trouble signal at FACP. Provide distinctive indicating audible tone and LED-indicating light. Maximum permissible elapsed time between occurrence of trouble condition and its indication at FACP is 200 seconds.

2.03 MANUAL PULL STATIONS

- A. Description: Double-action type, fabricated of metal or plastic, and finished in red with molded, raised-letter operating instructions of contrasting color.
 - 1. Break-Glass Feature: Stations requiring breaking of glass panel are unacceptable. Stations requiring breaking of concealed glass rod are acceptable.
 - 2. Station Reset: Key or wrench operated, double pole, double throw, switch rated for voltage and current at which it operates. Stations have screw terminals for connections.

2.04 SMOKE DETECTORS

A. General:

- 1. Factory Nameplate: Serial number and type identification.
- 2. Operating Voltage: 24 VDC, nominal.
- 3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
- 4. Plug-in Arrangement: Detector and associated encapsulated electronic components are mounted in module that connects to fixed base with twist-locking plug connection. plug connection requires no springs for secure mounting and contact maintenance. Terminals in fixed base accept building wiring.
- 5. Integral Visual Indicating Light: Connect to indicate detector has operated.

B. Photoelectric Smoke Detectors:

- 1. Detector Sensitivity: Between 2.5 and 3.5% per foot (0.008 and 0.011% per millimeter) smoke obscuration when tested according to UL 268.
- 2. Sensor: An infrared detector light source with matching silicon-cell receiver.

C. Duct Smoke Detector: Ionization type.

- 1. Sampling Tube: Design and dimensions as recommended by manufacturer for specific duct size and installation conditions where applied.
- 2. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.05 OTHER DETECTORS

- A. Thermal Detector: Combination fixed-temperature and rate-of-rise unit with mounting plate arranged for outlet box mounting; 135 degrees Fahrenheit (57 degrees Celsius) fixed-temperature setting, except as indicated.

2.06 ALARM-INDICATING DEVICES

- A. Equip alarm-indicating devices for mounting as indicated. Provide terminal blocks for system connections.
- B. Horns: Electric-vibrating-polarized type, operating on 24 VDC, with provision for housing operating mechanism behind grille. Horns produce sound-pressure level of 90 dB, measured 10 feet (3 meter) from source.
- C. Visual Alarm Devices: Xenon strobe lights with clear or nominal white polycarbonate lens. Mount lenses on an aluminum faceplate. Word "FIRE" is engraved in minimum 1 inch (25 millimeter) high letters on lens.
 - 1. Devices have minimum light output as stated in NFPA 72.
 - 2. Strobe Leads: Factory connected to screw terminals.

3. Combination devices consist of factory-combined, audible and visual alarm units in single mounting assembly.
- D. Remote Alarm Indicator: LED type, mounted flush in single gang wall plate.
1. Connected to indicate alarm operation of single detector or other device.
 2. Legend: "Alarm."

2.07 REMOTE DEVICE LOCATION-INDICATING LIGHTS AND IDENTIFICATION PLATES

- A. Description: An LED-indicating light in vicinity of each sprinkler water-flow switch and valve tamper switch denotes associated device is in abnormal or trouble mode. Lamp is flush mounted in single gang wall plate. Red, laminated, phenolic-resin identification plate at indicating light identifies, in engraved white letters, room where valve is located or protected spaces downstream from water-flow switch.

2.08 CENTRAL FIRE ALARM CONTROL PANEL (FACP)

- A. Comply with UL 864.
- B. Cabinet: Lockable steel enclosure. Arrange panel so operations required for testing or for normal care and maintenance of system are performed from front of enclosure. If more than single unit is required to form complete control panel, provide exactly matching modular unit enclosures. Accommodate components and allow ample gutter space for interconnection of panels and field wiring. Identify each enclosure by an engraved, red, laminated, phenolic-resin nameplate. Lettering on enclosure's nameplate shall not be less than 1 inch (25 millimeter) high. Identify individual components and modules within cabinets with permanent labels.
- C. Systems: Alarm and supervisory systems are separate and independent in FACP. Alarm-initiating zone boards in FACP consist of plug-in cards. Construction requiring removal of field wiring for module replacement is unacceptable.
- D. Control Modules: Types and capacities required to perform functions of fire alarm systems. Local, visible, and audible signals announce alarm, supervisory, and trouble conditions. Each type of audible alarm has different sound.
- E. Zones: Provide for alarm and supervisory zones indicated. Each room shall be a dedicated zone (i.e. Electrical Room, Stairway, Storage Room, etc.)
- F. Indicating Lights: Provide individual LED devices for each zone. An LED test switch for each FACP section illuminates LED devices on that section of control panel. Manual toggle test switches or push test-buttons do not require key to operate. Alarm and supervisory signals light red LED of associated zone. Trouble signals light an amber LED for associated zone.
- G. Resetting: Provide necessary controls to prevent resetting of any alarm, supervisory, or trouble signal while alarm or trouble condition still exists.
- H. Alphanumeric Display and System Controls (Structure 900): Arrange to provide basic interface between human operator at FACP and addressable system components, including annunciation, supervision, and control. LCD with minimum of 32 characters shows alarm, supervisory, and component status messages and indicates control commands to be entered into system for control of smoke detector sensitivity and other parameters. Arrange keypad for use in entering and executing control commands.

- I. Digital alarm communicator transmitter (DACT) to communicate alarm, trouble, and supervisory status. DACT shall be figured to provide discrete outputs for alarm and trouble from fire alarm panel to plant SCADA panel for primary means of alarm transmission.
- J. Instructions: Printed or typewritten instruction card mounted behind lexan plastic or glass cover in stainless-steel or aluminum frame. Install frame in location observable from FACP. Include interpretation and appropriate response for displays and signals, and briefly describe functional operation of system under normal, alarm, and trouble conditions.

2.09 EMERGENCY POWER SUPPLY

- A. Components include sealed lead-acid battery, charger, and automatic transfer switch. Battery nominal life expectancy is 10 years, minimum.
- B. Battery capacity is adequate to operate complete alarm system in normal or supervisory (nonalarm) mode for period of 24 hours. At end of this period, battery has sufficient capacity to operate system, including alarm-indicating devices in either alarm or supervisory mode, for period of 15 minutes minimum.
 - 1. Future magnetic door holders are not served by emergency power. Magnetic door holders will be configured for release when normal power fails.
- C. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Provide capacity for 150% of connected system load while maintaining batteries at full charge. In event batteries are fully discharged, charger recharges them completely within 4 hours. Charger output is supervised as part of system power supply supervision.
- D. Integral Automatic Transfer Switch: Transfers load to battery without loss of signals or status indications when normal power fails.

2.10 WIRE

- A. Wire: Solid-copper conductors with 600 V rated, 75 degrees Celsius, color-coded insulation.
 - 1. Low-Voltage Circuits: No. 16 AWG, minimum.
 - 2. Line-Voltage Circuits: No. 12 AWG, minimum.

PART 3 – EXECUTION

3.01 INSTALLATION, GENERAL

- A. Install system according to NFPA 72.
- B. Fire Alarm Power Supply Disconnect: Paint red and label "FIRE ALARM." Provide with lockable handle or cover.

3.02 EQUIPMENT INSTALLATION

- A. Manual Pull Stations: Mount semiflush in recessed back boxes with operating handles 48 inch (1220 millimeter) above finished floor or lower as indicated.
- B. Water-Flow Detectors and Valve Supervisory Switches: Connect for each sprinkler valve station required to be supervised.

- C. Smoke Detectors: Install ceiling-mounted detectors not less than 4 inch (100 millimeter) from side wall to near edge. Install detectors located on wall at least 4 inch (100 millimeter), but not more than 12 inch (300 millimeter), below ceiling. For exposed solid-joist construction, mount detectors on bottom of joists. On smooth ceilings, install detectors not over 30 feet (9 meter) apart in any direction. Install detectors no closer than 60 inch (1520 millimeter) from air registers.
- D. Audible Alarm-Indicating Devices: Install not less than 90 inch (2280 millimeter) above finished floor nor less than 6 inch (150 millimeter) below ceiling. Install bells and horns on flush-mounted back boxes with device-operating mechanism concealed behind grille or as indicated. Combine audible and visual alarms at same location into single unit.
- E. Visual Alarm-Indicating Devices: Install 80 inch (2030 millimeter) above finished floor or 6 inch (150 millimeter) below ceiling whichever is lower.
- F. Device Location-Indicating Lights: Locate in public space near device they monitor.
- G. FACP: Surface mount with tops of cabinets not more than 72 inch (1830 millimeter) above finished floor.

3.03 WIRING INSTALLATION

- A. Wiring Method: Install wiring in metal raceway according to Section 26 05 19.
- B. Wiring within Enclosures: Install conductors parallel with or at right angles to sides and back of enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire alarm system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- C. Cable Taps: Use numbered terminal strips in junction, pull or outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
- D. Color Coding: Color-code fire alarm conductors differently from normal building power wiring. Use 1 color code for alarm circuit wiring and different color code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visual alarm-indicating devices. Paint fire alarm system junction boxes and covers red.
- E. Risers: Install at least 2 vertical cable risers to serve fire alarm system. Separate risers in close proximity to each other with minimum 1 hr rated wall, so loss of one riser does not prevent receipt or transmission of signal from other floors or zones.
- F. Wiring to Central-Station Transmitter: 1 inch (27 millimeter) GRS between FACP and central-station transmitter connection as indicated. Install number of conductors and electrical supervision for connecting wiring as needed to suit central-station monitoring function. Final connections to terminals in central-station transmitter are made under another contract.

3.04 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals according to Section 26 05 53.

3.05 GROUNDING

- A. Ground cable shields and equipment according to system manufacturer's instructions to eliminate shock hazard and to minimize, to greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments.

- B. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding.
- C. Install grounding electrodes of type, size, location, and quantity as indicated. Comply with installation requirements of Section 26 05 26.
- D. Ground equipment and conductor and cable shields. For audio circuits, minimize, to greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.

3.06 FIELD QUALITY CONTROL

A. Manufacturer's Field Services:

- 1. Supplier's or manufacturer's representative for equipment specified herein shall be present at jobsite or classroom designated by Owner for workdays indicated, travel time excluded, for assistance during equipment installation, equipment startup, and training of Owner's personnel for system operation. Include:
 - a. 1 man-day for Installation Services.
 - b. 1 man-day for Instructional Services.
 - c. 1 man-day for Post Start-Up Services
- 2. Supplier or manufacturer shall direct services to system and equipment operation, maintenance, and troubleshooting. See Section 01 61 00.
- 3. Factory-authorized service representative shall inspect field-assembled components, installation, and connection of switchgear; and to pretest and adjust switchgear components. Report results in writing. See Section 01 79 10.

B. Pretesting: After installation, align, adjust, and balance system and perform complete pretesting. Determine, through pretesting, conformance of system to requirements of Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.

C. Report of Pretesting: After pretesting is complete, provide letter certifying installation is complete and fully operable, including names and titles of witnesses to preliminary tests.

D. Final Test Notice: Provide 10 day minimum notice in writing when system is ready for final acceptance testing.

E. Minimum System Tests: Test system according to procedures outlined in NFPA 72. Minimum required tests are as follows:

- 1. Verify absence of unwanted voltages between circuit conductors and ground.
- 2. Test conductors for short circuits using insulation-testing device.
- 3. With each circuit pair, short circuit at far end of circuit and measure circuit resistance with ohmmeter. Record circuit resistance of each circuit on record drawings.
- 4. Verify that control unit is in normal condition as detailed in manufacturer's operation and maintenance manual.
- 5. Test initiating and indicating circuits for proper signal transmission under open circuit conditions. 1 connection each should be opened at not less than 10% of initiating and indicating devices. Observe proper signal transmission according to class of wiring used.

6. Test each initiating and indicating device for alarm operation and proper response at control unit. Test smoke detectors with actual products of combustion.
 7. Test system for specified functions according to approved operation and maintenance manual. Systematically initiate specified functional performance items at each station, including making possible alarm and monitoring initiations and using communications options. For each item, observe related performance at devices required to be affected by item under system sequences. Observe indicating lights, displays, signal tones, and annunciator indications.
 8. Test Both Primary and Secondary Power: Verify by test that secondary power system is capable of operating system for period and in manner specified.
- F. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by system test that total system meets Specifications and complies with applicable standards.
- G. Report of Tests and Inspections: Provide written record of inspections, tests, and detailed test results in form of test log. Submit log upon satisfactory completion of tests.
- H. Tag equipment, stations, and other components at which tests have been satisfactorily completed.

3.07 CLEANING AND ADJUSTING

- A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marred finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer.

END OF SECTION