Pathways Learning Center
Water Intrusion and Roof Repairs

2300 Victoria Street
Beaumont , Texas 77701

Beaumont Independent School District

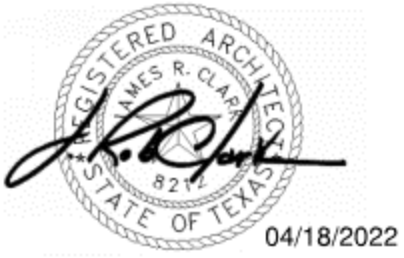
3395 Harrison Avenue
Beaumont, 77706

DOCUMENT 000107 - SEALS PAGE

1.1 DESIGN PROFESSIONALS OF RECORD

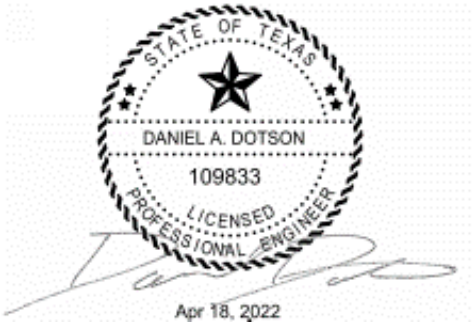
A. Architect:

1. Ronald M. Jones, AIA
2. 13662
3. Architectural Alliance Inc.



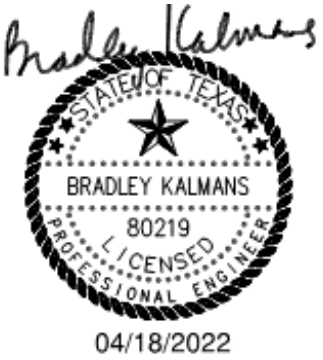
B. Structural Engineer:

1. Daniel A. Dotson
2. 109833
3. Tx PE Firm F-1160
4. Fittz & Shipman Inc.



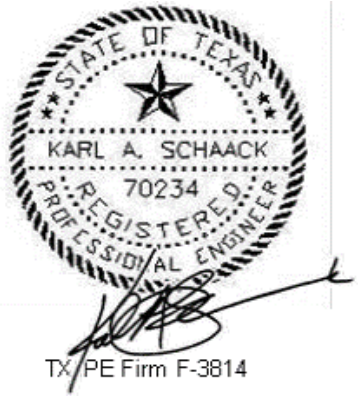
C. Mechanical/Electrical/Plumbing Engineer:

1. Bradley Kalmans
2. 80219
3. Tx PE Firm F-4111
4. Salas O'Brien Inc.



D. Building Envelope Engineer

1. Karl Schaack
2. 70234
3. Tx PE Firm F-3814
4. Price Consulting Inc.



END OF DOCUMENT 000107

Division	Section Title	Pages
	PROCUREMENT AND CONTRACTING DOCUMENTS GROUP	
DIVISION 00 - PROCUREMENT AND CONTRACTING REQUIREMENTS		
000107	SEALS PAGE	1
000110	TABLE OF CONTENTS	3
	SPECIFICATIONS GROUP	
	General Requirements Subgroup	
DIVISION 01 - GENERAL REQUIREMENTS		
012300	ALTERNATES	1
	Facility Construction Subgroup	
DIVISION 02 - EXISTING CONDITIONS		
020720	MINOR DEMOLITION AND RENOVATION WORK	7
024119	SELECTIVE DEMOLITION	4
DIVISION 03 - CONCRETE		
031000	CONCRETE FORMING AND ACCESSORIES	3
032000	CONCRETE REINFORCING	3
033000	CAST-IN-PLACE CONCRETE	8
DIVISION 05 - METALS		
054000	COLD-FORMED METAL FRAMING	8
055000	METAL FABRICATIONS	6
DIVISION 06 - WOOD, PLASTICS AND COMPOSITES		
060110	ROUGH CARPENTRY	4
DIVISION 07 - THERMAL AND MOISTURE PROTECTION		
072216	ROOF BOARD INSULATION	6
075350	METAL RETROFIT SINGLE-PLY ROOF SYSTEM	11
076200	SHEET METAL FLASHING AND TRIM	10
DIVISION 09 - FINISHES		
092900	GYPSUM BOARD	4
095113	ACOUSTICAL PANEL CEILINGS	3
096513	RESILIENT BASE AND ACCESSORIES	3
096519	RESILIENT FLOORING	4
099123	INTERIOR PAINTING	3
DIVISION 10 - SPECIALTIES		
101419	DIMENSIONAL LETTER SIGNAGE	4
104350	SIGNAGE SYSTEMS	3

END OF TABLE OF CONTENTS

DIVISION 22 – PLUMBING

Section

22 01 00 Plumbing Operating & Maintenance Manuals
22 05 00 Plumbing General Provisions
22 05 10 Plumbing Contract Quality Control
22 05 12 Shop Drawings, Coordination Drawings & Product Data
22 05 13 Electrical Provisions of Plumbing Work
22 05 14 Plumbing Alterations Project Procedures
22 05 15 Plumbing Earthwork
22 05 16 Excavating, Backfilling and Compacting for Utilities
22 05 23 Valves, Strainers & Vents
22 07 19 Plumbing Piping Insulation
22 08 00 Plumbing Commissioning Coordination
22 11 16 Domestic Water Piping & Appurtenances
22 11 19 Piping & Appurtenances for Cold Water Makeup
22 13 16 Soil, Waste and Sanitary Drain Piping, Vent Piping and Appurtenances
22 20 00 Plumbing Pipe & Fittings - General
22 63 11 Gas Piping and Appurtenances

DIVISION 23 - MECHANICAL

Section

23 01 00 HVAC Operating and Maintenance Manuals
23 05 00 Mechanical General Provisions
23 05 10 HVAC Contract Quality Control
23 05 11 Mechanical Alterations Project Procedures
23 05 12 Shop Drawings, Coordination Drawings & Product Data
23 05 13 Electrical Provisions of HVAC Work
23 05 14 HVAC Condensate Drain Piping System
23 05 17 HVAC Access Doors
23 05 18 Variable Frequency Inverter
23 05 19 Pressure and Temperature Instruments
23 05 23 HVAC Valves, Strainers and Vent
23 05 33 HVAC Pipe Heat Tracing
23 05 48 Vibration Isolation
23 05 93 Testing, Balancing and Adjusting (TAB) of Environmental Systems
23 05 94 Coordination of Testing and Balancing
23 07 13 External Duct Insulation
23 07 16 Vessel Insulation
23 07 19 HVAC Piping Insulation
23 08 00 Mechanical Commissioning Coordination
23 09 33 Building Management and Control System
23 20 00 Mechanical Pipe and Fittings – General
23 21 13 Hot Water and Chilled Water Piping, Valves & Appurtenances
23 21 23 HVAC Pumps
23 25 12 Flushing and Cleaning of Steel Piping Systems
23 25 13 Circulating Water System Chemical Treatment
23 31 13 Ductwork
23 31 14 Fabric Air Dispersion System
23 34 16 Fans
23 36 16 Variable Volume Terminal Units
23 37 13 Air Devices
23 41 00 Air Filtration
23 52 33 Copper Tube Boiler
23 65 27 Air Cooled Rotary Scroll Chiller
23 81 24 Weatherproof Roof Mounted Air Handling Units

23 82 16 Heating and Cooling Coils

DIVISION 26 - ELECTRICAL

Section
26 01 05 Electrical Operating and Maintenance Manuals
26 05 00 Electrical General Procedures
26 05 05 Electrical Alterations Project Procedures
26 05 10 Contract Quality Control
26 05 12 Electrical Shop Drawings, Coordination Drawings and Product Data
26 05 19 Conductors and Connectors – 600 Volt
26 05 27 Expansion of Existing Electrical Grounding System
26 05 33 Conduit Systems
26 05 35 Electrical Connections for Equipment
26 05 37 Electrical Boxes and Fittings
26 05 50 Firestops
26 09 25 Electrical Contactors
26 09 44 Lighting Controls
26 19 13 Combination Motor Controllers
26 24 25 Enclosed Switches
26 24 30 Fuses
26 27 73 Line Voltage Wiring Devices

ALTERNATE CHILLER EQUIPMENT PRICING FORM
BISD PATHWAY RENOVATION

Alternate No. 1 This Alternate shall establish the amount to be added to the Base Proposal for the Contractor to provide an Air-Cooled Rotary Scroll Chiller furnished and installed as manufactured by Carrier as indicated on the drawings and listed in the specifications. There are no Air-Cooled Rotary Scroll Chillers included in the base bid.

Undersigned agrees to complete the work for the lump sum amount of:

_____
(Amount written in words governs)

Dollars $_____
(Amount in figures)

Current Lead Time (Weeks) _____

Alternate No. 2 This Alternate shall establish the amount to be added to the Base Proposal for the Contractor to provide an Air-Cooled Rotary Scroll Chiller furnished and installed as manufactured by Daikin as indicated on the drawings and listed in the specifications. There are no Air-Cooled Rotary Scroll Chillers included in the base bid.

Undersigned agrees to complete the work for the lump sum amount of:

_____
(Amount written in words governs)

Dollars $_____
(Amount in figures)

Current Lead Time (Weeks) _____

Alternate No. 3 This Alternate shall establish the amount to be added to the Base Proposal for the Contractor to provide an Air-Cooled Rotary Scroll Chiller furnished and installed as manufactured by Trane as indicated on the drawings and listed in the specifications. There are no Air-Cooled Rotary Scroll Chillers included in the base bid.

Undersigned agrees to complete the work for the lump sum amount of:

_____
(Amount written in words governs)

Dollars $_____
(Amount in figures)

Current Lead Time (Weeks) _____

SECTION 02 07 20 - MINOR DEMOLITION AND RENOVATION WORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Performing repairs to existing substrate and repairing openings in substrate.

B. Modifying existing roof penetrations, curbs, piping, and utility service to provide proper flashing heights and flashing details.

C. Installing new nailers at designated locations.

D. Saw-cutting new primary and overflow scuppers in walls.

E. Performing other miscellaneous and incidental work required to install complete roofing system as specified and to obtain specified manufacturer's warranty.

1.2 RELATED SECTIONS

A. 07 22 16 - Roof Board Insulation.

B. 07 53 50 - Metal Retrofit Single-ply Roof System.

C. 07 62 00 - Sheet Metal Flashing and Trim.

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM).

B. Corps of Engineers (CRD).

1.4 PROJECT CONDITIONS

A. Environmental Requirements:

1. Do not perform renovation work in inclement weather or when rain is predicted with 30 percent or greater possibility.
2. When ambient temperature is below 60 degrees Fahrenheit (15 degrees Celsius), expose only enough materials required within designated period.
3. Do not expose materials to constant temperature in excess of 180 degrees Fahrenheit (82 degrees Celsius).

B. Emergency Equipment: Maintain on-site materials necessary to apply emergency temporary protection to work area in event of sudden rain events or inclement weather.

C. Smoking is prohibited on roof areas, in existing building, and all of Owner's property.

1.5 SEQUENCING AND SCHEDULING

A. Sequence demolition and renovation with sequence of new work to maintain facility in dry, watertight condition.

B. Coordinate roof work so that no more existing items are removed or new items installed in one day than can be replaced or covered with new roofing work in same day.

C. Coordinate work with Owner's operational requirements.

D. Coordinate work to maintain facility in dry, watertight condition.

1.6 WARRANTY

A. Provide Contractor's warranty covering defects in installed materials and workmanship for period of two years from date of final acceptance.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Treatment for Wood Nailers: Pressure preservative treated in accordance with AWPA C2, C9 standards, Above Ground Contact Alkaline Copper Quat-Type C (ACQ-C), Micronized Copper Quat (MCQ), Copper Azole-Type A (CBA-A), or similar acceptable treatment, at 0.20 pcf for wood, kiln-dried after treatment.

B. Lumber for Treated Wood Nailers:

1. Standard Grade Fir or No. 2 Southern Yellow Pine bearing UL label. Size shall be appropriate for application, minimum 1-1/2-inch (38mm) (nominal) thickness.
2. Complying with American Lumber Standards of manufacturer's association under whose rules lumber is produced.
3. Marked with mill identification.
4. Moisture Content: 19 percent maximum at time of installation.

C. Plywood: Minimum 3/4-inch (19mm) APA rated exterior grade sheathing, EXP 1 or "CDX", fire rated, bearing APA trademark.

D. Gypsum Roof Board: 1/2-inch thick moisture resistant gypsum roof board such as “DensDeck Prime” by Georgia Pacific or “SecuRock” by US Gypsum.

E. Fasteners:

1. Wood Substrate:
   a. Securement of metal flanged items such as flashing pans, metal edge/fascia, cleats, etc., shall be nails, No. 11 gauge, stainless steel or double hot-dipped galvanized, ASTM A153, steel wire with 3/8-inch (9mm) diameter head and 1-1/2-inch (38mm) long ring shank such as "R-103-A Stormguard Asphalt and Fiberglass Shingle Nail" by Maze Nails (800/435-5949).
   b. Securement of wood to wood shall be nails, No. 11 gauge, stainless steel or double hot-dipped galvanized steel wire nail with ring shank and 9/32-inch (7mm) diameter head such as "Stormguard PTL Anchor-Down Nail" by Maze Nails (800/435-5949); 10d or length required to provide 1-inch (25mm) penetration minimum into substrate.
   c. Securement of exposed items to wood substrate shall be No. 14 stainless steel screw with stainless steel washer and integral rubber seal; length required to provide 1-1/2inch (38mm) penetration minimum into substrate.
   d. Fasteners for securing roofing materials to wood substrate shall be a hardened stainless steel nail with a 1-inch (25mm) diameter round head and ring shank; length to provide 1-inch (25mm) penetration into substrate, as manufactured by Simplex Nail Co.
   e. Fasteners for securing steel to wood substrate shall be No. 14 stainless steel wood screw with stainless steel washer and integral rubber seal, length to achieve minimum 1-1/2-inch (38mm) embedment into substrate.
   f. Fasteners for securing wood nailer to wood nailer in vertical position shall be 20 gauge galvanized steel plate, 2-inches wide by 4-inches long such as “MP 24 Mending Plate” by Simpson Strong-Tie Co., Inc. and “A34 Framing Anchor” by Simpson Strong-Tie Co., Inc. for corner connections.
2. Concrete Substrate:
   a. Fasteners for securing sheet metal items such as surface-mounted counterflashings, termination/compression bars, etc., to concrete substrate shall be a pre-assembled drive anchor with an alloy or coated steel drive screw, a lead/zinc alloy expansion anchor body (1/4-inch (6mm) diameter, 1-1/2-inch [38mm] length) and a stainless steel washer with integral rubber seal (1-1/8-inch diameter) such as "Zamac Hammer-Screw" as manufactured by Powers Fasteners, Inc.
   b. Fasteners for securing wood blocking to concrete substrate at roof perimeters shall be sleeved stainless-steel stud expansion bolt, 1/2-inch (13mm) diameter (minimum), with 3/4-inch diameter steel washer such as "Kwik Bolt 3" by Hilti, "Tru Bolt Wedge" by ITW Ramset, or "Lok/Bolt" by Powers Fasteners, Inc. Fasteners for securing wood blocking to concrete substrate for miscellaneous applications shall be 1/4-inch diameter, 2-3/4-inch long stainless-steel or hot-dipped galvanized screw with hex head such as "Tapcon" by ITW Buildex.
3. Masonry Substrate:
   a. Fasteners for securing wood to solid masonry at roof perimeters shall be stainless steel expansion anchor, 3/8-inch (9mm) diameter (minimum), with 3/4-inch diameter steel washer such as "Countersunk Kwik Bolt 3" by Hilti. Fasteners for securing wood to solid masonry for miscellaneous applications shall be 1/4-inch diameter, 2-3/4-inch long hot-dipped galvanized or stainless-steel screw with hex head such as "Tapcon" by ITW Buildex.

b. Fasteners for securing wood to hollow base masonry shall be 3/8-inch (9mm) diameter (minimum), stainless-steel threaded rod, with 3/4-inch diameter washer, nut, and screen tube such as "HIT C-20 Adhesive Anchor" by Hilti.
c. Fasteners for securing sheet metal items to concrete substrate shall be a pre-assembled drive anchor with an alloy or coated steel drive screw, a lead/zinc alloy expansion anchor body (1/4-inch (6mm) diameter, 1-1/2-inch [38mm] length) and a stainless steel washer with integral rubber seal (1-1/8-inch diameter) such as "Zamac Hammer-Screw" as manufactured by Powers Fasteners, Inc.

4. Steel Substrate:
a. Fasteners for securing plywood to steel substrate shall be self-drilling, 1-1/2-inch long coated No. 10 screw with wafer head such as "Traxx Wood to Metal Fastener" by ITW Buildex. Fasteners for securing wood nailers/blocking to steel substrate shall be hot-dipped galvanized, CR-10 coated, or stainless-steel self-drilling screw, 3/4-inch (19mm) drill point with 5/8-inch (16mm) diameter washer such as “Purlin Fastener” by OMG.
b. Fasteners for securing steel to steel substrate shall be self-tapping No. 14, 1-1/2-inch long stainless steel screw with stainless steel washer and bonded integral rubber seal.

5. Plywood Clip: 20 gauge galvanized steel H-clip such as "PSCL Panel Sheathing Clip" by Simpson Strong-Tie Co., Inc. (800/999-5099).
6. Receiver in Reglet: Soft, malleable lead sheet, size and shape to fit in joint and maintain compression against receiver.

F. Rust Inhibitive Primer: 100 percent acrylic resin primer such as “Metalclad Interior-Exterior Acrylic Latex Flat Primer & Finish #41702”, Devoe & Raynolds Co.

G. Paint: Prime Coat: Semi-gloss alkyd enamel, red lead pigmented primer such as "1710 Kel-Guard Alkyd Rust-Preventative Red Oxide Primer" by Kelly-Moore; and Finish Coat: Semi-gloss alkyd enamel such as "6630 Plasti-Namel Semi-gloss Enamel" by Kelly-Moore.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine existing building and existing roofing to determine existing physical conditions that affect removal of existing roofing and installation of new roofing.

B. Verify that required barricades and other protective measures are in place.

3.2 PREPARATION

A. Take measures to maintain watertight conditions during term of Contract.

B. Install interior protection and dust partitions where penetrations shall be removed or replaced.

C. Protect adjacent surfaces.

3.3 MINOR DEMOLITION OPERATIONS

A. Execute demolition in careful and orderly manner with least possible disturbance or damage to adjoining surfaces and structure.

B. Avoid excessive vibrations in demolition procedures that would be transmitted through existing structure and finish materials.

C. Roof Renovations:

1. Modify and/or remove existing roofing, flashings, sheet metal, and other such items in order to install new roof system.
2. Do not stockpile debris on roof surface. Promptly dispose of obsolete equipment and debris at authorized disposal site each day. Use chutes or other similar containerized equipment to transfer debris from roof surface to dumpsters.

3.4 MINOR RENOVATION WORK

A. Prepare substrates in accordance with roofing manufacturer's recommendations.

B. Metal Roof Panels:

1. Install new metal roof panels of like type, weight, gauge, and dimensions to provide suitable substrate in deteriorated areas or where through penetrations are removed and at internal gutter.
2. Metal Roof Panels:
    a. At openings greater than 12-inches (300mm) in diameter, extend new panels 12-inches (300mm) minimum past nearest bar joist or support member. Mechanically fasten new panels with screws spaced 6-inches (150mm) on-center.
    b. Remove loose rust or other foreign material from existing roof panels to remain that would prohibit proper installation of new materials.
    c. Remove rust by wire brushing or other appropriate method. Apply rust inhibitor over prepared areas of metal deck.
    d. Cut roof panels along gutters flush with inside vertical face of gutter.

C. Nailers:

1. Install new nailers as required as part of Base Proposal price.
2. Clean and prepare existing surfaces to receive wood nailers and curbs.
3. Secure 2X base nailer into structure and/or substrate for anchorage of cleats, flanges, and/or fascias of sheet metal fabrications, width of nailer shall be as necessary to extend a minimum 1/2-inch beyond horizontal flange of sheet metal fabrication.
4. Install 2X wood nailer, minimum, as base nailer at roof perimeters.
5. Install wood nailers continuously with 1/4-inch (6mm) gap between each section. Set level and true. Pre-drill nailers prior to attachment. Countersink fastener in base nailer so that washer and head of fastener or nut are recessed below top of nailer.

6. Securely fasten to structure with appropriate fasteners to resist minimum 200 pounds per linear foot force in any direction. Use of powder-actuated fasteners is prohibited. Place a fastener within 3-inches (75mm) of each end of each section of wood blocking.
7. On standing seam metal roofs, install two layers of wood nailers with the first layer installed between the raised standing seams, flush with the top surface of the seams. Mechanically fasten the base nailer directly to the structural purlins with purlin fasteners spaced a maximum of 16-inches on center. Install a minimum of 2 fasteners in sections of wood nailers installed between standing seams positioned approximately 3-inches from each end of the nailer. Fasten the top layer of wood nailers to the bottom layer of wood nailers with appropriate fasteners penetrating the bottom layer of wood nailers a minimum of 1 inch.
8. Stagger joints in subsequent layers of nailers from joints in underlying layer of nailers a minimum of 12-inches (300mm).
9. Install nailers for curbs so that ends and sides of adjoining nailers are aligned to form right angles (nominal) at corners. Weave ends of subsequent layers of nailers at corners so that ends of nailers do not align.
10. Secure nailers to wood substrate using nails spaced 24-inches (600mm) on-center, staggered. Install nails on an angle.
11. Secure nailers with self-drilling steel fastener to steel framing spaced 16-inches (400mm) on-center.
12. When attaching nailers along perimeters of roofs, reduce fastener spacing 50 percent at a distance of 10 feet (3m) from each corner of roof.
13. Secure new nailer to existing nailer or curb when increasing curb height utilizing appropriate fasteners, gusset plates, and framing anchors.

D. Plywood/Gypsum Sheathing:

1. Install new sheathing at curbs, and perimeters as denoted in Drawings or as required to provide suitable substrate for flashing installation.
2. Secure sheathing to substrate with flat head fasteners (type appropriate for substrate) spaced 12-inches (300mm) on-center.
3. Secure sheathing to wood substrate with nails spaced 6-inches (150mm) on-center.

E. Equipment and Curb Renovation:

1. Remove, retain, and reinstall existing equipment as required to facilitate new flashing.
2. Securely fasten equipment on curbs after new flashing is installed.
3. Curb flashing height shall be 8-inches (200mm) minimum above newly finished roof surface.
4. Include raising of curb flashing to provide minimum 8-inch (200mm) height.
5. Paint existing sheet metal vent hoods, covers, caps, etc., that are to be reinstalled.

F. Plumbing Vents:

1. Extend plumbing vents or modify as necessary to accommodate new roof installation.
2. Provide pipe extensions and no-hub couplings where necessary to achieve minimum 8-inch (200mm) height above top of newly finished roof surface.
3. Utilize same material type and size as existing for new extension.
4. Clean and paint exposed portion of vent pipe; color selected by Owner's Representative.

G. Painting Items:

1. Paint existing equipment hoods, covers, heat-flues/exhausts, access ladder, steel framed supports, and other rooftop related exposed steel metal items to remain.
2. Use rotary wire wheel or other mechanical abrading method to remove corrosion on sheet metal surfaces down to bare sound metal.
3. Clean prepared areas and adjacent surfaces to receive new paint.
4. Apply paint to prepared and cleaned surfaces in adequate coverage utilizing napped rollers to achieve monolithic finish appearance. Utilize heat resistant paint at heat exhaust vent.

H. New Scuppers:

1. Saw-cut new primary and overflow scupper openings to minimum 12-inches wide by 6-inches high at designated locations.
2. Locate bottom edge of overflow scupper a maximum of 2-inches above bottom edge of primary scupper.
3. Provide opening in masonry utilizing wet-saw cutting methods or other appropriate method for subject materials.
4. Repair damaged dampproofing or other barrier materials present in wall assembly.

I. Metal Wall Panel Renovation: Cut and renovate existing preformed metal wall panels to accommodate new roof system at rise walls. Resecure cut bottom edge of wall panels to existing framing with grommeted self-drilling screws spaced 6-inches on-center.

3.5 CLEANING

A. Materials, equipment, and debris resulting from demolition operations shall become property of Contractor. Remove and dispose of demolition debris in accordance with applicable city, state, and federal laws at authorized disposal site.

B. Leave substrate clean and dry, ready to receive roofing system.

END OF SECTION 02 07 20

SECTION 024119 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Demolition and removal of selected portions of building damaged by moisture intrusion.
2. Demolition and removal of selected finishes damaged by moisture intrusion or as required for removal to install new replacement mechanical systems and then patched back to match.
3. Salvage of existing items to be reused or recycled.

1.2 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.3 CLOSEOUT SUBMITTALS

A. Inventory of items that have been removed and salvaged.

1.4 QUALITY ASSURANCE

A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.5 FIELD CONDITIONS

A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.

1. Hazardous materials will be removed by Owner before start of the Work.
2. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.

E. Storage or sale of removed items or materials on-site is not permitted.

F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1. Maintain fire-protection facilities in service during selective demolition operations.

G. Arrange selective demolition schedule so as not to interfere with Owner's operations.

1.6 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

3.2 PREPARATION

A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Arrange to shut off utilities with utility companies.
2. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
3. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
    a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
    b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
    c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
    d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
    e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
    f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.

3.4 PROTECTION

A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

C. Remove temporary barricades and protections where hazards no longer exist.

3.5 SELECTIVE DEMOLITION

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand

tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.

2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
3. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
4. Maintain fire watch during and for at least 8 hours after flame-cutting operations.
5. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
6. Dispose of demolished items and materials promptly.

B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

C. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.6 CLEANING

A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."

B. Burning: Do not burn demolished materials.

C. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 024119

SECTION 031000 - CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Form-facing material for cast-in-place concrete.
2. Shoring, bracing, and anchoring.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Concrete Formwork: Design, engineer, erect, shore, brace, and maintain formwork, shores, and reshores in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.

1. Design wood panel forms in accordance with APA's "Concrete Forming Design/Construction Guide."
2. Design formwork to limit deflection of form-facing material to 1/240 of center-to-center spacing of supports.
    a. For architectural concrete specified in Section 033300 "Architectural Concrete," limit deflection of form-facing material, studs, and walers to 0.0025 times their respective clear spans (L/400).

2.2 FORM-FACING MATERIALS

A. As-Cast Surface Form-Facing Material:

1. Provide continuous, true, and smooth concrete surfaces.
2. Furnish in largest practicable sizes to minimize number of joints.
3. Acceptable Materials: As required to comply with Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete, and as follows:
    a. Plywood, metal, or other approved panel materials.
    b. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
        1) APA Plyform Class I, B-B or better; mill oiled and edge sealed.

B. Concealed Surface Form-Facing Material: Lumber, plywood, metal, plastic, or another approved material.

1. Provide lumber dressed on at least two edges and one side for tight fit.

PART 3 - EXECUTION

3.1 INSTALLATION OF FORMWORK

A. Comply with ACI 301.

B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 and to comply with the Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete" for as-cast finishes.

C. Construct forms tight enough to prevent loss of concrete mortar.

1. Minimize joints.
2. Exposed Concrete: Symmetrically align joints in forms.

D. Construct removable forms for easy removal without hammering or prying against concrete surfaces.

1. Install keyways, reglets, recesses, and other accessories, for easy removal.

E. Do not use rust-stained, steel, form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces.

1. Provide and secure units to support screed strips.
2. Use strike-off templates or compacting-type screeds.

G. At construction joints, overlap forms onto previously placed concrete not less than 12 inches.

H. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.

1. Determine sizes and locations from trades providing such items.
2. Obtain written approval of Architect prior to forming openings not indicated on Drawings.

I. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

J. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

K. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete.

1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
4. Install dovetail anchor slots in concrete structures, as indicated on Drawings.
5. Clean embedded items immediately prior to concrete placement.

3.3 SHORING AND RESHORING INSTALLATION

A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.

1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

END OF SECTION 031000

SECTION 032000 - CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel reinforcement bars.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Each type of steel reinforcement.
2. Bar supports.
3. Mechanical splice couplers.

B. Shop Drawings: Comply with ACI SP-066:

1. Include placing drawings that detail fabrication, bending, and placement.
2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.

C. Construction Joint Layout: Indicate proposed construction joints required to build the structure.

1. Location of construction joints is subject to approval of the Architect.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1. Reinforcement to Be Welded: Welding procedure specification in accordance with AWS D1.4/D1.4M

B. Material Certificates: For each of the following, signed by manufacturers:

1. Epoxy-Coated Reinforcement: CRSI's "Epoxy Coating Plant Certification."

C. Material Test Reports: For the following, from a qualified testing agency:

1. Steel Reinforcement:
   a. For reinforcement to be welded, mill test analysis for chemical composition and carbon equivalent of the steel in accordance with ASTM A706/A706M.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.4/D 1.4M.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A615/A615M, Grade 60 , deformed.

B. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.

C. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.

2.2 REINFORCEMENT ACCESSORIES

A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.

1. Manufacture bar supports from steel wire or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
   a. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.
   b. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

B. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch in diameter.

2.3 FABRICATING REINFORCEMENT

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

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection of In-Place Conditions:

1. Do not cut or puncture vapor retarder.
2. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

3.2 INSTALLATION OF STEEL REINFORCEMENT

A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.

B. Accurately position, support, and secure reinforcement against displacement.

1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
2. Do not tack weld crossing reinforcing bars.

C. Preserve clearance between bars of not less than 1 inch, not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.

D. Provide concrete coverage in accordance with ACI 318.

E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

F. Splices: Lap splices as indicated on Drawings.

1. Bars indicated to be continuous, and all vertical bars shall be lapped not less than 36 bar diameters at splices, or 24 inches, whichever is greater.
2. Stagger splices in accordance with ACI 318.
3. Weld reinforcing bars in accordance with AWS D1.4/D 1.4M, where indicated on Drawings.

3.3 JOINTS

A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement.
2. Continue reinforcement across construction joints unless otherwise indicated.
3. Do not continue reinforcement through sides of strip placements of floors and slabs.

3.4 INSTALLATION TOLERANCES

A. Comply with ACI 117.

3.5 FIELD QUALITY CONTROL

A. Inspections:

1. Steel-reinforcement placement.
2. Steel-reinforcement welding.

END OF SECTION 032000

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - Part I – General

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions, apply to this section reference new mechanical equipment concrete pads.

B. Reference structural drawings for additional notes and details reference cast-in-place concrete.

1.2 SUMMARY

A. Section specifies cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures and finishes

1.3 RELATED SECTIONS

A. Coordinate Work of Section with work of other sections, including Division 01 Sections as required to properly execute the work and as necessary to maintain satisfactory progress of the work.

1.4 SUBMITTALS

A. Product Data: Submit Manufacturer’s Technical Data, installation instructions and recommendations for each product. Include data substantiating that materials comply with specified requirements.

1. Product data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, joint systems, curing compounds and others as requested by Architect/Engineer.

B. Design Mixtures: For each concrete mixture.

C. Shop Drawings: Submit for reinforcement, prepared by Professional Engineer registered in the State of Texas for fabrication, bending and placement of concrete reinforcement. Comply with ACI SP-66(88), “ACI Detailing Manual”, showing bar schedules, stirrup spacing, and diagrams of bent bars and arrangement of concrete reinforcement. Include special reinforcement required for openings through concrete structures.

D. Laboratory test reports for concrete materials and mix design test.

E. Materials Certificates in lieu of Material Laboratory Test Reports when permitted by Architect/Engineer. Materials Certificates shall be signed by Manufacturer and Contractor, certifying that each material item complies with or exceeds specified requirements, Provide

certification from admixtures manufacturers that chloride content complies with specification requirements,

1.5 QUALITY ASSURANCE

A. This section outlines minimum standards and requirements. Refer to the Structural Drawings for additional requirements. In the event of conflict, information on Structural Drawings shall take precedence. Bring all conflicts and discrepancies between documents to the attention of the Architect and Engineer and do not work until such conflicts and discrepancies are clarified and corrected.

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

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities"

C. ACI Publications: Comply with the following rules unless modified by requirements in the Contract Documents:

1. ACI 301, "Specification for Structural Concrete," Sections 1 through 5
2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials"

D. Pre-Installation Conference: Conduct conference at Project site in accordance with Section 013100,"Project Management and Coordination"

PART 2 - Part II - PRODUCTS

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

B. Plain-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from as-drawn steel wire into flat sheets.

C. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet

D. Bar Supports: Bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic or pre-cast concrete according to CRSI's " Manual of Standard Practice"

2.3 CONCRETE MATERIALS

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

1. Portland cement: ASTM C 150, Type I / II. Supplement with the following
   a. Fly Ash: ASTM C 618, Class F, unless noted otherwise, no more than 15% fly ash by weight

B. Normal-Weight Aggregates: ASTM C 33, graded, 1½" (38mm) and ¾" (19mm) nominal maximum coarse-aggregate size.

C. Water: ATM C 94/C 94M and potable.

D. Air-Entraining Admixture: ASTM C 260

E. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride

1. Water-Reducing Admixtures: ASTM C 494/C 494M, Type A
2. Retarding Admixture: ASTM C 494/C 494M, Type B
3. Water-Reducing and Retarding Admixtures: ASTM C 494/C 494M, Type D
4. High-Range, Water-Reducing Admixtures: ASTM C 494/C 494M, Type F
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II

2.4 VAPOR RETARDERS

A. Plastic Vapor Retarder: ASTM E 1745, Class A, or polyethylene sheet, ASTM D 4397, not less than 15 mils (0.381mm) thick. Include manufacturer's recommended adhesive or pressure-sensitive joint tape.

B. Reference 072660 Below-Slab Vapor Barrier.

2.5 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: potable

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

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, non-dissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering

F. Clear, Solvent-borne, Membrane-Forming Curing Compound: ASTM C 1315, Type 1, Class A

G. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A

H. Contractor use caution to review curing methods and chemicals with manufacturer of floor finish material to prevent compatibility issues with surface adhesion or reactions to adhesives.

2.6 RELATED MATERIALS

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

2.7 CONCRETE MIXTURES

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301

B. Proportion normal-weight concrete mixtures as follows:

1. Minimum Compressive Strength: 3000 psi at 28 days for footing; 3500 psi at 28 days for all other concrete
2. Maximum-Water-Cementitious Material Ratio: 0.45 slab on grade. 0.50 All other
3. Slump Limit: 4” (100mm) plus or minus 1”(25mm)
4. Air Content: 5.5 % plus or minus 1.5% at point of delivery for 1 ½” (38mm) nominal maximum aggregate size.
5. Max 20% Fly Ash
6. Air Content: No entrained air for troweled finished floors

2.8 FABRICATING REINFORCEMENTS

A. Fabricating steel reinforcement according to CRSI’s “ Manual of Standard Practice”

2.9 CONCRETE MIXING

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

1. When air temperature is between 85 and 90 ºF (30 and 32 ºC), reduce mixing and delivery time from 1.5 hours to 75 minutes; when air temperature is above 90 ºF (32 ºC), reduce mixing and delivery time to 60 minutes.

PART 3 - Part III – EXECUTION

3.1 FORMWORK

A. Design, erect, shore, brace and maintain formwork according to ACI 301 to support vertical, lateral, static and dynamic load and construction loads that might be applied until structure can support such loads

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation and position indicated within tolerance limits of ACI 117

C. Chamfer exterior corners and edges of permanently exposed concrete

3.2 EMBEDDED ITEMS

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

3.3 VAPOR RETARDERS

A. Plastic Vapor Retarder: Place, protect and repair vapor retarders according to ASTM E 1643 and manufacturer's written instructions.

1. Lap joints 6" (150mm) and seal with manufacturer's recommended tape

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's " Manual of Standard Practice" for placing reinforcement

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete

3.5 General: Construct joints true to line with faces perpendicular to surface plane of concrete

A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect

B. Contraction joints in Slabs-on-Grade: Form weakened plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least ¼ of concrete thickness as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8" (3.2mm). Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving tool marks on concrete surfaces.

2. Sawed Joints: Form contraction joints with power saw equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8" (3.2mm) wide joints into concrete when cutting action will not tear, abrade or otherwise damage surface and before concrete develops random contraction cracks

C. Isolation Joints in Slab-on-Grade: After removing formwork, install joint0filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams and other locations as indicated

3.6 CONCRETE PLACEMENT

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

B. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated on architects slab plan. Deposit concrete to avoid segregation.

1. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301

C. Cold-Weather Placement: Comply with ACI 306.1

D. Hot-Weather Placement: Comply with ACI 301

3.7 FINISHED FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish or to be covered with a coating or covering material applied directly to concrete

C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:

1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix 1 part Portland cement to 1.5 parts fine sand

with a 1:1 mixture of bonding admixture and water. Add white Portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours

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

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

3.8 FINISHING FLOORS AND SLAB

A. General: Comply with ACI 302.1R recommendations for screeding, re-straightening and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms or rakes to produce a profile amplitude of 1/4” (6mm) in 1 direction.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Re-straighten, cut down high spots and fill low spots. Repeat float passes and re-straightening until surface is left with a uniform, smooth, granular texture.

D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects and that would telegraph through applied coatings and floor coverings.

1. Apply trowel finish to surfaces indicated, exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint or another thin-film-finish coating system.
2. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding 10’ (3.05m) long straightedge resting on 2 high spots and placed anywhere on the surface does not exceed 1/8”

E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated and where ceramic or quarry tile is to be installed by either thickset or thin-set method. While concrete is still plastic, slightly scarify surface with fine broom.

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

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

3.9 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 309.1 for cold weather protection and ACI 301 for hot weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder (6 mil poly) to unformed concrete surfaces if hot, dry or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding and bull-floating or darbying concrete, but before float finishing.

C. Cure concrete according to ACI 308.1, as follows:

1. Slab - Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in the widest practicable width, with sides and ends lapped at least 12" (300mm) and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
2. Sidewalks and site paving - Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
    a. After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with binding of floor covering used on Project.

3.10 CONCRETE SURFACE REPAIRS

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

3.11 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports

1. Testing Services: Tests shall be performed according to ACI 301

END OF SECTION 033000

SECTION 054000 - COLD-FORMED METAL FRAMING (WHERE PATCH AND REPAIRING EXISTING CONDITIONS DAMAGED BY WATER INTRUSION)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior non-load-bearing wall framing.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at **Project site.**

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Cold-formed steel framing materials.
2. Load-bearing wall framing.
3. Exterior non-load-bearing wall framing.
4. Interior non-load-bearing wall framing.
5. Vertical deflection clips.
6. Single deflection track.
7. Double deflection track.
8. Drift clips.
9. Post-installed anchors.
10. Power-actuated anchors.

B. Sustainable Design Submittals: To be discussed during project review.

C. Shop Drawings:
1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product certificates.

C. Product test reports.

D. Research Reports:

1. For **post-installed anchors and power-actuated fasteners**], from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

B. Product Tests: Mill certificates or data from a qualified independent testing agency.

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

D. Comply with AISI S230 "Standard for Cold-Formed Steel Framing - Prescriptive Method for One and Two Family Dwellings."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products to be reviewed prior to approval and regardless must comply with written specification.

2.2 PERFORMANCE REQUIREMENTS

A. Cold-Formed Steel Framing Standards: Unless more stringent requirements are indicated, framing shall comply with AISI S100, AISI S200, and the following:

1. Wall Studs: AISI S211.
2. Headers: AISI S212.
3. Lateral Design: AISI S213.

B. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

2.3 COLD-FORMED STEEL FRAMING MATERIALS

A. Contractor is encouraged, where possible to assure products are provided using recycled material.

B. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:

1. Grade: As **required by structural performance**.
2. Coating: **G60**.

C. Steel Sheet for Clips: ASTM A653/A653M, structural steel, zinc coated, of grade and coating as follows:

1. Grade: **As required by structural engineer's requirements.**
2. Coating: **G60**.

2.4 INTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: **0.0428 inch.**
2. Flange Width:[**1-3/8 inches**] unless otherwise noted by structural for wind loading conditions.
3. Section Properties: Per structural for any wind or other load conditions.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and matching minimum base-metal thickness of steel studs.

C. Vertical Deflection Clips: Manufacturer's standard clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.

1. Applicable for long spans to be coordinated with architect and engineers.

D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure.

E. Double Deflection Tracks: Manufacturer's double, deep-leg, U-shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges.

F. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.5 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from ASTM A1003/A1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated.

2.6 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A36/A36M, zinc coated by hot-dip process according to ASTM A123/A123M.

B. Anchor Bolts: ASTM F1554, **Grade 36**, threaded carbon-steel **hex-headed bolts, other other pre-approved, with encased end threaded,** carbon-steel nuts, and flat, hardened-steel washers; zinc coated by **hot-dip process according to ASTM A153/A153M, Class C.**

C. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on [**ICC-ES AC01**] as approved by structural engineer and as appropriate for the substrate.

1. Uses: Securing cold-formed steel framing to structure.
2. Type: Torque-controlled expansion anchor, Torque-controlled adhesive anchor or adhesive anchor for interior applications pre-approved by architect and engineeer.
3. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5, unless otherwise indicated.

D. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

E. Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.

1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.

2.7 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: **ASTM A780/A780M, MIL-P-21035B** o**r SSPC-Paint 20**.

B. Cement Grout: Portland cement, ASTM C150/C150M, Type I; and clean, natural sand, ASTM C404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

C. Nonmetallic, Non-shrink Grout: Factory-packaged, nonmetallic, noncorrosive, non-staining grout, complying with ASTM C1107/C1107M, and with a fluid consistency and 30-minute working time.

D. Shims: Load-bearing, high-density, multi-monomer, non-leaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.

E. Sill Sealer Gasket: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members as required.

PART 3 - EXECUTION

3.1 PREPARATION

A. Install sill sealer gasket at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.2 INSTALLATION, GENERAL

A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed steel framing according to AISI S200, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.

C. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.

D. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

E. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

F. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.

G. Install insulation, specified in Section 072100 "Thermal Insulation," in framing-assembly members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.

H. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

3.3 INSTALLATION OF EXTERIOR NON-LOAD-BEARING WALL FRAMING

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.

B. Fasten both flanges of studs to **top and** bottom track unless otherwise indicated. Space studs as follows:

1. Stud Spacing: **As indicated on Drawings**.

C. Set studs plumb, except as needed for diagonal bracing or required for non-plumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.

1. Install single deep-leg deflection tracks and anchor to building structure.
2. Install double deep-leg deflection tracks and anchor outer track to building structure.
3. Connect vertical deflection clips to **infill** studs and anchor to building structure.
4. Connect drift clips to cold-formed steel framing and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced vertically in rows indicated **on Shop Drawings** but not more than 48 inches apart. Fasten at each stud intersection.

1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within **18 inches** of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.

1. Install solid blocking at **96-inch centers but not less indicated on Shop Drawings**.

G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.4 INSTALLATION OF INTERIOR NON-LOAD-BEARING WALL FRAMING

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.

B. Fasten both flanges of studs to **top and** bottom track unless otherwise indicated. Space studs as follows:

1. Stud Spacing: **As indicated on Drawings but not less than 16” on center**.

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.

1. Install single deep-leg deflection tracks and anchor to building structure.
2. Install double deep-leg deflection tracks and anchor outer track to building structure.
3. Connect vertical deflection clips to studs and anchor to building structure.
4. Connect drift clips to cold-formed steel metal framing and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on **Shop Drawings but not less than** 48 inches apart. Fasten at each stud intersection.

1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within **18 inches** of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.

1. Install solid blocking at not less than **96-inch centers** or as **indicated on Shop Drawings**].

G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 INSTALLATION TOLERANCES

A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.6 REPAIRS

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

3.7 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field and shop welds will be subject to testing and inspecting.

C. Testing agency will report test results promptly and in writing to Contractor and Architect.

D. Cold-formed steel framing will be considered defective if it does not pass tests and inspections.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

END OF SECTION 054000

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Miscellaneous steel framing and supports.
2. Fabricated and hot dip galvanized handrails and anchors.
3. Additional requirements for anchors listed under mechanical section for equipment support.

B. Products furnished, but not installed, under this Section include the following:

1. No items.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Steel handrails hot dip galvanized after fabrication.

B. Shop Drawings: Show fabrication and installation details. **Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items**]

C. Samples: For each type and finish..

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.2 METALS

A. Cast iron downspout boots coordinated by pre-engineered metal building manufacturer supplied downspout dimensions for proper fit.

B. Steel for fabricating railing as indicated on drawings to be hot dip galvanized after fabrication.

C. Nickel Silver Castings: ASTM B584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).

2.3 FASTENERS

A. General: Unless otherwise indicated, provide **Type 304** stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless steel fasteners for fastening **aluminum, stainless steel, or nickel silver**.
2. Provide bronze fasteners for fastening bronze.

B. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329/F2329M.

C. Post-Installed Anchors: **Torque-controlled expansion anchors or** pre-approved **chemical anchors**.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1**] [**Group 2**] stainless steel bolts, ASTM F593, and nuts, ASTM F594.

D. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B633, Class Fe/Zn 5, as needed for fastening to inserts.

2.4 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with Painting Sections.

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

C. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.

D. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

F. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

H. Shrinkage-Resistant Grout: Factory-packaged, non-metallic, non-staining, non-corrosive, non-gaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

I. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained concrete with a minimum 28-day compressive strength of 3000 psi.

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, not less than 8 inches from ends and corners of units and 24 inches o.c.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

2.7 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Galvanize **exterior** miscellaneous steel trim.

2.8 GENERAL FINISH REQUIREMENTS

A. Finish metal fabrications after assembly.

2.9 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Shop prime iron and steel items **not indicated to be galvanized** unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

1. Shop prime with **universal shop primer.**

C. Preparation for Shop Priming: Prepare surfaces to comply with **SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning." Or SSPC-SP 3, "Power Tool Cleaning." requirements indicated below:**

1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
3. Items Indicated to Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

4. Other Steel Items: SSPC-SP 3, "Power Tool Cleaning."
5. Galvanized-Steel Items: SSPC-SP 16, "Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals."

D. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

A. Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Anchor supports for toilet partitions and shower partitions stainless to all floor or masonry wall connections, no variance in any case.

3.3 REPAIRS

A. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 055000

SECTION 06 01 10 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Installation of wood nailers at curbs, perimeters, penetrations, walls, and as necessary to install new systems.

B. Exterior sheathing.

1.2 RELATED SECTIONS

A. 02 07 20 - Minor Demolition and Renovation Work

B. 07 53 50 - Metal Retrofit Single-ply Roof System.

C. 07 62 00 - Sheet Metal Flashing and Trim.

1.3 QUALITY ASSURANCE

A. Provide sufficient workmen and supervisors who shall be present at all times during execution of this portion of the work and who shall be thoroughly familiar with the type of construction involved and the materials and techniques specified.

B. All work shall conform to pertinent standards.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store all materials up, off the ground and cover with a weatherproof covering anchored sufficiently so as to resist wind blow-off.

B. Keep all materials clearly identified with all grade marks legible. Keep all damaged material clearly identified as damaged and store separately to prevent its inadvertent use.

C. Do not allow installation of damaged or otherwise non-complying material.

D. In the event of damage, immediately make all necessary repairs and replacements to the approval of Owner and at no additional cost to Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Wood Members, Nailers, and Blocking Lumber: Noncombustible Standard Grade Fir or No. 2 Southern Yellow Pine bearing UL label, Kiln-dried after treatment, complying with American Lumber Standards of manufacturer's association under whose rules lumber is produced, minimum size 2-inches (50mm) by 6-inches (150mm), nominal.

B. Treatment for Wood Members: Pressure-preservative treated in accordance with AWPA C2, C9 standards, Above Ground Contact Alkaline Copper Quat Type C (ACQ-C) or Copper Azole Type A (CBA-A) at 0.25 pounds per cubic foot for (ACQ-C) or 0.20 pcf for (CBA-A) wood.

C. Plywood:

1. Exterior Sheathing:
   a. Thickness: 1/2-inch and 3/4-inch, nominal.
   b. Grade: C - D.
   c. Exterior grade

D. Fasteners:

1. Wood Substrate:
   a. Securement of metal flanged items such as flashing pans, metal edge/fascia, cleats, etc., shall be nails, No. 11 gauge, stainless steel wire with 3/8-inch (9mm) diameter head and ring shank fasteners for anchoring flanges of sheet metal fabrications shall be of sufficient length to achieve a minimum 1-inch embedment into solid wood substrate such as "R-103-A Stormguard Asphalt and Fiberglass Shingle Nail" by Maze Nails (800/435-5949).
   b. Securement of wood to wood shall be nails, No. 11 gauge, stainless steel wire nail with ring shank and 9/32-inch (7mm) diameter head such as "Stormguard PTL Anchor-Down Nail" by Maze Nails (800/435-5949); 10d or length required to provide 1-inch (25mm) penetration minimum into substrate. Securement of exposed items to wood substrate shall be No. 14 stainless steel screw with stainless steel washer and integral rubber seal; length required to provide 1-inch (25mm) penetration minimum into substrate.
   c. Fasteners for securing roofing materials to wood substrate shall be a hardened stainless steel nail with a 1-inch (25mm) diameter round head and ring shank; length to provide 1-inch (25mm) penetration into substrate, as manufactured by Simplex Nail Co.
2. Plywood Clip: 20 gauge galvanized steel H-clip such as "PSCL Panel Sheathing Clip" by Simpson Strong-Tie Co., Inc. (800/999-5099).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Nailers:

1. Replace wood nailers and curbs with new nailers and curbs as required.
2. Install wood nailers to match height of new insulation board.
3. Secure 2X base nailer into structure and/or substrate for anchorage of cleats and/or fascias of sheet metal fabrications, width as necessary to extend beyond horizontal flange of sheet metal fabrication.
4. Clean and prepare existing surfaces to receive wood nailers and curbs.
5. Install 2 X 6 wood nailer, minimum, as base nailer at perimeters or tops of parapet walls. Nailers shall match width of wall and provide minimum 1-inch per foot slope toward roof.
6. Install wood nailers and curbs continuously with 1/4-inch (6mm) gap between each section. Set level and true. Pre-drill nailers prior to attachment. Countersink fastener in base nailer so that washer and head of fastener or nut are recessed below top of nailer.
7. Securely fasten to structure with appropriate fasteners to resist minimum 175 pounds per linear foot (780N per 300mm) force in any direction and spaced 12-inches on-center. Use of powder-actuated fasteners is prohibited. Place a fastener within 3-inches (75mm) of each end of each section of wood blocking.
8. Secure nailers to concrete deck with appropriate fasteners spaced 24-inches (600mm) on-center. Secure nailer with a minimum of two fasteners per nailer.
9. Stagger joints in subsequent layers of nailers from joints in underlying layer of nailers a minimum of 12-inches (300mm).
10. Install nailers so that ends and sides of adjoining nailers are aligned to form right angles (nominal) at corners.
11. Weave ends of subsequent layers of nailers at corners so that ends of nailers do not align.
12. Secure nailers to metal deck with screws spaced 12-inches (300mm) on-center, 6-inches (150mm) on-center, 10 foot (3m) from each corner.
13. Secure nailers to wood substrate using nails 24-inches (600mm) on-center, staggered. Install nails on an angle.
14. Secure nailers with self-tapping steel fastener to structural steel with self-drilling screw or through-bolt spaced 12-inches on-center.
15. If attaching wood nailer to concrete masonry block, install stainless steel threaded rod spaced 12-inches (300mm) on-center in fully grouted cell/core of CMU.
16. Reduce fastener spacing 50 percent at a distance of 10 feet (3m) from each corner.
17. Secure new nailer to existing nailer or curb when increasing curb height utilizing appropriate fasteners, gusset plates, and framing anchors.

B. Plywood/Gypsum Sheathing:

1. Install new sheathing at walls, curbs, and over unsuitable substrates to receive new roofing. Replace damaged, deteriorated, or non-salvageable existing sheathing.
2. Secure sheathing to substrate with flat head fasteners (type appropriate for substrate) spaced 12-inches (300mm) on-center.
3. Secure sheathing to wood substrate with nails spaced 6-inches (150mm) on-center.
4. Install new sheathing at roof hatches and metal curbs. Secure sheathing to substrate with flat head fasteners (type appropriate for substrate) spaced 12-inches (300mm) on-center. Trim exposed ends of screws on inside of hatch/curb.

3.2 CLEAN UP

A. Premises shall be kept in a neat and orderly condition.

B. After installation of all rough carpentry, contractor shall remove all construction debris and equipment from job site.

END OF SECTION 06 01 10

SECTION 07 22 16 - ROOF BOARD INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Installation of flute fill, secondary insulation board, and crickets over metal roof panels.

1.2 RELATED SECTIONS

A. 02 07 20 - Minor Demolition and Renovation.

B. 07 53 50 - Metal Retrofit Single Ply Roof System.

C. 07 62 00 - Sheet Metal Flashing & Trim.

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM).

B. Standards:

1. FM Global Approval Guide.
2. Underwriters Laboratories: Building Materials Directory.
3. National Roofing Contractors Association (NRCA): The NRCA Roofing and Waterproofing Manual.
4. ASCE 7-10: "Minimum Design Loads for Buildings and Other Structures."
5. Polyisocyanurate Insulation Manufacturer’s Association: Technical Bulletin 109 – “Storage and Handling Recommendations for Polyisocyanurate”.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Classified by Underwriters Laboratories Inc. as Class A rated material.
2. Follow local, state, and federal regulations, safety standards, and codes. When conflict exists, the more restrictive document shall govern.
3. Minimum R-25 insulation.

B. Installation:

1. Install in accordance with manufacturer's current published application procedures, general requirements of NRCA, and as supplemented by these documents.

2. Consider roof system manufacturer's technical specifications part of this Specification and use as reference for specific application procedures.

C. Install roof system in manner to resist minimum wind uplift pressures of: 60 psf for the field of the roof; 90 psf in perimeter zones; and 135 psf in corners; based on 150 mph wind speed, Exposure B, Risk Category III/IV, Enclosed, and Safety Factor of 2.0.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials in accordance with manufacturer's recommendations.

B. Outdoor Storage:

1. Tarp and shield insulation from moisture and exposure to sun.
2. Elevate insulation above substrate 4-inches minimum.
3. Secure insulation to resist high winds.
4. Do not use insulation which has been determined "wet" or which has been wet and has dried.
5. Distribute insulation stored on roof deck to prevent concentrated loads that would impose excessive stress or strain on deck or structural members, or impede drainage.
6. Remove manufacturer plastic shrink wrapping from materials prior to covering with protective tarps/canvas.

1.6 SEQUENCING AND SCHEDULING

A. Plan roof layout with respect to roof deck slope to prevent rainwater drainage into completed roofing.

B. Do not install more insulation than can be made watertight in same day.

1.7 PROJECT CONDITIONS

A. Environmental Recommendations:

1. Apply roofing and insulation in dry weather.
2. Do not proceed with roof construction during inclement weather or when precipitation is predicted with 30 percent or more possibility.
3. Do not apply insulation over wet or moist deck or in foggy conditions.
4. Consider days when wind speeds are 30 mph or greater as "inclement weather" days.

B. Maintain on site equipment and material necessary to apply emergency temporary weather protection to incomplete work in event of sudden precipitation.

PART 2 - PRODUCTS

2.1 ROOF INSULATION

A. Secondary Layer Insulation: Rigid, closed cell polyisocyanurate rigid board insulation utilizing non-chlorine/non-ozone depleting blowing agent, bonded to non-asphaltic coated fiberglass facers, ASTM C 1289, Type II, Class 2, Grade 2 (20 psi), 2-inch thickness; maximum Board Size 4 feet by 8 feet; such as "ACFoam-III" by Atlas Roofing Corp, "ENRGY 3 CGF" by Johns Manville, “Resista” by Firestone, “SecurShield Polyiso” by Carlisle, "EnergyGuard Ultra" by GAF or approved equal.

B. Tapered Insulation for Field of Roof: Rigid, closed cell polyisocyanurate foam core bonded to coated fiberglass facers suitable to receive cold process adhesive; ½-inch thickness at low point tapered to provide minimum resulting slope 1/4-inch per linear foot; such as “Tapered AC Foam III” by Atlas, "Tapered Resista" by Firestone, “Tapered SecurShield Polyiso” by Carlisle, "Tapered EnergyGuard Ultra" by GAF or approved equal.

C. Tapered Perlite Insulation: Perlite complying with ASTM C-728 to be used for crickets, saddles, tapered edge strips, such as “Tapered Fesco Edge Strip” by Johns Manville.

D. Fill Board Insulation:

1. Option: Expanded Polystyrene Insulation board conforming to ASTM C 578. Custom-cut expanded polystyrene (EPS) insulation board conforming to ASTM C 578, minimum density of 1.0 pcf; thickness to match height at top of standing seam or rib of metal panel; custom-cut to fill panel configuration between high ribs and/or seams of metal panels.
2. Option: Rigid, closed cell polyisocyanurate rigid board insulation utilizing non-chlorine/non-ozone depleting blowing agent, bonded to fiber reinforced facers custom cut and sized to fit between metal roof panel seams such as "H-Shield Bevel Cut" or “H-Shield Straight Cut” by Hunter Panels, or approved equal.

2.2 RELATED MATERIALS

A. Base Insulation Fasteners: CR-10 fluorocarbon coated meeting or exceeding FM 4470, self-tapping heavy duty screws of sufficient length to penetrate the steel deck a minimum of 3/4-inch (19mm), minimum 3-inch (75mm) diameter steel plates with recessed #3 Phillips screw head for use with insulation, such as "#14 Heavy Duty Roofing Fastener" as manufactured by OMG, “PerLock Heavy Duty Fastener” by DerbiGum, “Parafast HD Fastener” by Siplast, “HD Fastener” by Johns Manville, or as approved by manufacturer to achieve the designated uplift criteria.

B. Heat Resistant Insulation: Molded hydrous calcium silicate-based or perlite-based heat resistant rigid pipe insulation, 2-inches in thickness and sized for installation around circular/tubular element such as “Sproule Pipe Insulation” or “Thermo-12 Gold” by Industrial Insulation Group, 800/334-7997.

C. Compressible Fill Insulation: Foil or paper faced compressible fiberglass batten roll insulation of proper size and thickness to insert at openings at penetrations, perimeters, and curbs such as manufactured by Owens Corning.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Roof system manufacturer's representative shall inspect roof deck and associated substrates and provide written acceptance of conditions.

B. Manufacturer's approved roofing contractor shall inspect and approve deck and substrates.

C. Roofing contractor shall examine roof deck and related substrates and verify that there are no conditions that would prevent roof system manufacturer's approved application of roof system. These conditions include, but are not limited to, the following:

1. Inadequate support or anchorage of decking or substrates to structure.
2. Accumulations of moisture.
3. Tears, holes, cracks, or punctures.
4. Ridges, uneven conditions, or gaps.
5. Rust or other forms of deterioration.
6. Presence of foreign materials.

D. Start of work constitutes acceptance of substrate and site conditions.

3.2 PROTECTION

A. Provide special protection from traffic on yet to be removed roofing and newly installed roof materials.

3.3 PREPARATION

A. Do not install insulation until defects in roof deck and substrates are corrected in order to meet roof system manufacturer's requirements and to ensure that deck conditions will not restrict roof drainage.

B. Broom sweep and clean areas to receive new insulation.

C. Metal Roof Panels: Contractor to verify the presence of items (i.e. conduit) that may be located along the underside of the deck that could be damaged due to screw penetration.

D. Perform pull-out resistance tests in general accordance with ANSI/SPRI FX-1-2006 with each of the specified screw fasteners on the existing metal roof panels and steel framing. Provide results of pull-test for determination of the type of fastener to be used for the application.

3.4 APPLICATION

A. General:

1. Stagger end joints of insulation boards 1/2 of overall length of board.
2. Butt joints tightly allowing no more than 1/4-inch (6mm) wide gaps between units. Fill joints between adjacent boards with like insulation or foam adhesive.
3. Do not use warped, bent, or otherwise damaged insulation boards.
4. Field cut and fit insulation at penetrations, curbs, and walls.
5. After installation of initial layer of insulation, install subsequent layers of insulation directly over preceding layer.
6. Stagger all joints (side and end) between layers of insulation.
7. Install tapered insulation in field of roof to achieve a resulting 1/4-inch per foot (minimum) slope on designated roof areas.
8. Field cut tapered insulation boards to create crickets at upslope sides of curbs, along walls, and between drains and to form sumps at drains to direct water to drainage medium.

B. Loose Laid Insulation Over Metal Roof Panels:

1. Loose lay fill insulation over metal roof panels and between ribs and/or seams.
2. Butt joints tight, allowing no more than 1/4-inch wide gaps between units.
3. Do not use warped or bent insulation boards.
4. Field cut and fit boards at penetrations, curbs, and walls.

C. Mechanical Attachment of Insulation:

1. Mechanically fasten insulation layer to roof deck in strict accordance with manufacturer’s criteria to achieve specified wind uplift resistance.
2. Fully engage and seat fastener. Do not overtighten or strip threads. Bent, deformed, or unseated fasteners or plates are unacceptable.
3. Fasteners to must penetrate top flange (rib) of metal form deck minimum 3/4-inch (19mm). Do not overdrive fasteners. Remove and replace overdriven, stripped, or non-engaged fasteners.
4. Properly seat mechanical fasteners and keep heads flush with plates. Cupped plates or unseated screw heads are not acceptable.
5. Do not rupture or deform surface of the insulation by mechanically fastening.

D. Heat Exhaust Vents:

1. Install heat resistant insulation around existing heat exhaust flue, vent pipes, or other penetrations that experience elevated operation temperature.
2. Install new sheet metal base around insulation and strip flange into new roof.

E. Insulation Filler: Install compressible fiberglass insulation at openings in deck at penetrations, perimeters, expansion joints, and/or curbs.

3.5 CLEANING

A. Remove debris and material wrappers from roof to dumpster daily. Leave insulation clean, dry, and ready to receive new roofing.

3.6 ADJUSTING

A. Remove damaged insulation and install acceptable new units before installation of roof system.

3.7 PROTECTION

A. Provide special protection from traffic on completed work.

END OF SECTION 07 22 16

SECTION 07 53 50 - METAL RETROFIT SINGLE-PLY ROOF SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Mechanically-attached reinforced thermoplastic single-ply membrane roofing system, related membrane flashings, and other accessories over existing metal panel roof system.

1.2 RELATED SECTIONS

A. 07 22 16 - Roof Board Insulation.

B. 07 62 00 - Sheet Metal Flashing and Trim.

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM).

B. Standards:

1. FM Global.
2. Underwriters Laboratories: Building Materials Directory.
3. National Roofing Contractors Association (NRCA): The NRCA Roofing and Waterproofing Manual.
4. ASCE 7-2010: "Minimum Design Loads for Buildings and Other Structures".
5. Polyisocyanurate Insulation Manufacturer's Association: Technical Bulletin 109 – "Storage and Handling Recommendations for Polyisocyanurate".

1.4 QUALITY ASSURANCE

A. Applicator:

1. Approved by manufacturer of accepted roofing system.
2. A single applicator with a minimum of five years previous successful experience in installations of similar systems.
3. Minimum five years experience in single-ply roofing with two years experience seaming system same as one currently being proposed.
4. Be present at job site at all times when work is being performed. Supervise workers as required to ascertain workmanship, progress, and adherence to details.
5. Report to Owner's Representative.
6. Be responsible for schedule and coordination.
7. Have authority to make binding commitments upon Contractor in the field.

B. Regulatory Requirements: Classified by Underwriters' Laboratories, Inc. as a UL 790 Class A roof covering.

C. Notify Owner's Representative a minimum of forty-eight hours in advance of start of field work. In event that Owner provides a full-time Owner's Representative, do not perform work until Owner's Representative is present except as authorized in writing by Owner.

D. Schedule manufacturer's technical representative to be on site during initial of membrane installation and periodically during project duration. Manufacturers shall provide a written report to Owner's Representative after each inspection outlining observations and any corrective procedures.

E. Install roof system in manner to resist minimum wind uplift pressures of: 60 psf for the field of the roof; 90 psf in perimeter zones; and 135 psf in corners; based on 150 mph wind speed, Exposure B, Risk Category III/IV, Enclosed, and Safety Factor of 2.0.

1.5 SUBMITTAL

A. General:

1. Applicator's License Certificate: Copy of the roofing material manufacturer's agreement/ contract indicating date application was approved.
2. Material manufacturer's written approval/acceptance of specified roof system and issuance of specified warranty for project.
3. Shop drawings of details, if proposed different from project drawings.
4. Manufacturer's product data sheets with Material Safety Data Sheets (MSDS) on each material proposed for usage.
5. Sample of warranty that is to be issued upon project completion.
6. Samples of products proposed for use.

B. Shop Drawings:

1. Original drawings, prepared by Contractor, subcontractor, supplier, or distributor, which illustrate some portion of the Work, showing fabrication, layout, setting, or erection details, prepared by a qualified detailer.
2. Prepare shop drawings for those details that are proposed different than the project drawings. Indicate on a roof plan, the proposed location of detail presented on shop drawing.
3. Indicate joints, types, and locations of fasteners, shapes, sizes, expansion joints, special conditions, and installation procedures for each flashing condition. Note critical dimensions, gauge, and finish of sheet metal for each flashing condition.
4. Submit shop drawings showing layout, joining, profiles, and anchorages of fabricated work, including major counterflashings, trim, and fascia units, gutters, downspouts, scuppers, and expansion joint systems.

C. Product Data: Submit manufacturer's catalog sheets, providing descriptive data for each material proposed for use in construction of roof assembly and related flashings and components.

D. Samples: Provide physical examples of materials/components proposed for use to comprise the specified roof system.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original, unopened containers or packages with labels intact and legible.

B. Store materials in accordance with manufacturer's recommendations. Store rolled goods on clean raised platforms. Store other materials in dry area, protected from water and direct sunlight, and maintain at a temperature of 50 to 90 degrees Fahrenheit (10 to 32 degrees Celsius).

C. Deliver materials in sufficient quantities to allow continuity of work without delay.

D. Store materials in weather protected environment, clear of ground, and free from moisture. Protect materials against damage. Keep all materials used in construction of the roofing free from moisture prior to and during application. Do not store in plastic bags or other protective coating which may create condensation within bags.

E. Store roof insulation and membrane on pallets or dunnage at least 4-inches (100mm) above the ground, roof, or deck and protect as necessary to keep dry.

F. Handle all materials so as to prevent damage to roofing system components and completed roof system.

G. Proper storage of materials is the sole responsibility of Contractor. Protect all materials susceptible to moisture including, but not limited to, all roll goods, insulation, cant strip, wood, and plywood in dry, above ground, watertight storage. Keep labels intact and legible, clearly showing the product, manufacturer, and other pertinent information.

H. Any materials becoming wet or damaged will be rejected and shall be removed from job site immediately. Any materials found to be improperly stored at jobsite shall be considered wet at the discretion of Owner's Representative and removed from jobsite.

I. Store products in temperature-controlled environment to prevent detrimental affects from low or elevated temperatures.

1.7 PROJECT CONDITIONS

A. Environmental Requirements:

1. Apply roofing in dry weather.
2. Do not remove existing roofing and flashing in inclement weather or when rain is predicted (30 percent or more possibility).
3. When ambient temperature is below 60 degrees Fahrenheit (16 degrees Celsius), expose only enough sensitive cements, sealants, and adhesives as required within a four hour period.
4. Do not expose membrane and accessories to a constant temperature in excess of 180 degrees Fahrenheit (82 degrees Celsius).

B. Protection:

1. Provide special protection and avoid traffic on completed areas of membrane installation.
2. Restore to original condition or replace work or materials damaged during handling of roof materials.
3. Take precautions as required to protect adjacent work and structures.

C. Emergency Equipment: Maintain on site equipment necessary to apply emergency temporary edge seal in event of sudden storms or inclement weather.

D. Restrictions:

1. Smoking is prohibited on roof areas.
2. Maintain facility and all utility services in a functional condition for Owner's utilization.

1.8 SEQUENCING/SCHEDULING

A. Install new roof membrane system immediately after completion of insulation installation.

B. Schedule work as required to prevent traffic and material handling over completed work.

C. Do not expose new material to water or sun damage in quantities greater than can be weatherproofed during same day. See additional roof protection provisions herein.

1.9 WARRANTY

A. Contractor: Provide Owner a written warranty for a period of two years after Owner's final acceptance covering all repairs required to correct all defects due to faulty materials or workmanship and to otherwise maintain the roof in a watertight condition and to correct all other defects without regard to watertightness. Make repairs promptly on notification and at no expense to Owner.

B. Roof System Manufacturer: Manufacturer of the single-ply membrane roof system shall furnish a written guarantee that warrants and guarantees Owner with a watertight condition of roof system and all components thereof for a period of twenty years from date of Owner's final acceptance. Warranty and guarantee shall cover all labor and materials required to maintain a watertight condition and a roof system free of defects.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable TPO Manufacturers:

1. Johns Manville.
2. GAF Materials Corp.
3. Carlisle, Inc.
4. Firestone.

B. Acceptable PVC/KEE Manufacturers:

1. Johns Manville.
2. GAF Materials Corp.
3. Carlisle, Inc.
4. Seaman Corp.

C. Products furnished for roofing system shall be products of a single manufacturer.

2.2 SINGLE-PLY ROOFING MEMBRANE

A. TPO Single Ply Membrane: Polyester-reinforced thermoplastic polyolefin single ply membrane, complying with ASTM D 6878, minimum 0.060-inch thickness, white in color, with enhanced weathering package, and reflectivity, complying with solar reflectance of 0.80 and thermal emittance of 0.75; such as "EverGuard TPO" by GAF; "SureWeld TPO" by Carlisle; “UltraPly” by Firestone; or "JM TPO" by Johns Manville.

B. PVC/KEE Single Ply Membrane: Polyester-reinforced elastomeric sheet compounded with PVC/KEE polymer, complying with ASTM D 4454 for PVC/KEE membranes and ASTM D 6754 for KEE membrane, minimum 0.060-inch (60-mil) thickness, white in color, with a minimum solar reflectance of 0.70 and thermal emittance of 0.75 such as "Sure-Flex PVC KEE" by Carlisle, "JM PVC KEE" by Johns Manville, "EverGuard PVC XK60" by GAF, "Fibertite XT" by Seaman Corp., or approved equal.

2.3 RELATED MATERIAL

A. Membrane Fasteners and Plates: CR-10 fluorocarbon coated, self-drilling screw with 3/4-inch drill-point, 0.17-inch shank diameter and 0.21-inch thread diameter and 0.485-inch hex-head, of sufficient length to penetrate the steel supports a minimum of 3/4-inch (19mm), minimum 3-inch (75mm) diameter steel plates with recessed screw head for attachment of roof membrane to steel purlins, such as “Purlin Fastener” as manufactured by OMG.

B. Membrane Fasteners and Plates (Optional System): CR-10 fluorocarbon coated, self-drilling screw with 3/4-inch drill-point, 0.17-inch shank diameter, 0.21-inch thread diameter, and 0.485-inch hex-head, of sufficient length to penetrate the metal roof panels a minimum of 3/4-inch (19mm), such as "#15 Extra Heavy-duty Roofing Fastener" as manufactured by OMG, "Drill-Tec Extra Heavy Duty #15" and "XHD Barbed Scam Plate” as manufactured by GAF, Inc., with 3-inch diameter corrosion-resistant steel plate with a high-solids coating on top surface such as “Rhino Bond” plate for attachment of insulation and induction weld attachment of membrane.

C. Flashing: Minimum 60 mil, reinforced or unreinforced, flashing membrane as required and furnished by membrane manufacturer, color to match membrane.

D. Bonding Adhesive: Low-solvent or water-based VOC compliant bonding adhesive furnished by membrane manufacturer for adhering flashing membrane or roof membrane to substrates such as “FTR-190e Bonding Adhesive” by Fibertite.

E. Sealants: Membrane manufacturer's approved sealant to seal penetrations through the membrane system or miscellaneous caulking applications that come in contact with roof system components.

F. Lap/Seam Sealant: Liquid formulation sealant. As furnished by membrane manufacturer for sealing cut edges of reinforced membrane and flashing sheets.

G. Water Cut-off Mastic: As furnished by membrane manufacturer for this system.

H. Inside Corners and Outside Corners and Molded Pipe Flashings: White molded pipe flashings as furnished by membrane manufacturer for this system.

I. Walkway Pads: PVC, KEE, or TPO based, reinforced walkpads, as approved by membrane manufacturer.

J. Sponge Tubing: 2-inch diameter compressible foam rubber tubing for use at expansion joints.

K. Protection Sheet: Cut sections of membrane with rounded corners, extending a minimum of 2-inches beyond edges of overlying item.

L. Other miscellaneous materials shall be of the best grade available and approved in writing by roof system manufacturer for the specific application.

PART 3 - EXECUTION

3.1 GENERAL

A. Perform entire work of this Section in accordance with the best standards of practice relating to trades involved.

B. Follow local, state, and federal regulations, safety standards, and codes. When conflict exists, the more restrictive document shall govern.

C. Follow insurance underwriter's requirements acceptable for use with specified products or systems.

D. Consider roof system manufacturer's current technical specifications a part of this Specification and use as a reference for specific application procedures and recommendations.

E. Mechanically fasten both the reinforced membrane and insulation to metal roof panels.

F. Refer to manufacturer's technical specifications for proper fastener selection and spacing in accordance with specific deck types and appropriate roll width for field of roof and perimeters.

3.2 EXAMINATION OF SURFACES

A. Verify that preparatory work has been completed.

B. Examine roof areas for conditions that would prevent proper application of new roofing.

C. Verify that new wood nailers are properly installed to receive roofing system.

D. Examine substrate, roof deck, and related surfaces, and verify that there are no conditions such as inadequate anchorage, foreign materials, moisture, ridges, or other conditions that would prevent the satisfactory installation of the roofing system.

E. Correct or complete any conditions requiring correction or completion prior to installation of roofing system. Notify Owner's Representative in writing of unacceptable conditions.

F. Start of work under this Section constitutes acceptance of substrate and site conditions.

G. Verify:

1. Substrates are clean, smooth, and free from depressions, waves, projections, defects, and damage.
2. Surfaces in contact with any single-ply material are free from grease, oil, or other foreign material.
3. Surfaces in contact with roofing membrane are free from sharp edges, fins, or projections.

4. Materials are completely dry and free from ice and snow, including substrate, deck, insulation, and roofing membrane as applicable. Confirm dryness by moisture meter and demonstrate to Owner's Representative.
5. Roof equipment, openings, curbs, pipes, sleeves, ducts, vents, cant strips, and blocking members are solidly and properly set.
6. Mechanical/electrical work to be covered has been installed, tested, and approved.
7. Work has been completed where possible for all other trades that require work or traffic on the roofing area.

3.3 PREPARATION

A. Verify that debris has been completely removed.

B. Broom clean roof insulation immediately prior to roofing application. Debris under roof membrane is unacceptable.

C. Perform pull-out resistance tests in general accordance with ANSI/SPRI FX-1-2016 with each of the specified screw fasteners on the existing metal roof panels and steel framing. Provide results of pull-test for determination of the type of fastener to be used for the application.

3.4 APPLICATION

A. Roofing Membrane - General:

1. Install roof membrane in accordance with roofing manufacturer's specification and installation instructions. Cut sheets to maximum size possible in order to minimize seams.
2. Position membrane over substrate without stretching membrane. Allow membrane to relax for one-half hour before bonding, fastening, welding, and flashing.
3. Begin installation of new roofing system at the lowest point of the project area and work to the highest point to prevent backwater laps. This will include completion of all flashings, terminations, and seals on a daily basis.
4. Execute work so membrane can be temporarily sealed on a down slope surface at the end of each day with nite-seal in accordance with the detail drawings.
5. Portions of the roof membrane that have permanent creases and/or wrinkles prior to installation shall be removed and discarded.

B. Mechanically-fastened System:

1. Install mechanically fastened roofing system over the field of the roof with the length of the sheets parallel to the long dimension of the roof.
2. Position the roof membrane perimeter sheet along the perimeter of the roof over the acceptable substrate.
3. Option 1: Secure the membrane with appropriate fasteners installed into the structural steel supports spaced 6-inches on-center. Install fasteners positioned in membrane pre-formed tabs or in field of sheet. Apply strip of flashing membrane over fasteners installed in field of sheet.

4. Option 2: Heat-weld membrane to coated plates used to secure the insulation board via induction weld process in accordance with manufacturer's recommendations.
5. Work shall progress across the roof deck with manufacturer's recommended minimum overlap provided at the previously secured sheet edge. Secure opposite length of the sheet with fasteners and plates, and overlap accordingly.

C. Membrane Splicing:

1. Install membrane to achieve a minimum distance between the edge of the fastening plate and edge of the membrane of 1-1/2-inches (38mm). Splices at end roll overlaps (width of the membrane) shall be 6-inches (150mm) wide, minimum. Plan sheet layout so that end roll overlaps can be stripped in with a continuous membrane head lap (minimum 18-inches [450mm] wide).
2. Allow top sheet to fall freely into place over bottom ply without wrinkling or stretching.
3. Surfaces to be welded must be cleaned, primed and dirt-free. Remove excessive dirt by washing with a detergent. Rinse thoroughly, allow to dry, and then wipe surface with manufacturer's solvent/cleaner.
4. Use automatic hot-air welding equipment approved by roof system manufacturer for all field seams. Perform small work and repairs using hand welders. Roof system manufacturer's representative shall be on site at start of project to supervise welding operations and to inspect and approve welded seams.
5. Probe all laps each day to verify that welder set-up is effective. Allow membrane to cool. In addition, perform random lap test sample checks (including checks at start of each day) to verify peel strength. Perform lap seam test sample checks in presence of Engineer/Consultant. Engineer/Consultant will retain test samples for project file.
6. Apply lap seam sealant along cut edges of the membrane and reinforced flashing material, around membrane patches, and along terminations in strip-in membrane.
7. Apply a membrane patch over all T-joints of overlapping flashing and membrane lap seams.

D. Flashing:

1. General:
   a. Install flashing at all roof penetrations, interruptions, and any roof intersection including roof edges with vertical or sloped surfaces in accordance with manufacturer's recommended procedures and the detail drawings.
   b. Raise/modify all curbs, projections, and risewall conditions as required to accommodate new roofing.
   c. Apply manufacturer's bonding adhesive to both underside of flashing and surface to which it is to be bonded, at a rate of approximately one gallon (3.8 liter) per 50 square feet ($4.6m^2$) of surface coverage.
   d. Do not apply bonding adhesive to that portion of flashing that overlaps onto itself. Use hot-air welding throughout the system where membrane overlaps itself.
   e. Allow bonding adhesive to dry to finger touch until it does not string or stick to a dry finger. Roll the flashing into dry adhesive. Take care to assure that flashing does not bridge where there is any change of direction.

f. Mechanically fasten top edge of membrane flashing through appropriate termination bar with approved fasteners spaced 6-inches on-center. Install waterblock behind top edge of membrane flashing and seal top edge of flashing with sealant.
g. Install flashings for vents, pipes, soil vents, and other round projections using pre-manufactured and/or field-fabricated boot flashings and accordance with manufacturer's recommendations and the detail drawings.
h. Install preformed flashing membrane as required to form a continuous membrane seal in each corner or change in plane.
i. Install pre-molded outside and inside corner pieces at appropriate locations along walls and around curbs.

2. Penetrations:
   a. Flash penetrations with pre-formed or field-formed flashings or polymer-coated metal pan as indicated on drawings.
   b. Apply sealant or water cut-off mastic at top of flashing between flashing and penetration.
   c. After flashing is installed, secure with steel draw band and seal top edge with sealant.
   d. Install grout and pourable sealer in pan. Install sheet metal bonnet or hood/cover at penetrations.
3. Curbs:
   a. Extend flashing membrane to designated height on curbs.
   b. At curbs with removable cover/hood, wrap flashing over top of curb and secure with angle termination bar.
   c. At curbs with non-removable cover/hood, extend flashing to maximum height and secure with termination bar with fasteners at 6-inches on-center. Apply water block behind top edge of flashing and apply sealant along top edge of termination bar.
   d. Extend flashings at curbs to form rounded outer corners on horizontal tie-ins. Apply pre-molded outside corner pieces at corners.
4. Polymer-coated Metal:
   a. Install polymer-coated metal flashings at curbs, penetrations, and perimeters as designated.
   b. Hot-air weld flashing membrane to coated metal and field membrane to provide monolithic seal, extending a minimum of 4-inches (100mm) beyond end of flange.
   c. Apply sealant/water-block at fastening points under flanges.
   d. Rise Walls: Extend flashing up walls to terminate under through-wall flashing, or minimum 8-inches above finished new roof surface and secure with termination bar with fasteners spaced at 6-inches on-center. Apply water block behind top edge of flashing and apply sealant along top edge of termination bar.
   e. Parapet Walls: Install flashing membrane up and over top of wall extending 1-inch below top of exterior wall finish. Trim leading edge of flashing to form continuous straight line and adhere/secure in place to prevent displacement.

E. Walk Pads/Protection Pads:

1. Install walk pads at roof access points and around rooftop equipment in accordance with manufacturer’s installation guidelines.
2. Install protection pads under equipment and piping supports and other items installed on top of the roof surface.

F. Daily Seal:

1. Ensure that water does not flow beneath any completed sections of membrane system. This will include completion of all flashings, terminations, and daily seals.
2. Seal new membrane at the deck/substrate level.
3. Temporarily seal any loose membrane edge with manufacturer's water cut-off sealant. Exercise caution to ensure that membrane is not temporarily sealed in such a manner as to promote water migration below the membrane or impede drainage.
4. Install daily night seals by extending the roof membrane beyond the insulation and sealing to existing roof surface.
5. When work is resumed, remove and dispose of membrane where asphalt or other sealants were previously applied before resuming installation.
6. Install insulation at end of work day to allow proper staggering of insulation joints and layers.
7. Install loose insulation at daily seal to prevent ponding and/or collection of water on temporary membrane seal.

3.5 CLEANING

A. Upon completion of installation of roof system, flashings, and sheet metal, clean surfaces of roof membrane and membrane flashings by power washing methods. Remove debris, dirt, adhesives, sealants, surface contaminants, or materials that cause surface discoloration from surfaces.

B. Remove all work related dirt, debris, drippage, spills, etc. from finishes of roof surface, building, or building grounds.

END OF SECTION 075350

SECTION 07 62 00 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SECTION INCLUDES:

A. Shop or field-formed sheet metal work for moisture protection.

B. Types of work specified in this Section include:

1. Roof penetration bonnets.
2. Receivers.
3. Counter flashings.
4. Roof edge flashing.
5. Coping.
6. Plumbing vent pipes.
7. Through-wall scuppers.
8. Collector heads and downspouts.
9. Miscellaneous sheet metal accessories.

1.2 RELATED SECTIONS:

A. 02 07 20 - Minor Demolition and Renovation Work.

B. 07 53 50 - Metal Retrofit Single Ply Roofing.

1.3 REFERENCES:

A. American Society for Testing and Materials (ASTM).

B. Federal Specifications (FS).

C. National Roofing Contractor's Association (NRCA): NRCA Roofing and Waterproofing Manual, latest edition.

D. Sheet Metal and Air Conditioning Contractor's National Association, Inc. (SMACNA): Architectural Sheet Metal Manual, latest edition.

E. ANSI/SPRI ES-1: "Wind Design Standard for Edge Systems Used With Low Slope Roofing Systems."

1.4 WARRANTY:

A. Contractor's Warranty: Provide Owner a written warranty which shall warrant sheet metal work to be free of leaks and defects in materials and workmanship for two years after date of final acceptance by Owner.

B. For pre-finished metal, provide manufacturer's twenty-year guarantee covering deterioration or failure of the fluoropolymer finish.

1.5 PERFORMANCE REQUIREMENTS:

A. Roof edge sheet metal flashing shall be certified by the manufacturer or shop-fabricator to comply with ANSI/SPRI Standard ES-1 for 150 mph wind speed and horizontal design pressure and vertical design pressure applicable for the eave height of the subject building. ANSI/SPRI ES-1 Test Method RE-3 Test for Copings: The coping shall be tested for 150 mph wind speed and horizontal design pressure and vertical design pressure applicable for the eave height of the subject building

B. The sheet metal coping product shall be UL Classified by Underwriters Laboratories, Inc. or other third-party verification of compliance with the ANSI/SPRI ES-1 Wind Design Standard.

C. Provide base sheet metal that is manufactured in the United States and incorporates some percentage of recycled content. Provide documentation from manufacturer/supplier supporting this information.

1.6 MOCK-UPS:

A. Contractor to prepare mock-ups utilizing materials proposed for the finished product and to simulate the desired appearance of the finished product. Mock-ups shall be of appropriate size to depict finishes and connections

B. Schedule of mock-ups shall include the following: Typical wall counter flashing condition(s); Typical metal edge/fascia and coping condition(s); size of mock-ups shall be 3 feet minimum.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Acceptable Pre-finished Sheet Metal Manufacturers:

1. Berridge Manufacturing Company.
2. Peterson Aluminum Corporation (PAC CLAD).
3. McElroy Metals, Inc.

4. Metal Building Components, Inc. (MBCI).
5. Firestone Metal Co (Una-Clad).
6. Or approved equal.

2.2 SHEET METAL MATERIAL:

A. Pre-finished Metal: "Kynar 500" or "Hylar 5000" fluoropolymer pre-finished G90 galvanized/galvalume sheet metal, minimum 24 gauge. "Kynar 500" or "Hylar 5000" finish shall consist of a two coat Polyvinyladine flouride, minimum 70 percent by weight in coatings, dry film thickness 1 mil, factory applied by metal manufacturer or supplier. Color selected by Owner from manufacturer's standard color chart.

B. Zinc-coated (Galvanized) Sheet Metal: Commercial quality with 0.20 percent copper, in accordance with ASTM A 526 except ASTM A 527 for lock forming; coating designation G90 hot-dip galvanized, 24 gauge minimum.

C. Polymer-coated Metal: 24 gauge G-90 galvanized steel base metal laminated with polymer (TPO/PVC/KEE) coating, 1mm (0.020-inch) thick, compatible with thermoplastic sheet membrane color to match membrane such as "FiberTite FiberClad Coated Metal" by Seaman, "Sure-Flex/Sure-Weld Coated Metal" by Carlisle, or as approved by membrane material manufacturer.

D. Stainless Steel Sheet Metal: ASTM A240, Type 304, ASTM A480, No. 2B/2D Mill Finish, gauge as scheduled.

2.3 FASTENERS:

A. Fasteners shall be same metal as flashing and sheet metal being joined.

B. Exposed fasteners shall be self-sealing or gasketed for watertight installation.

C. Heads of fasteners, including but not limited to, rivets, screws, and bolts, that are exposed or visible shall have same manufactured finishes as item being secured; color to match when applicable.

D. Mechanical Fasteners:

1. Refer to Section 02 72 00 – Minor Demolition and Renovation Work.
2. Washers: Steel washers with bonded rubber sealing gasket.
3. Screws: Self-tapping sheet metal type compatible with material fastened.
4. Rivets: Stainless steel material for the head and stem, closed end, color to match sheet metal items being adjoined.

2.4 RELATED MATERIALS:

A. Solder:

1. ASTM B 32, alloy grade 58, 50 percent tin, 50 percent lead.
2. For Use with Stainless Steel: 60-40 tin/lead solder, ASTM B 32.

B. Flux:

1. Phosphoric acid type, manufacturer's standard.
2. For Use with Steel or Copper: Rosin flux.
3. For Use with Stainless Steel: Acid-chloride type flux, except use rosin flux over tinned surfaces.

C. Underlayment: Self-adhering rubberized asphalt sheet membrane, 40-mil thick, suitable for high-temperature applications up to 250 degrees Fahrenheit such as "Blueskin PR 200HT" by Henry, “WIP 300 HT” by Carlisle, or approved equal.

D. Adhesives: Type recommended by flashing sheet manufacturer for waterproof and weather resistant seaming and adhesive application of flashing sheet.

E. Metal Accessories: Sheet metal clips, straps, anchoring devices, and similar accessory units as required for installation of work, matching or compatible with material being installed, noncorrosive, size and gauge required for performance.

F. Sealant:

1. Type A: One component polyurethane sealant such as "Sikaflex 1a" by Sika Corp. or “Sonolastic NP1” by BASF, color to match finish of metal.
2. Type B: Low modulus silicone sealant for sealing metal-to-metal surface (i.e. metal edge, cover plates) such as “Sikasil WS-290” or “Sikasil WS-295” by Sika Corp., “795 Silicone Building Sealant” or “790 Silicone Building Sealant” by Dow Corning, or “GE Silpruf 2000” by Momentive Performance Technologies; color to match finish of metal.
3. Type C: Self-adhering elastomeric butyl tape, 1/8-inch (3mm) by 3/8-inch (9mm), such as "Extru-Seal" by Pecora Corp.
4. Type D: Type A: One component moisture cure polyether polymer sealant available in over 175 standard colors such as "Tite Bond Weather Master Sealant" by Franklin International, color to match finish/color of adjacent sheet metal.

G. Termination Bar: 1/8-inch (3mm) thick, 1-inch (25mm) wide extruded aluminum bar with flat profile, factory punched oval holes (1/4-inch by 3/8-inch [6mm by 9mm]) spaced 6-inches (150mm) on-center, such as "TB 125" by The TruFast Corp. or “Heavy Flat Bar” by OMG.

H. Stainless Steel Clamp: Stainless steel banding with worm-drive tightening, sized for application such as "Make-A-Clamp Kit" by Dynamic Fastener, 800/821-5448.

I. Flexible Flashing/Underlayment: Self-adhering elastomeric sheet suitable for high temperature application; “WIP 300 HT” By Carlisle Coatings & Waterproofing, "Vycor Plus Self-adhering Flashing" by GCP, or approved substitute.

2.5 FABRICATION - GENERAL:

A. Fabricate work in accordance with SMACNA Architectural Sheet Metal Manual and other recognized industry practices and approved shop drawings.

B. Comply with material manufacturer's instructions and recommendations for forming material.

C. Shop fabricate work to greatest extent possible. Fabricate inside and outside corners for metal edge flashings and copings from single piece with equal length legs, minimum 3 feet. Notch, lap, and seam inside and outside corners of counter flashings.

D. Fabricate for waterproof and weather resistant performance with expansion provisions for running work sufficient to permanently prevent leakage, damage, or deterioration of work. Form work to fit substrates.

E. Make angle bends and folds for interlocking metal with full regard for expansion and contraction to avoid buckling.

F. Form materials with straight lines, sharp angles, smooth curves, and true levels. Avoid tool marks, buckling, and oil canning.

G. Fold back edges of exposed ends of sheet metal edge to form hem, 1/2-inch minimum.

H. Lap joints 1-inch (25mm) minimum. Rivet and solder joints on parts that are to be permanently and rigidly assembled for copper, stainless, aluminum, and galvanized sheet metal. Install rivets, spaced 1-inch (25mm) on-center and apply solder to secure and seal exposed edge of sheet metal in a uniform continuous bead with smooth top finish. Clean residue upon completion of soldering process. Fabricate sheet metal assemblies so that adjoining sections are nested to achieve continuous metal-to-metal contact.

I. Seams:

1. Fabricate non-moving seams in sheet metal with flat-lock seams.
2. Pre-finished Galvanized Sheet Metal: Seal pre-finished metal seams with rivets, spaced 1-inch (25mm) on-center, and silicone sealant, color to match metal finish.
3. Metal Other than Aluminum: Tin edges to be seamed, form seams, and solder.

J. Expansion Provisions: Where lapped type expansion provisions in work cannot be used or would not be sufficiently waterproof or weatherproof, form expansion joints of intermeshing hooked flanges, not less than 1-inch deep, filled with sealant concealed within joints.

K. Sealant Joints: Where movable, non-expansion type joints are indicated or required for proper performance of work, form metal to provide for proper installation of elastomeric sealant in compliance with SMACNA standards.

2.6 FABRICATED ITEMS:

A. Receivers and Counter Flashings: Minimum 24-gauge pre-finished sheet metal formed in maximum 10 foot (3m) lengths; fabricate “S”-shaped receiver to engage counter flashing a minimum of 1-inch; fabricate counter flashing with broken fascia of length to extend over top edge of base flashing a minimum of 4-inches with 1/2-inch hemmed drip edge.

B. Wind Clips: Minimum 24-gauge pre-finished sheet metal, 1-inch (25mm) wide, length to engage counter flashing a minimum of 1/2-inch (13mm).

C. Roof Penetration Bonnet: Minimum 24-gauge prefinished sheet metal; fabricate bonnet in two-piece adjustable construction with 1/2-inch caulk trough along top edge and a skirt, with hemmed edge, of length to extend over top edge of pan a minimum of 2-inches (50mm).

D. Angle Termination Bar: 1-inch by 1-inch (25mm by 25mm) 24-gauge galvanized sheet metal.

E. Through-Wall Flashing: 24-gauge stainless steel sheet metal, fabricate with minimum 4-inch vertical nailing flange with canted base and "S"-shaped receiver to engage counterflashing a minimum of 1-inch.

F. Cleats/Clips:

1. Concealed Cleats/Clips: Continuous strips, 22-gauge sheet metal, same metal type and fascia profile as adjacent metal item, with 3/4-inch drip edge formed at a 30 degree angle with vertical wall.
2. Exposed Cleats/Clips: 24-gauge pre-finished sheet metal.

G. Through-wall scupper: Polymer-coated sheet metal with 4-inch (100mm) wide nailing flanges with rounded corners and flanges to engage collector head at primary scuppers and prefinished sheet metal face plate with 4-inch wide flanges at overflow scuppers.

H. Collector Head and Downspouts: 24 gauge pre-finished sheet metal. Collector head shall be 2-inches wider than scupper opening with overflow port in side of head. Downspout shall be 5-inches (125mm) by 5-inches (125mm) with seam located on back of downspout. Downspout straps shall be 1-inch wide double-hemmed pre-finished sheet metal with rounded corners.

I. Coping:

1. Shop-Fabricated Option: 24-gauge pre-finished sheet metal for 8-inch maximum width and 22-gauge for 8-inch to 12-inch width with 6-inch (150mm) wide back-up plates of same profile. Form 3/4-inch drips with 5/8-inch returns at 30-degree angle with vertical wall at bottom end of both interior and exterior fascias. Fabrication to meet specified ANSI/SPRI ES-1 requirements for 120 mph.

2. Pre-Manufactured Option: Pre-manufactured prefinished sheet metal coping of designated dimensions and meeting ANSI/SPRI ES-1 requirements for 110 mph with continuous cleat installed over sloped substrate such as “Sloped Formed Coping” by Hickman Engineered Systems, “One Coping” by Metal Era, or approved equal.

J. Metal Edge/Fascia:

1. Shop-Fabricated Option: 24-gauge Pre-finished sheet metal with 4-inch horizontal flange, 1/2-inch high knuckle, and fascia length to extend a minimum of 1-inch below top edge of exterior wall cladding meeting ANSI/SPRI ES-1 for 150 mph wind speed. Form 3/4-inch drip with 5/8-inch return at 30° angle with vertical wall.
2. Premanufactured Option: Continuous 24-gauge prefinished Kynar 500 coated galvanized sheet metal canted gravel stop with fascia extender meeting ANSI/SPRI ES-1 for 110 mph wind speed such as “MBED Style G” by Hickman, “EdgeSystem One Gravel Stop” by Metal Era or approved equal.

K. Fascia Extender: 24 gauge pre-finished sheet metal with 1/2-inch stiffening rib at mid-span with 3/4-inch drips with 5/8-inch returns at 30-degree angle with vertical wall at bottom end formed in 10-foot lengths.

PART 3 - EXECUTION

3.1 EXAMINATION:

A. Verify that substrates are smooth and clean to extent needed for sheet metal work.

B. Verify that reglets, nails, cants, and blocking to receive sheet metal are installed and free of concrete and soil.

C. Do not start sheet metal work until conditions are satisfactory.

3.2 INSTALLATION:

A. Install sheet metal with lines, arises, and angles sharp and true, and plane surfaces free from objectionable wave, warp, or buckle. Exposed edges of sheet metal shall be folded back to form 1/4-inch (6mm) hem on concealed side from view. Finished work shall be free from water retention and leakage under all weather conditions. Install prefabricated corners or transitions at changes in direction, elevation or plane, and at intersections. Locate field joints not less than 12-inches (300mm), nor more than 3 feet (1m) from actual corner. Laps for all metals, except for prefinished metal, shall be 1-inch (25mm) wide, fastened with rivets spaced 1-inch (25mm) on-center and soldered.

B. Anchor units of work securely in place to prevent damage or distortion from wind or buckling. Provide 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 permanently watertight and weatherproof.

C. Install fabricated sheet metal items in accordance with manufacturer's installation instructions and recommendations and with SMACNA Architectural Sheet Metal Manual.

D. Separations: Provide for separation of metal from non-compatible metal or corrosive substrates by coating affected surfaces with zinc chromate or other permanent liquid-applied or sheet product separation at locations of contact.

E. Continuous Cleat: At exposed edges of metal edge flashings, fascias, copings, and where required, attach continuous cleat at 6-inches (150mm) on-center with appropriate fasteners positioned on the vertical face and fastened into 2X blocking, concrete/masonry substrate, metal wall panels, or steel substrate. At a distance of 10 feet (3m) from each direction of corner, install fasteners 3-inches (75mm) on-center. Install cleat so fascia extends a minimum of 1-inch (25mm) below top of exterior wall finish.

F. Counter Flashings:

1. Install new counter flashings under equipment housing flanges and existing or new receivers along rise or parapet walls to extend a minimum of 4-inches below top edge of base flashing.
2. Secure counter flashing at 6-inches (150mm) on-center with self-tapping screws.
3. Saw-cut Reglet Mounted Assemblies: Saw cut new joint, 1/2-inch by 1-inch deep, in existing masonry/concrete where required and to install new receiver. Clean and prepare joint surfaces to receive sealant and insert receiver into joint. Secure new receiver in place with lead wedges spaced 12-inches (300mm) on-center wedged into joint. Install backer rod into saw-cut reglet and apply a continuous bead of sealant, Type B, along reglet and top edge of receiver and tool sealant to provide outward sloping finished surface. Secure counter flashing to receiver utilizing self-tapping grommetted screws spaced 6-inches (150mm) on-center.
4. Surface-mounted Assemblies: Secure two-piece surface-mounted receiver and counter flashing assemblies along concrete substrates. Install sealant tape, Type C, between receiver and substrate. Secure receiver to substrate with termination bar and appropriate fasteners spaced 12-inches on-center. Install a continuous bead of sealant, Type B, along caulk trough/top edge of receiver and tool sealant to provide outward sloping finished surface. Secure counter flashing to receiver utilizing grommetted self-tapping screws spaced 6-inches (150mm) on-center.
5. Install new receivers extending behind wall finish and secure vertical flange of receiver 6-inches on-center to back-up wall or metal wall panels. Extend underlayment and/or dampproofing material over vertical flange of receiver, where applicable.
6. Lap adjacent sections of receivers and counter flashings a minimum of 4-inches (100mm). Apply a continuous bead of sealant, Type B in lap.
7. Trim existing counter flashings at curbs and walls that are to remain to receive new flashings. Secure new counter flashing to trimmed existing flashing utilizing self-tapping screws spaced 6-inches (150mm) on-center.
8. Install wind clips to termination bar spaced 24-inches (600mm) on-center and engage drip edge of counter flashing a minimum of 1/2-inch (13mm).
9. Fabricate the counter flashing to form an integral closure at terminations.

G. Roof Penetration Bonnet:

1. Install sheet metal bonnet on penetrating element to cover the top of the penetration pans.
2. Round or Pipe Penetrations:
   a. Set bonnet in sealant, Type C; utilize Type B sealant at heat sensitive areas.
   b. Install stainless steel draw band and tighten to secure to penetration.
   c. Seal top of bonnet with sealant, Type B.

H. Pre-fabricated Metal Edge/Fascia:

1. After membrane installation, nail the continuous galvanized spring clip to the vertical face of the wood nailer. Locate the fasteners 3/4-inch below the roof edge (approximately center of nailer) and 12-inches on-center using a minimum 1-1/2-inch galvanized ring shank roofing nail. Allow 1/4-inch gap between sections of clip. Install mitered corners first then field sections. Insert one splice plate under each end of miter cover. Install miter covers by engaging miter cover onto anchor cleat and rotating miter cover up and over anchor bar miter until engaged along entire length of the anchor bar.
2. Install fascia extender in locations where indicated prior to installation of fascia/edge flashing system. Secure clip and fascia extender to wood nailers with appropriate fasteners at 6-inches on-center.
3. Install roofing membrane flashing over the spring clip allowing it to extend down the face to the drip edge. Locate and hang joint covers at all joints between corners and straight sections.
4. Install preformed curved sections to match radius of existing construction.
5. Install prefabricated inside and outside corners fabricated from one piece of sheet metal.
6. Hook each section of fascia cover over the top of the spring clip and membrane. Press down on the fascia until the drip edge is engaged. Allow 1/8-inch gap for expansion.

I. Low-profile Metal Edge:

1. Install metal edge flashing/cleat on top of single ply membrane along eaves.
2. Secure horizontal flange of metal flashing to substrate with appropriate fasteners spaced 3-inches on-center, staggered.
3. Butt adjacent sections of metal flashing and install back-up plate under butt joint with beads of sealant, Type B, in laps.
4. Strip-in flange of metal flashing with single ply membrane concealing flange and extending beyond edge of flange to achieve proper welded lap seam.

J. Coping:

1. Install new 2X wood nailers and/or 2X wood nailers and plywood to provide substrate on top of wall to have a resulting positive slope (minimum 1-inch per foot) toward roof.
2. Install and adhere underlayment or flashing membrane over the wood substrate extending a minimum of 1-inch below top of wall system. Lap ends minimum of 3-inches (75mm) and secure membrane in place on exterior vertical face.
3. Install metal coping segments allowing 1/2-inch (13mm) spaces between segments. Lock coping onto cleat and install appropriate fasteners through the interior fascia spaced 24-inches (600mm) on-center in enlarged holes.

4. Fabricate standing seam at joints of adjoining sections of coping. Apply sealant, Type B, in seam prior to forming.
5. Install appropriate fastener through neoprene washer and cover plate between coping segments.
6. Install cap bead of sealant, Type B, over sealed/riveted lap seam in coping at corners. Apply tape on coping to provide straight edges of tooled cap bead. Remove tape upon completion of tooling.

K. Scupper/Collector Head/Downspout:

1. After field membrane is installed, install sheet metal scupper insert into wall opening. Set scupper in sealant and secure flanges of scupper to wall and deck with appropriate fasteners.
2. Strip-in flanges of scupper with appropriate flashing membrane.
3. Install sealant, Type A, around exterior opening of scupper between metal insert and wall.
4. Attach face plate to scupper insert and wall and apply sealant around perimeter of face plate.
5. Attach collector head to scupper insert. Secure collector head to scupper insert and wall and apply sealant around perimeter.
6. Install new downspouts plumb and level, attached to columns or wall with straps located at top and bottom of downspout and 10 feet (3m) on-center, maximum. Extend downspouts into existing and/or new inlet or pipe. Provide “square-to-round” sheet metal transition to connect downspout to opening of pipe/inlet.
7. Install splash block under discharge port of downspouts.

3.3 CLEANING:

A. Remove flux and residual acid immediately by neutralizing with baking soda and washing with clean water. Leave work clean and free of stains, scrap, and debris.

B. Clean exposed metal surfaces, removing substances which might cause corrosion of metal or deterioration/damage of finishes. Paint (color to match) areas of prefinished metal where finish is damaged. Replace sheet metal items when damaged finish can not be repaired to an acceptable condition.

C. Prime soldered area of phosphatized metal after cleaning to prevent rusting.

D. Paint with elastomeric coating, metal flashings that have been soiled with bitumen. Use medium nap roller to apply paint to surfaces to achieve monolithic finished color.

END OF SECTION 07 62 00

SECTION 092900 - GYPSUM BOARD (Where patching and repairing of existing water intrusion gypsum board has occurred or opening for new mechanical services.)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior gypsum board.
2. Texture finishes.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Type X gypsum board for all repairs thickness and fire rating to be maintained where patching existing wall construction damaged by water intrusion.
2. Textured finishes: Patch shall match texture of adjacent surfaces.

B. Sustainable Design Submittals:

1. As required by IBC.

C. Samples: For each texture finish indicated on same backing indicated for Work.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

B. Approved manufacturers: American Gypsum, CertainTeed Gypsum, Georgia-Pacific, Lafarge North America, National Gypsum, PBCO and USG Corporation.

2.3 INTERIOR GYPSUM BOARD (Reference Sheet A301 for ceiling applications)

A. Gypsum Board, Type X: ASTM C1396/C1396M.

1. Thickness: 5/8 inch.
2. Long Edges: Tapered.

2.4 TRIM ACCESSORIES

A. Interior Trim: ASTM C1047.

1. Material: A**luminum-coated steel sheet.**
2. Shapes:
   a. Cornerbead.
   b. Bullnose bead.
   c. LC-Bead: J-shaped; exposed long flange receives joint compound.
   d. L-Bead: L-shaped; exposed long flange receives joint compound.
   e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
   f. Expansion (control) joint.
   g. Curved-Edge Cornerbead: With notched or flexible flanges.

2.5 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C475/C475M.

B. Joint Tape:

1. Interior Gypsum Board: Paper.
2. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.

C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints beveled panel edges 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 setting-type compound (verify) for each gypsum type.
   a. Use setting-type compound for installing paper-faced metal trim accessories.
3. Fill Coat: For second coat, use sandable topping compound.
4. Finish Coat: For third coat, use sandable topping compound.

2.6 AUXILIARY MATERIALS

A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.

B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

1. Confirm special conditions with architect during construction process for correct adhesive.

C. Steel Drill Screws: ASTM C1002 unless otherwise indicated.

1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

D. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."

E. Vapor Retarder: As specified in Section 072600 "Vapor Retarders."

2.7 TEXTURE FINISHES

A. Primer: Reference painting for spray or rolled “Orange Peel” texture prior to painting. Note where patching damage due to water intrusion, retexture entire wall for uniform finish.

PART 3 - EXECUTION

3.1 INSTALLATION AND FINISHING OF PANELS

A. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

B. Comply with ASTM C840.

C. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

D. 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.

E. Prefill open joints beveled edges and damaged surface areas.

F. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

G. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C840:

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
2. Level 4: All surfaces that will be exposed to view unless otherwise indicated]

a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting with “Orange Peel” texture by painter.

3.2 APPLYING TEXTURE FINISHES

A. Texture finished “Orange Peel” by painting section.

3.3 PROTECTION

A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

B. Remove and replace panels that are wet, moisture damaged, and mold damaged.

END OF SECTION 092900

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes replacement of existing non-rated acoustical panels and exposed suspension systems for interior ceilings damaged by water intrusion.

1. Due to cutting of ceiling grids for installation of new replacement mechanical systems, contractor shall consolidate like 2x2 ceiling tiles for installation in classrooms and plan to install new similar tiles in corridors and additional classroom spaces as required to meet the demand for a complete and finished ceiling system.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**] <**Insert location**>.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Verify sustainable guidelines and documentation requirements with architect.

C. Samples: For each exposed product and for each color and texture specified.

D. Delegated-Design Submittal: For seismic restraints for ceiling systems.

1. Include design calculations for seismic restraints including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, and coordinated with each other, using input from installers of the items involved.

B. Product test reports.

C. Research reports.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Verify sustainable guidelines and documentation requirements with architect.

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic restraints for ceiling systems.

C. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

2.2 ACOUSTICAL PANELS 2x2

A. Armstrong

B. Acoustical Panel Standard: Manufacturer's standard panels according to ASTM E1264.

C. Perforated mylar film

D. Color: White

E. Light Reflectance (LR): 0.85

F. Ceiling Attenuation Class (CAC): 35

G. Noise Reduction Coefficient (NRC): 75

H. Articulation Class (AC): 170

I. Edge/Joint Detail: Beveled Tegular

J. Thickness: to match existing.

K. Modular Size: 24 x 24

L. METAL SUSPENSION SYSTEM 2x2 Armstrong black to match existing where patching water damaged areas or areas torn-out for installation of new replacement mechanical systems.

1. Structural Classification: Intermediate-duty system.
2. End Condition of Cross Runners: butt-edge type.
3. Face Design: Flat, flush.
4. Cap Material: Cold-rolled steel.

5. Cap Finish: Painted white

2.3 ACCESSORIES

A. Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

PART 3 - EXECUTION

3.1 PREPARATION

A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated. Layout openings for penetrations centered on the penetrating items.

3.2 INSTALLATION

A. Install acoustical panel ceilings according to ASTM C636/C636M and manufacturer's written instructions.

B. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.

1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
2. Do not use exposed fasteners, including pop rivets, on moldings and trim.
3. Arrange directionally patterned acoustical panels as follows:
   a. As indicated on reflected ceiling plans.
   b. Install panels with pattern running in one direction parallel to [**long**] [**short**] axis of space.
   c. Install panels in a basket-weave pattern.
4. Install **impact** clips in the Girl’s Conditioning Workout Area according to panel manufacturer's written instructions unless otherwise indicated.

3.3 FIELD QUALITY CONTROL

A. Special Inspections: Manufacturer qualified special inspector to perform inspections.

1. Periodic inspection during the installation of suspended ceiling grids according to ASCE/SEI 7.

END OF SECTION 095113

SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thermoplastic-rubber base.
2. Rubber molding accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified.

PART 2 - PRODUCTS

2.1 THERMOPLASTIC-RUBBER BASE B1

A. Product Standard: ASTM F1861, Type TP (rubber, thermoplastic).

1. Style and Location:
   a. Style B, Cove: Provide in areas with resilient floor coverings .

B. Thickness: 0.125 inch .

C. Height: 4 inches .

D. Lengths: Coils in manufacturer's standard length .

E. Outside Corners: Job formed .

F. Inside Corners: Job formed .

G. Colors: Match Architect's sample .

2.2 RUBBER MOLDING ACCESSORY

A. Description: Rubber carpet edge for glue-down applications nosing for resilient floor covering reducer strip for resilient floor covering joiner for tile and carpet transition strips .

B. Profile and Dimensions: As indicated .

C. Locations: Provide rubber molding accessories in areas indicated .

D. Colors and Patterns: Match Architect's sample .

2.3 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

C. Do not install resilient products until materials are the same temperature as space where they are to be installed.

D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.2 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. Job-Formed Corners:

1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
   a. Form without producing discoloration (whitening) at bends.
2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
   a. Miter or cope corners to minimize open joints.

3.3 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient accessories.

B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.4 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.

B. Cover resilient products subject to wear and foot traffic until Substantial Completion.

3.5 ATTIC STOCK

A. Upon completion of the project, general contractor shall provide owner with **three (3) unopened boxes of 4" coved rubber total of 360 linear feet of base** for storage by the owner.

END OF SECTION 096513

SECTION 096519 - RESILIENT TILE FLOORING

PART 1 - PART 1 – GENERAL

1.1 SUBMITTALS

A. Product Specification

B. Specification for Adhesive

C. Floor Layouts

D. Samples

E. Schedule

F. Qualifications for Installer

1.2 CLOSEOUT SUBMITTALS

A. Maintenance Instructions

B. Warranty

1.3 QUALITY ASSURANCE

A. Environmental: FloorScore® Certified

B. Installer Qualifications: Installer who has been trained in the installation of resilient sheet flooring.

C. Mockups: Install 100 sf of product at designated location for architect review and approval.

1.4 MATERIAL STORAGE AND HANDLING

A. Store tiles on a flat surface and squarely on top of one another.

B. Store away from vents and direct sunlight.

C. When palletizing, first place a 5/8” or thicker plywood on the pallet. Stack 2 rows high side by side with no airspace between. Then quarter turn for 2 rows side by side. Do not exceed 12 boxes high. If you are stacking pallets, use a 1” thick plywood in between pallets.

D. Store in protected dry conditions between 65 and 85 degrees.

1.5 SITE CONDITIONS

A. The permanent HVAC system must be on for 7 days prior to, during and after installation between 65- and 85-degrees Fahrenheit or 18 to 29 degrees Celsius.

B. Material and adhesive must be acclimated to the installation area for a minimum of 48 hours prior to installation.

PART 2 - PART 2 – PRODUCTS

2.1 TESTING REQUIREMENTS

A. Slip Resistance ASTM D2047: ADA Compliant

B. Static Load Limit ASTM F970: 1000 psi

C. Residual Indentation F1914: passes, 8%

D. Flexibility ASTM F137: Passes

E. Resistance to Heat ASTM F1514: Passes

F. Resistance to Light ASTM F1515: Passes

G. Resistance to Chemicals ASTM F925: Passes

H. Radiant Flux ASTM E648: / 0.45 W/sq. cm., Class I

I. Smoke Density ASTM E662: Passes, <450

2.2 RESILIENT TILE

A. Luxury Vinyl Plan Flooring Three (3) Color Pattern

1. Manufacturer: Manington No Reservation Express

2. Pattern: As shown on architectural darwings

3. Product: ***Stoic*** NR301 6” x 36”
Benevolence NR102 7.25 x 48
Vivacious NR309 6 x 36”

2.3 INSTALLATION MATERIALS

A. Adhesives:

1.	Shaw 4100 spreadable	95% RH	8 lbs	pH 10
2.	S150 spray	95% RH	NA	pH 11
3.	Shaw 4151 for high moisture	99% RH	10 lbs.	pH 12
4.	Shaw 200 for low demand areas	85% RH	5 lbs	pH 5-9

B. Weld Rod

1. Heat
2. Chemical

C. Primer: Shaw 9050

D. Leveling and Patching Compounds: Use only Portland-based patching and leveling compounds. Do not install resilient flooring over gypsum-based patching and/or leveling compounds.

E. Take Abatement Coating: Shaw 6200

F. Barrier Coat Floor Encapsulation: Shaw 9000

PART 3 - PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content, pH, smoothness, and level.

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

3.2 PREPARATION

A. Concrete substrates should be tested for Internal Relative Humidity according to ASTM F 2170 and must not exceed 90% RH.

B. The PH of the concrete sub-floor must be between 7 and 10.

C. Substrates shall be smooth, structurally sound, permanently dry, clean and free of all foreign material such as dust, wax, solvents, paint, grease, oils, old adhesive residue, curing and hardening/ curing compounds, sealers and other foreign material that might prevent adhesive bond.

D. Concrete floors shall be flat and smooth within 1/8” in 6 feet or 3/16” in 10 feet.

3.3 INSTALLATION

A. LAYOUT AND INSTALLATION

B. Install using conventional tile and plank installation techniques. Plank products should have a minimum of 6 to 8” seam stagger. Center rooms and hallways so borders are not less than half of a tile or plank.

C. Work out of multiple boxes at the same time. In hallways and small spaces, work lengthwise from one end. Ensure cut edges are always against the wall.

D. To cut products, score the top side of the material with a utility knife. Bend the product and finish the cut through the back side. It may be necessary to use a heat gun to cut around vertical obstructions. Allow the heated product to return to room temperature before installation.

E. If you cut the product into a fine point, it may delaminate. Use an ethyl cyanoacrylate-based super glue to fuse the points together. Clean all glue from the top surface immediately. Alcohol-based super glues may cause the vinyl to swell.

F. Roll the plank or tile with a 3-section 100 lb. roller. Re-roll the floor within the working time of the adhesive. Continue to roll the floor throughout the working day to ensure a proper bond.

G. Use floor protection after installation. DO NOT use a plastic adhesive-based protection system.

3.4 MAINTENANCE

A. Initial Maintenance

1. Sweep, vacuum or dust mop to remove dirt and grit.
2. If needed, add neutral cleaner to cool water following the manufacturer's instructions.
3. Scrub with a low-rpm machine or auto scrubber. Use a red pad or brush.
4. Never use brown or black pads (too aggressive and can damage the product)
5. Remove the cleaning solution with a wet-dry vacuum or auto scrubber until the floor is dry.
6. Rinse the floor with clean water. Repeat the rinse process if necessary, to remove all haze.

B. Routine Maintenance

1. Sweep, vacuum, or dust mop to remove dirt and grit.
2. Add neutral pH cleaner to cool water following the manufacturer's instructions.
3. As needed, scrub with a low-rpm machine or auto scrubber to retain appearance. Use a red (light scrubbing) pad and neutral cleaner following the manufacturer's instructions.

C. Preventative Floor Care

1. Use walk-off mats that are as wide as the doorway and long enough for weather conditions.
2. Use mats with a non-staining backing.
3. Floor protectors should be used on all furniture legs.
4. The surface area of the floor protectors should be no less than 1" in diameter.

D. Full maintenance instructions will be provided by the manufacturer.

E. Attic Stock: Contractor upon completion of this project to provide <u>seven (7)</u> unopened boxes of each of the three colors for storage by the Owner for future repairs.

END OF SECTION 096519

SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Primers.
2. Water-based finish coatings.
3. Solvent-based finish coatings.
4. Floor sealers and paints.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type of topcoat product.

C. Product Schedule: Use same designations indicated on Drawings and in the Interior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

1.3 QUALITY ASSURANCE

A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Sherwin Williams

2.2 PAINT PRODUCTS, GENERAL

A. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

B. Colors: **As selected by Architect from manufacturer's full range**

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

1. Proceed with coating application only after unsatisfactory conditions have been corrected. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

C. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

3.3 INSTALLATION

A. Apply paints according to manufacturer's written instructions.

B. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

C. Painting Fire-Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint the following work where exposed in equipment rooms:
   a. Equipment, including panelboards **and switch gear**.
   b. Uninsulated metal and plastic piping.
   c. Pipe hangers and supports.
   d. Metal and plastic conduit.
   e. Tanks that do not have factory-applied final finishes.
   f. Duct, equipment, and pipe insulation paintable jacket material.
2. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 CLEANING AND PROTECTION

A. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

B. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 INTERIOR PAINTING SCHEDULE

A. Drywall With Existing Paint:

1. Interior Drywall Previously Painted Various Paint Systems

    a. Patch repair all areas of damage drywall and texter to match existing.
    b. Primer: One coat ProMar 200 Zero V.O.C. Primer White
    c. Intermediate Coat: Pro Industrial Waterbased Alkyd Urethane
    d. Topcoat: Pro Industrial Waterbased Alkyd Urethane

B. Steel Substrates: (exposed steel, door frames, doors, etc)

1. Water Based Epoxy (Sherwin Williams Products)
    a. Prime Coat: B66W00310 – Pro Industrial Pro-cryl Primer Off White
    b. Intermediate Coat: Pro Industrial Waterbased Alkyd Urethane
    c. Topcoat: Pro Industrial Waterbased Alkyd Urethane

3.6 EXTERIOR PAINTING SCHEDULE

A. Hollow Metal Doors and Frames

1. Cast Iron Boots for downspouts:
    a. Prime Coat: B50AZ0006 – Kem Kromik Universal memtal Primer Gray Gray
    b. Intermediate Coat: B66W00661 – Pro Industrial High Performance Acrylic – Egg Shell Extra White.
    c.
2. Galvanized Steel:
    a. Prime Coat: B66W00310 Pro Industrial Pro-Cryl Universal Primer Off White
    b. Intermediate Coat: B53W02151 – PI WB ALK UR SG EW
    c. Top Coat: PI WB ALK UR SG EW

END OF SECTION 099123

SECTION 101419 - DIMENSIONAL LETTER SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Dimensional characters.
    a. Cast dimensional characters.
    b. Cutout dimensional characters.
    c. Fabricated channel dimensional characters.
    d. Illuminated, fabricated channel dimensional characters.
    e. Molded-plastic dimensional characters.
    f. Illuminated, molded-plastic dimensional characters.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

C. Shop Drawings: For signs.

1. Include fabrication and installation details and attachments to other work.
2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
3. Show message list, typestyles, graphic elements, and layout for each sign.
4. Show locations of electrical service connections.
5. Include diagrams for power, signal, and control wiring.

D. Samples: For each exposed product and for each color and texture specified.

E. Delegated Design Submittal: For [**signs indicated in "Performance Requirements"**

1. Include structural analysis calculations for signs indicated to comply with design loads; signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS

A. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five Years

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Signs and supporting elements shall withstand the effects of gravity and other loads within limits and under conditions indicated.

B. Thermal Movements: For exterior fabricated channel dimensional characters allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: **120 deg F, ambient; 180 deg F, material surfaces.**

2.2 DIMENSIONAL CHARACTERS

A. Cast Characters where indicated on drawings: Characters with uniform faces, sharp corners, and precisely formed lines and profiles, and as follows:

1. Sign International or other prior approved.
2. Character Material: Cast **aluminum**.
3. Character Height: **As indicated on Drawings.**
4. Finishes:
   a. Integral Metal Finish: As selected by Architect from full range of industry finishes.
   b. Integral Aluminum Finish: Baked-Enamel: Manufacturer to match **Architect's sample.**
   c. Overcoat: **Manufacturer's standard baked-on clear coating**.
5. Mounting: To be verify due to application to pre-engineered metal siding coordinate during design and shop drawing phase.

2.3 FABRICATION

A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.

1. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
2. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
3. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
4. Internally brace dimensional characters for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.
5. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.
6. Castings: Fabricate castings free of warp, cracks, blowholes, pits, scale, sand holes, and other defects that impair appearance or strength. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks before finishing.

B. Brackets: Fabricate brackets, fittings, and hardware for bracket-mounted signs to suit sign construction and mounting conditions indicated. Modify manufacturer's standard brackets as required.

1. <u>VERIFY ALL ANCHORING CONDITIONS DURING SHOP DRAWING REVIEW PHASE WITH GENERAL CONTRACTOR IN ORDER TO PROPERLY PREAPRE FOR ANCHORING AND BACK-UP FRAMING.</u>

PART 3 - EXECUTION

3.1 INSTALLATION OF DIMENSIONAL CHARACTERS

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
2. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
3. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

B. Mounting Methods:

1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
   a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.

b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.

2. Projecting Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
   a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place spacers on studs, place sign in position, and push until spacers are pinched between sign and substrate, embedding the stud ends in holes. Temporarily support sign in position until adhesive fully sets.
   b. Thin or Hollow Surfaces: Place spacers on studs, place sign in position with spacers pinched between sign and substrate and install washers and nuts on stud ends projecting through opposite side of surface, and tighten.
3. Through Fasteners: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.
4. Back Bar and Brackets: Remove loose debris from substrate surface and install backbar or bracket supports in position, so that signage is correctly located and aligned.
5. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.

C. Remove temporary protective coverings and strippable films as signs are installed.

END OF SECTION 101419

SECTION 104350 - SIGNAGE SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to the Section.

1.2 SUMMARY

A. Section includes Wall Mounted Frames where indicated on Drawings.

B. It is the intent that the work of this Section be performed as part of Section 10 14 00, “Signage”.

C. Section include removing and re-installing any historic designation signage where originally installed upon completion of the adaptive restoration.

D. Provide address numbers, size as required by city, to be mounted on the building corner as indicated on exterior elevation, size as required by City of Beaumont.

1.3 RELATED SECTIONS

A. Coordinate Work of this Section with work of other sections, including Division 01 Sections, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.

1.4 REFERENCES

A. International Code Council / American National Standards Institute (ICC/ANSI)

1. A117.1, Accessible and USEBLE Buildings and Facilities.

B. USATBCB – Americans with Disabilities Act (ADA), Accessibility

1. Guidelines for Buildings and Facilities (ADAAG)

1.5 SUBMITTALS

A. Submit under provisions of Section 013 33 00.

B. Manufacturer’s data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods

C. Shop Drawings: Indicate sign styles, lettering, locations, and dimensions of each interior sign.

D. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer’s full range of available colors and patterns.

E. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150mm) square, representing actual product, color, and patterns.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements of ICC/ANSI A117.1 and ADAAG.

B. Mock-up: Provide a mock-up of each sign type for evolution of mounting techniques and application workmanship.

1. Locate in areas designated by Architect and do not proceed with remaining work until workmanship approved by Architect.

C. Reinstall mock-up signs as required to produce acceptable work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store products in unopened protective packaging until ready for installation.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Specifications are based on products manufactured by Vista System Inc., Sarasota, FL; (800) 468-4782, or Architect approved equivalent. Other manufacturers must have a minimum of five (5) years experience manufacturing products meeting of exceeding the specifications and comply with Division 01 Section "Product Requirements" for requirements regarding substitutions to be considered.

B. Other Approved Manufacturers:
1. Inpro Signage Systems
2. Best Signage Systems
3. Mohawk Systems
4. Sign International

2.2 SIGNAGE

A. Products: Provide the following interior sign system types in the locations and in the configurations indicated.

B. Wall Mounted Frames: Wall-mounted signs with the Vista frame extrusions using any flat, flexible substrate to create a curved faced sign.

C. Color to be selected by Architect.

D. Wall mounted Frames:

1. Wall Frames – Portrait Series: Extruded Aluminum of the sizes specified. This Sign/product includes assembly. Style/Size to be selected by Architect.
2. Aluminum Frame Finish:

(a) To be selected by Architect.

3. Clear cover for extrusion thick polycarbonate, glossy one side, non-glare one side.

4. End Caps for Extrusions: Provided with matching screws.

   (a) To be selected by Architect.

5. Mounting

   (a) Mechanical with all mounting holes predrilled.
   (b) Mechanical with primary mounting holes predrilled and set with silicone sealant.

E. Wall Frames – Landscape Series: Extruded Aluminum pf the sizes specified. This sign/product includes assembly.

   (a) Style/Size To be selected by Architect.

2. Aluminum Frame finish:

   (a) To be selected by Architect.

3. Clear cover for extrusion polycarbonate, glossy one side, non-glare one side.
4. End Caps for Extrusions: Provided with matching screws.

   (a) To be selected by Architect.
   (b) Mechanical with all mounting holes predrilled.
   (c) Double faced tape
   (d) Mechanical with primary mounting holes predrilled and set with silicone sealant.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates is properly prepared. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Cleaning surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install in accordance with manufacturer’s instructions.
B. Located signs in accordance with approved shop drawings and ADA requirements.
C. Install signs after surfaces to receive signage are finished.

3.4 PROTECTION

A. Protect installed products until completion of project.

END OF SECTION 104350

SECTION 22 01 00 - PLUMBING OPERATING AND MAINTENANCE MANUALS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Compilation product data and related information appropriate for Owner's operation and maintenance of products furnished under Contract. Prepare operating and maintenance data as specified.

B. Instruct Owner's personnel in operation and maintenance of equipment and systems.

C. Submit three copies of complete manual in final form.

1.2 SUBMITTALS

A. Thirty (30) days after the Contractor has received the final scheduled identified submittals bearing the Architect/Engineer's stamp of acceptance (including resubmittals), submit for review one copy of the first draft of the Operating and Maintenance Manual. This copy shall contain as a minimum:
   1. Table of Contents for each element.
   2. Contractor information.
   3. All submittals, coordination drawings and product data, reviewed by the Architect / Engineer; bearing the Architect / Engineer's stamp of acceptance. (When submittals are returned from Engineer "Correct as Noted", corrected inserts shall be included.)
   4. All parts and maintenance manuals for items of equipment.
   5. Warranties (without starting dates)
   6. Certifications that have been completed. Submit forms and outlines of certifications that have not been completed.
   7. Operating and maintenance procedures.
   8. Form of Owner's Training Program Syllabus (including times and dates).
   9. Control operations/equipment wiring diagrams.
   10. Other required operating and maintenance information that are complete.

B. Copy will be returned to the Contractor within 15 days with comments for corrections.

C. Submit three (3) completed manuals in final form to the Architect / Engineer one day after substantial completion, and prior to Owner's instructions. Include all specified data, test and balance reports, drawings, dated warranties, certificates, reports, along with other materials and information.

D. The Architect/Engineer will review the manuals for completeness within fifteen (15) days.

E. The Contractor shall be notified of any missing or omitted materials. The Manuals shall be reworked by the Contractor, as required, in the office of the Architect / Engineer. The manuals will not be retransmitted.

F. Two (2) complete Manuals will be delivered to the Owner.

PART 2 - PRODUCTS

2.1 BINDERS

A. Commercial quality black three-ring binders with clear overlay plastic covers.

B. Minimum ring size: 1 inch; Maximum ring size: 3 inches.

C. When multiple binders are used, correlate the data into related groupings.

D. Label contents on spine and face of binder with full size insert. Label under plastic cover.

PART 3 - EXECUTION

3.1 OPERATION AND MAINTENANCE MANUAL

A. Form for Manuals:
1. Prepare data in form of an instructional manual for use by Owner's personnel.
2. Format:
a. Size: 8-1/2 inch x 11 inch.
b. Text: Manufacturer's printed data or neatly typewritten.
3. Drawings:
a. Provide reinforced punched binder tab and bind in text.
b. Fold larger drawings to size of text pages.
4. Provide flyleaf indexed tabs for each separate product or each piece of operating equipment.
5. Cover: Identify each volume with typed or printed title "Operating and Maintenance Instructions". List:
a. Title of Project
b. Identity of separate structures as applicable.
c. Identity of general subject matter covered in the manual.
6. Binder as specified.

B. Content of Manual:
1. Neatly typewritten Table of Contents for each volume arranged in systematic order as outlined in the specifications.
a. Contractor, name of responsible principal, address and telephone number.
b. A list of each product required to be included, indexed to content of the volume.
c. List with each product, name, address and telephone number of:
1) Subcontractor or installer.
2) Maintenance contractor as appropriate.
3) Identify area of responsibility of each.
4) Local source of supply for parts and replacement.
d. Identify each product by product name and other identifying symbols as set forth in Contract Documents.
2. Product Data:
a. Include those sheets pertinent to the specific product.
b. Annotate each sheet to:
1) Identify specific product or part installed.
2) Identify data applicable to installation.
3) Delete references to inapplicable information. (All options not supplied with equipment shall be marked out indicated in some manner.
3. Drawings:
a. Supplement product data with drawings as necessary to illustrate:
1) Relations of component parts of equipment and systems.
2) Control and flow diagrams.
b. Coordinate drawings with information in Project Record Documents to assure correct illustration of completed installation.
c. Do not use Project Record Documents as maintenance drawings.
4. Written text, as required to supplement product data for the particular installation:
a. Organize in consistent format under separate headings for different

procedures.
b. Provide logical sequence of instructions for each procedure.

5. Copy of each warranty, bond and service contract issued.
   a. Provide information sheet for Owner's personnel, giving:
      1) Proper procedures in event of failure.
      2) Instances that might affect validity of warranties or bonds.
6. Shop drawings, coordination drawings and product data as specified.

C. Sections for Equipment and Systems.
1. Content for each unit of equipment and system as appropriate:
   a. Description of unit and component parts.
      1) Function, normal operating characteristics, and limiting conditions.
      2) Performance curves, engineering data and tests.
      3) Complete nomenclature and commercial number of replaceable parts.
   b. Operating procedures:
      1) Start up, break-in, routine and normal operating instructions.
      2) Regulation, control, stopping, shut down and emergency instructions.
      3) Summer and winter operating instructions.
      4) Special operating instructions.
   c. Maintenance procedures:
      1) Routine operations
      2) Guide to trouble-shooting.
      3) Disassembly, repair and reassembly.
      4) Alignment, adjusting and checking.
      5) Routine service based on operating hours.
   d. Servicing and lubrication schedule. List of lubricants required.
   e. Manufacturer's printed operating and maintenance instructions.
   f. Description of sequence of operation by control manufacturer.
   g. Original manufacturer's parts list, illustrations, assembly drawings and diagrams required for maintenance.
      1) Predicted life of part subject to wear.
      2) Items recommended to be stocked as spare parts.
   h. As installed control diagrams by controls manufacturer.
   i. Complete equipment internal wiring diagrams.
   j. Each Contractor's coordination drawings.
   k. As installed color coded piping diagrams.
   l. Charts of valve tag number, with location and function of each valve.
   m. List of original manufacturer's spare parts and recommended quantities to be maintained in storage.
   n. Other data as required under pertinent sections of the specifications.
2. Prepare and include additional data when the need for such data becomes apparent during instruction of Owner's personnel.
3. Additional requirements for operating and maintenance data as outlined in respective sections of specifications.
4. Provide complete information for products specified in Division 22.
5. Provide certificates of compliance as specified in each related section.
6. Provide start up reports as specified in each related section.
7. Provide signed receipts for spare parts and material.
8. Provide training report and certificates.
9. Provide backflow preventer certified test reports.
10. Provide gas piping pressure test reports.

END OF SECTION

SECTION 22 05 00 - PLUMBING GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Except as modified in this Section, General Conditions, Supplementary Conditions, applicable provisions of the General Requirements, and other provisions and requirements of the contract documents apply to work of Division 22 Plumbing.

B. Applicable provisions of this section apply to all sections of Division 22, Plumbing.

1.2 CODE REQUIREMENTS AND FEES

A. Perform work in accordance with applicable statutes, ordinances, codes and regulations of governmental authorities having jurisdiction.

B. Plumbing work shall comply with applicable inspection services:
1. Underwriters Laboratories
2. National Fire Protection Association
3. State Health Department
4. Local Municipal Building Inspection Department
5. Texas Department of Licensing & Regulations (TDLR)
6. Texas Accessibility Standards (TAS Based on ADA)

C. Resolve any code violations discovered in contract documents with the Engineer prior to award of the contract. After Contract award, any correction or additions necessary for compliance with applicable codes shall be made at no additional cost to the Owner.

D. This Contractor shall be responsible for being aware of and complying with asbestos NESHAP regulations, as well as all other applicable codes, laws and regulations.

E. Obtain all permits required.

1.3 CONTRACTOR'S QUALIFICATIONS

A. An approved contractor for the work under this division shall be:
1. A licensed specialist in this field and have the personnel, experience, training, skill, and organization to provide a practical working system
2. Able to furnish evidence of having contracted for and installed not less than three systems of comparable size and type that has served their Owners satisfactorily for not less than three years.

1.4 REFERENCE SPECIFICATIONS AND STANDARDS

A. Materials which are specified by reference to Federal Specifications; ASTM, ASME, ANSI, or AWWA Specifications; Federal Standards; or other standard specifications must comply with latest editions, revisions, amendments or supplements in effect on date bids are received. Requirements in reference specifications and standards are minimum for all equipment, material, and work. In instances where specified capacities, size, or other features of equipment, devices, or materials exceed these minimums, meet specified capacities.

1.5 CONTRACT DRAWINGS

A. Contract drawings are diagrammatic only and do not give fully dimensioned locations of

various elements of work. Determine exact locations from field measurements.

1.6 PROJECT RECORD DOCUMENTS

A. Maintain at the job site a separate set of white prints (blue line or black line) of the contract drawings for the sole purpose of recording the "as-built" changes and diagrams of those portions of work in which actual construction is at variance with the contract drawings. Mark the drawings with a colored pencil. Prepare, as the work progresses and upon completion of work, reproducible drawings clearly indicating locations of various lines, valves, ductwork, traps, equipment, and other pertinent items, as installed. Include flow-line elevation of sewer lines. Record existing and new underground and under slab piping with dimensioned locations and elevations of such piping.

B. At the conclusion of project, obtain without cost to the Owner, erasable mylars of the original drawings and transfer as-built changes to these. Prior to transmittal of corrected drawings, obtain three sets of blue-line prints of each drawing, regardless of whether corrections were necessary and include in the transmittal (two sets are for the Owner's use and one set is for the Architect / Engineer's records). Delivery of these as-built prints and reproducibles is a condition of final acceptance. Provide record drawings on one set each (reproducible Dayrex mylar film positives) and AutoCad 2012 / Revit CAD files on disk (CD Rom).

C. As-Built drawings should indicate the following information as a minimum:
1. Indicate all addendum changes to documents.
2. Remove Engineer’s seal, name, address and logo from drawings.
3. Mark documents RECORD DRAWINGS.
4. Clearly indicate: DOCUMENT PRODUCED BY
5. Indicate all changes to construction during construction. Indicate actual routing of all piping, ductwork, etc. that were deviated from construction drawings.
6. Indicate exact location of all underground plumbing and flow line elevation.
7. Indicate exact location of all underground plumbing piping and elevation.
8. Indicate exact location of all underground electrical raceways and elevations.
9. Correct schedules to reflect (actual) equipment furnished and manufacturer.
10. During the execution of work, maintain a complete set of drawings and specifications upon which all locations of equipment, ductwork, piping, devices, and all deviations and changes from the construction documents in the work shall be recorded.
11. Location and size of all ductwork and mechanical piping above ceiling including exact location of isolation of domestic and plumbing valves.
12. Exact location of all electrical equipment in and outside of the building.
13. Fire Protection System documents revised to indicate exact location of all sprinkler heads and zone valves.
14. Exact location of all roof mounted equipment, wall, roof and floor penetrations.
15. Cloud all changes.

1.7 SPACE REQUIREMENTS

A. Consider space limitations imposed by contiguous work in selection and location of equipment and material. Do not provide equipment or material that is not suitable in this respect.

1.8 RELATION WITH OTHER TRADES

A. Carefully study all matters and conditions concerning the project. Submit notification of conflict in ample time to prevent unwarranted changes in any work. Review other Divisions of these specifications to determine their requirements.

B. Because of the complicated relationship of this work to the total project, conscientiously study the relation and cooperate as necessary to accomplish the full intent of the documents.

C. Provide sleeves and inserts in forms as required for the work. Stub up and protect open ends of pipe before any concrete is placed. Furnish sizes of required equipment pads. Furnish and locate bolts and fittings required to be cast in them.

D. Locate and size openings required for installation of work specified in this Division in sufficient time to prevent delay in the work.

E. Refer to other Divisions of the specifications for the scope of required connections to equipment furnished under that Division. Determine from the Contractor for the various trades, the Owner, and by direction from the Architect / Engineer, the exact location of all items.

1.9 CONCEALED AND EXPOSED WORK

A. When the word "concealed" is used in connection with insulating, painting, piping, ducts and the like, the work is understood to mean hidden from sight as in chases, furred spaces or above ceilings. "Exposed" is understood to mean open to view.

1.10 GUARANTEE

A. Guarantee work for one year from the date of substantial completion of the project. During that period make good any faults or imperfections that may arise due to defects or omissions in material, equipment or workmanship. At the Owner's option, replacement of failed parts or equipment shall be provided.

1.11 MATERIAL AND EQUIPMENT

A. Furnish new and unused materials and equipment meeting the requirements of the paragraph specifying acceptable manufacturers. Where two or more units of the same type or class of equipment are required, provide units of a single manufacturer.

1.12 NOISE AND VIBRATION

A. Select equipment to operate with minimum noise and vibration. If objectionable noise or vibration is produced or transmitted to or through the building structure by equipment, piping, ducts or other parts of work, rectify such conditions at no additional cost. If the item of equipment is judged to produce objectionable noise or vibration, demonstrate at no additional cost that equipment performs within designated limits on a vibration chart.

1.13 ACCEPTABLE MANUFACTURERS

A. Manufacturers names and catalog number specified under sections of Division 22 are used to establish standards of design, performance, quality and serviceability and not to limit competition. Equipment of similar design, equal to that specified, manufactured by a named manufacturer will be acceptable on approval. A request for prior approval of equipment not listed must be submitted ten (10) days before bid due date. Submit complete design and performance data to the Engineer.

1.14 OPERATING TESTS

A. After all plumbing systems have been completed and put into operation, subject each

system to an operating test under design conditions to ensure proper sequencing and operation throughout the range of operation. Tests shall be made in the presence of the Architect / Engineer. Make adjustments as required to ensure proper functioning of all systems. Special tests on individual systems are specified under individual sections. Submit three copies of all certifications and test reports adequately in advance of completion of the work to allow for remedial action as required to correct deficiencies discovered in equipment and systems.

1.15 WARRANTIES

A. Submit three copies of all warranties and guarantees for systems, equipment, devices and materials. These shall be included in the Operating and Maintenance Manuals.

1.16 BUILDING CONSTRUCTION

A. It shall be the responsibility of each sub-contractor to consult the Architectural and Engineering drawings, details, and specifications and thoroughly familiarize himself with the project and all job related requirements. Each subcontractor shall cooperate with the General Contractor to verify that all piping and other items are placed in the walls, furred spaces, chases, etc., so there will be no delays in the job.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 OPENINGS

A. Framed, cast or masonry openings for ductwork, equipment or piping are specified under other divisions. Drawings and layout work for exact size and location of all openings are included under this division.

3.2 HOUSEKEEPING PADS

A. Provide equipment housekeeping pads under all floor mounted and ground mounted plumbing equipment, and as shown on the drawings.

B. Concrete work as specified in Division 3.

C. Concrete pads:
   1. 4 inch high, rounded edges, minimum 2500 psi unless otherwise indicated on the drawings
   2. Chamfer strips at edges and corner of forms.
   3. Smooth steel trowel finish.
   4. Doweled to existing slab

D. Install concrete curbs around multiple pipe penetrations.

3.3 VANDAL RESISTANT DEVICES

A. Provide a handle for each loose keyed operated valve and hose bibb on the project.

B. Where vandal resistant screws or bolts are employed on the project, deliver to the Owner two suitable tools for use with each type of fastener used.

C. Proof of delivery of these items to the Owner shall be included in the Operating and

Maintenance Manuals.

3.4 INSTRUCTION OF OWNER'S PERSONNEL

A. Prior to final inspection, conduct an on-site training program to instruct the Owner's operating personnel in the operation and maintenance of the plumbing systems.
1. Provide the training during the Owner's regular working day.
2. The Instructors shall each be experienced in their phase of operation and maintenance of building plumbing systems and with the project.

B. Time to be allocated for instructions.
1. Minimum of 8 hours dedicated instructor time.
2. 4 hours on each of 2 days.

C. Before proceeding with the on-site training program, submit the program syllabus; proposed time and dates; and other pertinent information for review and approval.
1. One copy to the Owner.
2. One copy to the Architect / Engineer.

D. The Owner will provide a list of personnel to receive instructions, and will coordinate their attendance at the agreed upon times.

E. Use the operation and maintenance manuals as the basis of instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.

F. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shut down of each item of equipment.

G. Demonstrate equipment functions (both individually and as part of the total integrated system).

H. Prepare and insert additional data in the operating and maintenance manuals when the need for additional data becomes apparent during instructions.

I. Submit a report within one week after completion of the training program that instructions have been satisfactorily completed. Give time and date of each demonstration and hours devoted to the demonstration, with a list of people present.

J. At the conclusion of the on-site training program, have the person designated by the Owner sign a certificate to certify that he/she has a proper understanding of the system, that the demonstrations and instructions have been satisfactorily completed, and the scope and content of the operating and maintenance manuals used for the training program are satisfactory.

K. Provide a copy of the report and the certificate in an appropriately tabbed section of each Operating and Maintenance Manual.

3.5 EQUIPMENT IDENTIFICATION

A. Provide a laminated engraved plastic nameplate on each piece of equipment and starter.
1. Designation approved by Architect / Engineer.
2. Equipment includes, but is not limited to, water heaters, pumps, boilers and utility controllers.
3. Submit schedule of equipment to be included and designations.

B. Provide nameplates with ½ inch high letters and fastened with epoxy or screws.

3.6 OBSTRUCTIONS

A. The drawings indicate certain information pertaining to surface and subsurface obstructions which has been taken from available drawings. Such information is not guaranteed, however, as to accuracy of location or complete information.
   1. Before any cutting or trenching operations are begun, verify with Owner's representative, utility companies, municipalities, and other interested parties that all available information has been provided.
   2. Should obstruction be encountered, whether shown or not, alter routing of new work, reroute existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition.

B. Assume total responsibility for and repair any damage to existing utilities or construction, whether or not such existing facilities are shown.

3.7 PROTECTION

A. Protect work, equipment, fixtures, and materials. At work completion, work must be clean and in original manufacturer's condition.

END OF SECTION

SECTION 22 05 10 - PLUMBING CONTRACT QUALITY CONTROL

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Contract quality control including workmanship, manufacturer's instructions and demonstrations.

1.2 QUALITY CONTROL PROGRAM

A. Maintain quality control over supervision, subcontractors, suppliers, manufacturers, products, services, site conditions and workmanship to produce work in accordance with contract documents.

1.3 WORKMANSHIP

A. Comply with industry standards except when more restrictive tolerances or specified requirements indicate more rigid standards or more precise workmanship.

B. Perform work by persons qualified to produce workmanship of specified quality.

C. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, and racking. Under no conditions shall material or equipment be suspended from structural bridging.

D. Provide finishes to match approved samples. All exposed finishes shall be approved by the Architect. Submit color samples as required.

1.4 MANUFACTURER'S INSTRUCTIONS

A. Comply with instructions in full detail, including each step in sequence.

B. Should instruction conflict with Contract Documents, request clarification from Architect / Engineer before proceeding.

1.5 MANUFACTURER'S CERTIFICATES

A. When required in individual Specification Sections, submit manufacturer's certificate in duplicate, certifying that products meet or exceed specified requirements.

1.6 MANUFACTURER'S FIELD SERVICES

A. When required in individual Specification Sections, manufacturer shall provide qualified personnel to observe:
   1. Field conditions.
   2. Condition of installation.
   3. Quality of workmanship.
   4. Start-up of equipment.
   5. Testing, adjusting, and balancing of equipment.

B. Representative shall make written report of observations and recommendations to Architect / Engineer.

PART 2 - PRODUCTS

2.1 REFERENCE APPLICABLE SPECIFICATION SECTIONS

PART 3 - EXECUTION

3.1 PROTECTION OF EQUIPMENT

A. Do not deliver equipment to the project site until progress of construction has reached the stage where equipment is actually needed or until building is closed in enough to protect the equipment from weather. Equipment allowed to stand in the weather will be rejected, and the Contractor is obligated to furnish new equipment of a like kind at no additional cost to the Owner.

B. Adequately protect equipment from damage after delivery to the project. Cover with heavy tarpaulins, drop cloths or other protective coverings as required to protect from plaster, paint, mortar and/or dirt. Do not cover with plastic materials and trap condensate and cause corrosion.

END OF SECTION

SECTION 22 05 12 - PLUMBING SHOP DRAWINGS, COORDINATION DRAWINGS & PRODUCT DATA

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Prepare submittals as required by Division 1.

B. The term submittal, as used herein, refers to all:
1. Shop Drawings
2. Coordination Drawings
3. Product data

C. Submittals shall be prepared and produced for:
1. Distribution as specified
2. Inclusion in the Operating and Maintenance Manual, as specified, in the related section

1.2 SHOP DRAWINGS

A. Present drawings in a clear and thorough manner. Identify details by reference to sheet and detail, schedule, or room numbers shown on Contract Drawings.

B. Show all dimensions of each item of equipment on a single composite Shop Drawing. Do not submit a series of drawings of components.

C. Identify field dimensions; show relationship to adjacent features, critical features, work, or products.

D. Submit shop drawings in plan, elevation and sections, showing equipment in mechanical equipment areas.

1.3 COORDINATION DRAWINGS

A. Present in a clear and thorough manner. Title each drawing with project name. Identify each element of drawings by reference to sheet number and detail, or room number of contract documents. Minimum drawing scale: ¼ inch = 1 foot - 0 inch.

B. Prepare coordination drawings to coordinate installations for efficient use of available space, for proper sequence of installation, and to resolve conflicts. Coordinate with work specified in other sections and other divisions of the specifications.

C. For each mechanical room and for each outside equipment pad where equipment is located, submit plan and elevation drawings. Show:
1. Actual mechanical equipment and components to be furnished
2. Service clearance
3. Relationship to other equipment and components
4. Roof drains and leader piping
5. Fire protection piping and equipment

D. Identify field dimensions. Show relation to adjacent or critical features of work or products.

E. Related requirements:
1. Ductwork shop drawings
2. Coordination drawing specified in Division 26

F. Submit shop drawings in plan, elevation and sections, showing equipment in mechanical equipment areas.

G. Gas piping sketch indicating proposed location of piping prior to proceeding with the installation.

1.4 PRODUCT DATA AND INSTALLATION INSTRUCTION

A. Submit only pages which are pertinent to the project. All options which are indicated on the product data shall become part of the contract and shall be required whether specified are not.

B. Mark each copy of standard printed data to identify pertinent products, referenced to specification section and article number.

C. Show reference standards, performance characteristics and capacities; wiring and piping diagrams and controls; component parts; finishes; dimensions and required clearances.

D. Modify manufacturer's standard schematic drawings and diagrams to supplement standard information and to provide information specifically applicable to the work. Delete information not applicable.

E. Mark up a copy of the specifications for the product. Indicate in the margin of each paragraph the following: “Comply, ”Do Not Comply”, or “Not Applicable”. Explain all “Do Not Comply” statements.

F. Provide a separate transmittal for each submittal item. Transmittals shall indicate product by specification section name and number. Separate all submittals into appropriate specification section number. Do not combine specification sections.

1.5 MANUFACTURERS INSTRUCTIONS

A. Submit Manufacturer's instructions for storage, preparation, assembly, installation, start-up, adjusting, calibrating, balancing and finishing.

1.6 CONTRACTOR RESPONSIBILITIES

A. Review submittals prior to transmittal.

B. Determine and verify:
1. Field measurements
2. Field construction criteria
3. Manufacturer's catalog numbers
4. Conformance with requirements of Contract Documents

C. Coordinate submittals with requirements of the work and of the Contract Documents.

D. Notify the Architect/Engineer in writing at time of submission of any deviations in the submittals from requirements of the Contract Documents.

E. Do not fabricate products, or begin work for which submittals are specified, until such submittals have been produced and bear contractor's stamp. Do not fabricate products or begin work scheduled to have submittals reviewed until return of reviewed submittals with Architect/Engineer's acceptance.

F. Contractor's responsibility for errors and omissions in submittals is not relieved whether Architect/Engineer reviews submittals or not.

G. Contractor's responsibility for deviations in submittals from requirements of Contract Documents is not relieved whether Architect/Engineer reviews submittals or not, unless Architect/engineer gives written acceptance of the specific deviations on reviewed documents.

H. Submittals shall show sufficient data to indicate complete compliance with Contract Documents:
   1. Proper sizes and capacities
   2. That the item will fit in the available space in a manner that will allow proper service
   3. Construction methods, materials and finishes

I. Schedule submissions at least 15 days before date reviewed submittals will be needed.

1.7 SUBMISSION REQUIREMENTS

A. Make submittals promptly in accordance with approved schedule, and in such sequence as to cause no delay in the Project or in the work of any other Contractor.

B. Number of submittals required:
   1. Shop Drawings and Coordination Drawings: Submit one reproducible transparency and three opaque reproductions.
   2. Product Data: Submit the number of copies which the contractor requires, plus those which will be retained by the Architect/Engineer.

C. Accompany submittals with transmittal letter, in duplicate, containing:
   1. Date
   2. Project title and number
   3. Contractor's name and address
   4. The number of each Shop Drawing, Project Datum and Sample submitted
   5. Other pertinent data

D. Submittals shall include:
   1. The date of submission
   2. The project title and number
   3. Contract Identification
   4. The names of:
      a. Contractor
      b. Subcontractor
      c. Supplier
      d. Manufacturer
   5. Identification of the product
   6. Field dimensions, clearly identified as such
   7. Relation to adjacent or critical features of the work or materials
   8. Applicable standards, such as ASTM or federal specifications numbers
   9. Identification of deviations from contract documents
   10. Suitable blank space for General Contractor and Architect/Engineer stamps
   11. Contractor's signed and dated Stamp of Approval

E. Coordinate submittals into logical groupings to facilitate interrelation of the several items:
   1. Finishes which involve Architect/Engineer selection of colors, textures or patterns
   2. Associated items which require correlation for efficient function or for installation

1.8 SUBMITTAL SPECIFICATION INFORMATION

A. Every submittal document shall bear the following information as used in the project manual:
   1. The related specification section number
   2. The exact specification section title

B. Submittals delivered to the Architect/Engineer without the specified information will not be processed. The Contractor shall bear the risk of all delays, as if no submittal had been delivered.

1.9 RESUBMISSION REQUIREMENTS

A. Make re-submittals under procedures specified for initial submittals.
   1. Indicate that the document or sample is a re-submittal
   2. Identify changes made since previous submittals

B. Indicate any changes which have been made, other than those requested by the Architect / Engineer.

1.10 CONTRACTOR'S STAMP OF APPROVAL

A. Contractor shall stamp and sign each document certifying to the review of products, field measurements and field construction criteria, and coordination of the information within the submittal with requirements of the work and of Contract Documents.

B. Contractor's stamp of approval on any submittal shall constitute a representation to Owner and Architect/Engineer that Contractor has either determined and verified all quantities, dimensions, field construction criteria, materials, catalog numbers, and similar data or assumes full responsibility for doing so, and that Contractor has reviewed or coordinated each submittal with the requirements of the work and the Contract Documents.

C. Do not deliver any submittals to the Architect/Engineer that do not bear the Contractor's stamp of approval and signature.

D. Submittals delivered to the Architect/Engineer without Contractor's stamp of approval and signature will not be processed. The Contractor shall bear the risk of all delays, as if no submittal had been delivered.

1.11 ARCHITECT/ENGINEER REVIEW OF IDENTIFIED SUBMITTALS

A. The Architect/Engineer will:
   1. Review identified submittals with reasonable promptness and in accordance with schedule
   2. Affix stamp and initials or signature, and indicate requirements for re-submittal or approval of submittal
   3. Return submittals to Contractor for distribution or for resubmission

B. Review and approval of submittals will not extend to design data reflected in submittals which is peculiarly within the special expertise of the Contractor or any party dealing directly with the Contractor.

C. Architect/Engineer's review and approval is only for conformance with the design concept of the project and for compliance with the information given in the contract.

1. The review shall not extend to means, methods, sequences, techniques or procedures of construction or to safety precautions or programs incident thereto.
2. The review shall not extend to review of quantities, dimensions, weights or gauges, fabrication processes or coordination with the work of other trades.

D. The review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.

1.12 SUBSTITUTIONS

A. Do not make requests for substitution employing the procedures of this Section.

B. The procedure for making a formal request for substitution is specified in Div. 1.

PART 2 - PRODUCTS - NOT USED.

PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 22 05 13 - ELECTRICAL PROVISIONS OF PLUMBING WORK

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Electrical provisions to be provided as plumbing work are indicated in other Division 22 sections, on drawings, and as specified.

B. Types of work, normally recognized as electrical but provided as plumbing, specified or partially specified in this Section, include but are not necessarily limited to the following:
1. Motors for plumbing equipment.
2. Starters for motors of plumbing equipment, but only where specifically indicated to be furnished integrally with equipment.
3. Wiring from motors to disconnect switches or junction boxes for motors of plumbing equipment, but only where specifically indicated to be furnished integrally with equipment.
4. Wiring of field-mounted float control switches, flow control switches, and similar plumbing-electrical devices provided for plumbing systems, to equipment control panels.
5. Pipe heat tracing.

C. Refer to Division 22 sections for specific individual plumbing equipment electrical requirements.

F. Refer to Division 26 sections for motor starters and controls not furnished integrally with plumbing equipment.

G. Refer to Division 26 sections for junction boxes and disconnect switches required for motors and other electrical units of plumbing equipment.

1.2 RELATED WORK

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Specification Sections, apply to work of this Section.

1.3 QUALITY ASSURANCE

A. Wherever possible, match elements of electrical provisions of plumbing work with similar elements of electrical work specified in Division 26 sections for electrical work not otherwise specified.

B. For electrical equipment and products, comply with applicable NEMA standards, and refer to NEMA standards for definitions of terminology. Comply with National Electrical Code (NFPA 70) for workmanship and installation requirements.

1.4 SUBMITTALS

A. Include in listing of motors, voltage, notation of whether motor starter is furnished or installed integrally with motor or equipment containing motors.

PART 2 - PRODUCTS

2.1 MOTORS

A. Provide motors for plumbing equipment manufactured by one of the following:

1. Baldor Electric Company.
2. Century Electric Div., Inc.
3. General Electric Co.
4. Louis Allis Div.; Litton Industrial Products, Inc.
5. Lincoln Electric
6. Marathon Electric Mfg. Corp.
7. Reliance Electric Co.
8. Westinghouse Electric Corp.

B. Motor Characteristics. Except where more stringent requirements are indicated, and except where required items of plumbing equipment cannot be obtained with fully complying motors, comply with the following requirements for motors of plumbing work:

C. Temperature Rating. Rated for 40 deg. C environment with maximum 50 deg. C temperature rise for continuous duty at full load (Class A Insulation).

D. Provide each motor capable of making starts as frequently as indicated by automatic control system, and not less than 5 starts per hour for manually controlled motors.

E. Phases and Current Characteristics. Provide squirrel-cage induction polyphase motors for ¾ hp and larger, and provide capacitor-start single-phase motors for ½ hp and smaller, except 1/6 hp and smaller may, at equipment manufacturer's option, be split-phase type. Coordinate current characteristics with power specified in Division 26 sections, and with individual equipment requirements specified in other Division 22 requirements. For 2-speed motors provide two separate windings on polyphase motors. Do not purchase motors until power characteristics available at locations of motors have been confirmed, and until rotation directions have been confirmed.

F. Service Factor. 1.15 for polyphase motors and 1.35 for single-phase motors.

G. Motor Construction. Provide general purpose, continuous duty motors, Design "B" except "C" where required for high starting torque.
1. Frames. NEMA #56.
2. Bearings are to be ball or roller bearings with inner and outer shaft seals, regreasable except permanently sealed where motor is inaccessible for regular maintenance. Where belt drives and other drives produce lateral or axial thrust in motor, provide bearings designed to resist thrust loading. Refer to individual section of Division 22 for fractional-hp light-duty motors where sleeve-type bearings are permitted.
3. Except as indicated, provide open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation, and provide guarded drip-proof motors where exposed to contact by employees or building occupants. Provide weather-protected Type I for outdoor use, Type II where not housed. Refer to individual sections of Division 22 for other enclosure requirements.
4. Provide built-in thermal overload protection and, where indicated, provide internal sensing device suitable for signaling and stopping motor at starter.
5. Noise Rating: Provide "Quiet" rating on motors.

H. All motors shall be premium efficiency.

2.2 EQUIPMENT FABRICATION

A. Fabricate plumbing equipment for secure mounting of motors and other electrical items included in work. Provide either permanent alignment of motors with equipment, or adjustable mountings as applicable for belt drives, gear drives, special couplings and similar indirect coupling of equipment. Provide safe, secure, durable, and removable

guards for motor drives. Arrange for lubrication and similar running-maintenance without removal of guards.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install motors on motor mounting systems in accordance with motor manufacturer's instructions, anchored to resist torque, drive thrusts, and other external forces inherent in plumbing work. Secure sheaves and other drive units to motor shafts with keys and Allen set screws on flat surface of shaft. Unless otherwise indicated, set motor shafts parallel with machine shafts.

B. Verify voltage with Electrical Plans.

END OF SECTION

SECTION 22 05 14 - PLUMBING ALTERATIONS PROJECT PROCEDURES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Inspect and service existing equipment and materials that are to remain or to be reused.

B. Disposal of equipment, materials, or housekeeping pads to be abandoned. Prior to disposal, the Contractor shall verify with the Owner what is to be salvaged by the Owner and what is to become the property of the Contractor.

C. Handling of equipment and materials to be removed.

1.2 QUALITY ASSURANCE

A. Coordination with the Owner prior to the disconnection or shutdown of existing equipment, or to the modification of existing operational systems.

1.3 CONTRACT DRAWINGS

A. There is the possibility that existing conditions and devices are affected by the work indicated on the drawings and called for in the specifications (project manual) that do not appear on the drawings. It is the Contractor’s responsibility to visit the site and determine all of the existing conditions and to consider these existing conditions when making and presenting a proposal, to have a complete proposal.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Material used to upgrade and repair existing equipment shall conform to that specified.

B. Material used to upgrade and repair existing equipment shall not void existing warranties or listings of the equipment to be upgraded or repaired.

C. Material used to upgrade and repair existing equipment shall be new and shall be of the same manufacturer of the existing equipment, shall be acquired through the existing original equipment manufacturer’s approved distribution channels, shall have manufacturer’s warranties for the new material being used, and shall be listed for the use intended.

PART 3 - EXECUTION

3.1 INSPECTION

A. Existing materials and equipment indicated on the drawings or in the specifications to be reused shall be inspected for damaged or missing parts. Contractor shall notify the Architect/Engineer, in writing, accordingly.

B. If using materials specified or shown on the drawing voids or diminishes the warranty or operation of remaining equipment or systems, the Contractor shall notify the Architect/Engineer, in writing.

C. Verify field measurements, above and underground piping connections and flows.

D. Demolition Drawings are based on casual field observation, and when available, existing record documents. Report discrepancies to Architect before disturbing existing installation, and immediately after such discrepancies are discovered.

E. Field verify existing conditions and actual utility uses prior to final connections. Existing drawings may not have been available for all required information. Use pipe inspection camera system to field verify existing sanitary / grease waste connections. Verify flow direction and depth prior to connection to existing plumbing systems.

3.2 APPLICATION

A. Existing materials and equipment indicated on the drawings or in the specifications to be reused shall be cleaned and reconditioned, including cleaning of piping systems prior to installation and reuse.

B. Material and equipment removed that is not to be salvaged for Owner's use or for reuse on the project shall become the property of the Contractor and be removed from the site.

C. Material or equipment salvaged for Owner's use shall be carefully handled and stored where directed by the Owner or the Architect / Engineer. Relocate material and / or equipment as directed by Owner.

D. Materials and equipment not indicated to be removed or abandoned shall be reconnected to the new system.

E. Materials, equipment and housekeeping pads not to be reused or reconnected shall be removed for Owner’s review and salvaged by Contractor.

F. Prior to start of construction, Contractor shall walk areas to be renovated with Owner to identify and document items to be salvaged for Owner’s use.

G. Clean and repair existing materials and equipment that remain or are to be reused.

H. Contractor shall utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

3.3 SEQUENCE AND SCHEDULE

A. Coordinate utility service outages with Utility Company, Architect and Owner.

B. Provide additional or temporary valves, piping and connections to maintain existing systems in service during construction.

C. Existing Plumbing Service: Refer to drawings for work in remodeled areas. Where facilities in these areas are to remain in service, any related work to keep the facilities in operation is specified in this Division. Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from Owner at least 48 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area. Maintain acceptable temperature and humidity control within existing building during renovation activities.

D. Remove and replace existing Plumbing systems and appurtenances as occasioned by new or remodeled construction. Re-establish service that may be interrupted by remodeled construction.

E. Refer to other drawings series for work in remodeled areas. Where facilities in these areas are required to remain in service, any related work required to keep these facilities in operation is specified in this Division.

F. Remove and replace existing piping coincident with the construction.

G. Remove or relocate existing piping or housekeeping pads as occasioned by new or remodeled construction. Cap unused domestic piping beyond the new finish line.

H. Relocate all domestic piping as required to accommodate new work requiring precedence.

I. Remove concrete housekeeping pad where materials or equipment have been removed.

J. Remove all known utilities that do not provide service to the buildings that remain.

K. Remove existing plumbing vent penetrations through roof not to be reused.

3.4 DEMOLITION AND EXTENSION OF EXISTING PLUMBING WORK

A. The Contractor shall modify, remove, and/or relocate all materials and items so indicated on the drawings or required by the installation of new facilities. All removals and/or dismantling shall be conducted in a manner as to produce maximum salvage. Salvage materials shall remain the property of the Owner, and shall be delivered to such destination as directed by the Owner's representative unless they are not wanted, then it will be the responsibility of this Contractor to remove such items and properly dispose of them. Materials and/or items scheduled for relocation and which are damaged during dismantling or reassembly operations shall be repaired and restored to good operative condition. The Contractor may, at his discretion, and upon approval of the Owner's representative substitute new materials and/or items of like design and quality in lieu of materials and/or items to be relocated.

B. All items to be relocated shall be carefully removed in reverse to original assembly or placement and protected until relocated. The Contractor shall clean, repair, and provide all new materials, fittings, and appurtenances required to complete the relocations and to restore them to good operative order. All relocations shall be performed by workmen skilled in the work and in accordance with standard practice of the trades involved.

C. When items scheduled for relocation and/or reuse are found to be in damaged condition before work has been started on dismantling, the Contractor shall call the attention of the Owner's representative to such items and receive further instructions before removal. Items damaged in repositioning operations are the contractor's responsibility and shall be repaired or replaced by the contractor as approved by the owner's representative, at no additional cost to the Owner.

D. Plumbing, piping and appurtenances to be removed, salvaged, or relocated shall be removed to points indicated on the drawings, specified, or acceptable to the Owner's representative. Piping not scheduled for reuse shall be removed to the points at which reuse is to be continued or service is to remain. Such services shall be sealed, capped, or otherwise tied-off or disconnected in a safe manner acceptable to the Construction Inspector. All disconnections or connections into the existing facilities shall be done in such a manner as to result in minimum interruption of services to adjacent occupied areas. Services to existing areas or facilities that must remain in operation during the construction period shall not be interrupted without prior specific approval of the Owner's representative hereinbefore specified.

E. Repair adjacent construction and finishes damaged during demolition and extension work.

F. Maintain access to mechanical installations that remain active. Modify installation or provide access panel as appropriate.

G. Extend existing installations using materials and methods compatible with existing plumbing installations, or as specified.

H. Existing plumbing piping and devices found to need additional hangers installed should be added at no additional cost to the Owner.

3.5 PROTECTION OF THE WORK

A. Provide adequate temporary support and auxiliary structure as necessary to ensure structural value or integrity of affected portion of work.

B. Provide devices and methods to protect other portions of work from damage.

C. Execute fitting and adjustment of products to provide a finished installation to comply with specified products, functions, tolerances and finishes.

3.6 IDENTIFICATION OF EQUIPMENT IN RENOVATED AREAS

A. Identification of Equipment: Provide new identification of all existing equipment to be reused and located within the renovated areas. Do not include the description “existing”. Provide new nameplates for all existing plumbing equipment in renovated areas as specified in Section 22 05 00 Plumbing General Provisions.

END OF SECTION

SECTION 22 05 15 - PLUMBING EARTHWORK

PART 1 - GENERAL

A. Excavate and backfill for pipe trenches for underground piping and excavate for structures installed as part of plumbing work.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 EXCAVATION

A. Excavate trenches for underground piping to the required depth to ensure 2 foot minimum coverage over piping.

B. Cut the bottom of the trench or excavation to uniform grade.

C. Should rock be encountered, excavate 6 inches below grade, fill with bedding material and tamp well.

D. Lay out alignment of pipe trenches to avoid obstructions. Assure that proposed route of pipe will not interfere with building foundation before any cutting is begun. Should interference be found, contact the Architect/Engineer before proceeding.

3.2 BACKFILL

A. Backfill shall not be placed until the work has been inspected, tested and approved. Complete backfill to the surface of natural ground or to the lines and grades shown on drawings. Except where special materials are requested, use suitable friable soils from other excavation as backfill material. Do not use peat, silt, muck, debris or other organic materials. Deposit backfill in uniform layers and compact each layer as specified in Division 2.

B. Compacting Backfill. Place material in uniform layers of prescribed maximum thickness and wet or dry the material to optimum moisture content. Compact with power-driven tampers to the prescribed density. Place regular backfill in 8 inch maximum layers, loose measure. Compact to not less than 95 percent of maximum soil density as determined by ASTM D-698 Standard Proctor.

C. Restoration. Compact backfill, where trenching or excavation is required in improved areas such as pavements, walks, and similar areas, to a condition equal to the adjacent undisturbed earth, and restore surface of the area to the condition existing prior to trenching or excavating operation.

D. Provide 6 inch stabilized sand bed with 4 inch stabilized sand cover around each pipe.

3.3 DISPOSAL OF EXCESS MATERIAL

A. Remove excess excavation material or material unsuitable for backfill. Excess material can be spread on grade, or shall be removed from site as directed by the Owner/Architect.

END OF SECTION

SECTION 22 05 16 - EXCAVATING, BACKFILLING AND COMPACTING FOR UTILITIES OUTSIDE BUILDING SLAB

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 apply to this section.

B. Refer to Instructions to Bidders for substitution of materials and products.

C. Addenda issued during the bidding period that affect this section of the specifications.

1.2 WORK INCLUDED

A. Coordinating all excavating and backfilling for the underground storm sewer, sanitary sewer, water distribution lines, and all related appurtenances.

B. The extent of lines, excavation, and backfill shall be in conformance with the locations, lines, elevations and grades shown on the drawings prepared by the MEP Engineer.

1.3 RELATED WORK SPECIFIED IN OTHER SECTIONS

A. Earthwork

B. Water Distribution

C. Sanitary Sewer

D. Plumbing

1.4 REFERENCES

A. American Society for Testing and Materials (ASTM) Use current edition.
   1. ASTM D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3)
   2. ASTM D1556, Standard Test method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
   3. ASTM D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
   4. ASTM D4254, Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density

B. City Standards

C. Local Governing Agencies

D. Texas Health and Safety Code, Chapter 161, Subchapter Q, as amended by House Bill No. 1927.

1.5 WARRANTY

A. Provide written warranty against defects in the material and workmanship for the work of this Section for a period of one year from the Date of Substantial Completion of the Project. Refer to Division 1 for Warranty form.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Cement-Stabilized Sand: Clean, local sand mixed with not less than 1-1/2 sacks of Portland cement per ton; mix in a mill-type mixer.

B. Sand: Clean, local sand

C. Earth Backfill: Clean local material consistent with the surrounding earth material and free of large clods, roots, rocks or other debris.

PART 3 – EXECUTION

3.1 EXCAVATION

A. General:
1. All utility trenches shall be constructed in conformance with OSHA trench safety standards.
2. Sheeting and shoring shall be accomplished to the extent necessary to maintain the sides of the trench in a vertical position throughout the construction period for trenches five feet in depth or deeper. Where approved, trench sides may be laid back in lieu of shoring to meet OSHA safety standards.
3. Utilities shall not be constructed or laid in a trench in the presence of water. All water shall be sufficiently removed from the trench prior to the line placing operation to ensure a dry, firm bed on which to place the utility line.

B. Sanitary Sewer Trenches:
1. For pipe sizes less than 42 inches in diameter, the minimum trench width shall be outside diameter of pipe plus 18 inches.
2. Trenches shall be excavated to a depth of at least 6 inches below the barrel of pipe.

C. Appurtenances:
1. Any overdepth excavation below appurtenances shall be refilled with cement-stabilized sand.

D. Water Line Trenches:
1. Water lines shall be at least two feet in depth from the top of proposed grade to the top of pipe.
2. Trench width for water lines shall be a minimum of the outside pipe diameter plus 18 inches.
3. Trenches shall be excavated to a depth of at least 6 inches below the barrel of pipe.

3.2 PIPE BEDDING AND BACKFILL

A. Sanitary Sewer Trenches:
1. The cement-stabilized sand bedding shall not extend from a point 6 inches below the bottom of the pipe to the level of the spring line. This material shall not be used after it loses its moisture content.
2. The cement-stabilized sand shall be thoroughly rodded after being placed in the trench.
3. Bedding, sewer pipe, and initial backfill over the pipe must be placed in a single day for any given portion of pipe. Initial backfill shall be placed to one foot above

the top of pipe for earth backfill and 6 inches over the top of pipe for cement-stabilized sand backfill.

4. Remainder of trench backfill shall be placed the next day or later in 8 inch lifts.
5. Backfill shall be placed in uniform layers not to exceed 8 inches loose depth, and compacted to a minimum of 95 percent of Standard Maximum Density (ASTM D698).
6. Backfill, under pavement and to one foot from outer edge, shall b e cement-stabilized sand, up to one foot below subgrade elevation. Remainder of backfill to subgrade to be as specified in paragraph 5 above and stabilized where required.

B. Water Line Trenches:
   1. Pipe bedding shall consist of 6 inches of clean sand placed before the pipe is laid.
   2. After laying pipe and ensuring that the pipe is properly placed and supported by the sand bedding, clean sand backfill shall be placed to 6 inches above the top of pipe. The sand backfill shall be thoroughly rodded and tamped for compaction.
   3. For water lines to be beneath the building and pavement and to one foot from the outer edge of pavement, the remainder of the trench backfill shall be clean sand placed in 6 inch lifts and compacted to 95 percent Standard Proctor.
   4. For water lines not beneath the building and pavement or within one foot from the outer edge of pavement the remainder of the trench backfill shall be earth fill placed in uniform layers not to exceed 8 inch loose depth. Each lift shall be compacted to a minimum of 90 percent of Standard Density (ASTM D698) at the proper moisture content specified in the soils report for this project. All earth backfill shall be placed the next day or later after the pipe is laid.

C. Natural Gas Trenches:
   1. Natural gas lines shall not be installed under slabs on grade unless pipes are sleeved and vented as per Section 22 63 11.
   2. Natural gas lines shall not be installed in trenches with other utilities.

D. Utility Locators:
   1. Provide metallic locator over all underground utilities, including irrigation piping, plumbing, control wiring, conduit, data, etc. Locator tape shall be a maximum of 12 inches below grade and centered over the utility(s).

END OF SECTION

SECTION 22 05 23 - VALVES, STRAINERS AND VENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Plumbing Valves

B. Pipe strainers.

PART 2 - PRODUCTS

2.1 VALVES

A. Pressure Ratings:
1. Unless otherwise indicated, use valves suitable for 125 minimum psig working steam pressure (WSP) and 450 deg. F.
2. The pressure temperature rating of valves shall be not less than the design criteria applicable to components of the system.

B. Butterfly Valves
1. Butterfly valves shall conform to MSS-SP67.
2. Liners, inserts and discs shall be suitable for the intended service.
3. Valves shall have a full lug type body designed for installation between ANSI standard flanges and shall be rated at full working pressure with downstream flange removed.
4. All valves for domestic use must be lead free.

C. Balancing Valves
1. Provide balancing valves with:
   a. Corrosion resistant plug with resilient seal when required.
   b. O-ring stem seal.
   c. Permanently lubricated, corrosion resistant bearings.
2. Connections
   a. Through 2-inch pipe size use threaded connections.
   b. For valves 2-1/2-inch pipe size and larger shall be provided with 150 psig flange connections.
3. Provide each valve with:
   a. Memory stop.
   b. Plastic drip cap.
   c. 1/8-inch gauge tap.
4. All valves for domestic use must be lead free.

D. Ball Valves
1. Provide ball valves with:
   a. Blowout proof stem.
   b. Full size port, 316 stainless steel ball and stem.
   c. Cast bronze body.
   d. Threaded ends.
2. Seat, seals, thrust washers and packing shall be suitable for the intended service.
3. Service rating:
   a. 150 psi saturated steam.
   b. 600 psi WOG.
4. Provide with memory stop for balancing valves.
5. Where Viega ProPress fittings are used, Viega ProPress ball valves may be used.

6. All valves for domestic use must be lead free.

E. Valve Connections
1. Provide valves suitable to connect to adjoining piping as specified for pipe joints. Use pipe size valves. Sweated joints are not allowed.
2. Thread pipe sizes 2 inches and smaller.
3. Flange pipe sizes 2-1/2 inches and larger.
4. Use screw to solder adapters for copper tubing.
5. Use grooved body valves with mechanical grooved jointed piping.
6. Use press valves when using copper press systems.

F. Valve Operators
1. Provide suitable hand-wheels for gate, globe, angle or drain valves and inside hose bibbs.
2. When cocks and valves are furnished with square head stem:
   a. Provide one wrench for every ten cocks or valves sized 2 inches and smaller, minimum of two.
   b. Provide each cock or valve size 2-1/2 inches and larger with a wrench with setscrew.
3. Where butterfly valves are provided:
   a. Provide gear operators on valves 6 inches and larger.
   b. Where valves are located 7 feet or more above the finished floor in equipment room areas provide chain-operated sheaves. Extend chains to about 5 feet above floor and hook to clips, arrange to clear walking space.
   c. Lever lock handle with toothed plate for shut-off service and infinitely adjustable handle with lock and nut and memory stop for throttling service on valves 4 inches and smaller.

G. Acceptable Manufacturers (All listed must be lead free):
1. Apollo
2. Crane
3. Dezurik
4. Jenkins
5. Keystone
6. Kitz
7. Milwaukee Valve
8. Nibco
9. Stockham

H. Check Valves
1. Bronze body, 2 inches and smaller, bronze disc (Teflon disc for steam service), regrinding swing check, screw-in cap, threaded connection (Lead Free).
2. Iron body, 2-1/2 inches and larger, bronze trim, non-slam: stainless steel pins and springs, and bronze plate or bronze mounted, regrind-renew check, bronze seat ring and disc. Provide either wafer or threaded lug (Lead Free).
3. Acceptable Manufacturers (All listed must be lead free):
   a. Apollo
   b. Keystone
   c. Kitz
   d. Milwaukee
   e. Mission Duochek
   f. Nibco

I. Backflow Preventer (All valves for domestic use must be lead free):
1. BFP-1 (2 inches and smaller) bronze body, reduced pressure zone type with two

inline independent check valves with an intermediate relief valve, complete with two full port ball valve shut-offs and ball type test cocks. Bronze strainer on inlet. Provide air gap fitting with full size drain piped to nearest floor drain. Watts 909-QT-S-LF.

2. BFP-2 (2-1/2 inches and larger) stainless steel or FDA epoxy coated ductile iron reduced pressure zone type with two inline independent check valves with reverse relief valves, two non-rising stem resilient sealed gate valves, cast iron strainer on inlet. Provide air gap fitting piped full size to nearest floor drain. Apollo RP4ALF-YS or Watts 909-NRS-BB-S-LF.

J. Provide valves of same manufacturer throughout where possible.

K. Provide valves with manufacturer's name and manufacturing location, duty and pressure rating clearly marked on outside of body.

L. Where valves are installed in insulated piping, provide with extended neck so valve operator and stop plate clears the full thickness insulation.

M. Provide valve, seat, and trim materials suitable for the intended service.

N. Provide memory stops for all valves used for throttling service. Valves for throttling service shall be butterfly, plug, globe, or ball type.

2.2 PIPE SYSTEMS STRAINERS

A. Body:
1. Bronze "Y" pattern or basket as shown on the drawings.
2. Line size.
3. Threaded strainer blow down port.
4. ASTM A #126 Class B Cast Iron Body.

B. Construction:
1. 2-inch size and smaller with screw connections rated 400 psi WOG.
2. Over 2-inch size with flanged connections, rated 125 psi WOG.

C. Fabricate screens of Monel or type 304 stainless steel:
1. With 20 mesh woven wire in piping systems through 2 inches.
2. With 0.045 perforations in piping systems 2-1/2 inches and 3 inches.
3. With 0.125 perforations in piping systems 4 inches and larger.

D. Start-up:
1. Provide an additional fine mesh disposable screen for use during start-up operations.
2. Remove after 30 days.
3. Attach to piping for Owner’s review.

E. Acceptable Manufacturers (All listed must be lead free):
1. Apollo
2. Crane
3. Keckley
4. Kitz
5. Mueller
6. McAlear
7. Muesco
8. Nibco
9. Zurn

2.3 VALVE SCHEDULE

A. Domestic Service

1. Gas shut-off service: UL approved for natural gas service.
   a. Nibco Ball Valve, full port through 1 inch: T-585-70-UL
   b. Nibco Ball Valve conventional port 1-1/4 inch through 3 inches: T-580-70-UL
   c. Resun 2-1/2 inch and larger: 143 - 1-UL
   d. DeZurick 2-1/2 inch and larger: Series 425 or 435
   e. Locking Type: Rockford ¾ inch and 1-inch PNP-400
      Mueller 1-1/4 inch through 4 inches: Lub-O-seal
   f. Conbraco Ball Valve, full port through 4 inches: 64-100 Series
   h. Milwaukee Full Port ¼ inch-2 inch
   i. Milwaukee Standard Port 2-1/2 inch & 3 inches
   j. Kitz Full Port 2 inch =- #68
2. Cold and Hot water service (all listed must be Lead Free):
   a. Nibco Ball Valve full port through 2 inches: T-585-66-LF
   b. Nibco Ball Valve 2-1/2 inch and 3-inch conventional port: T-580-66-LF
   c. Nibco Butterfly Valve 4 inch and larger: LD-2000 EDPM Gaskets
   d. Watts Ball Valve 4 inch and larger: G-4000-FDA
   e. Viega ProPress Bronze Ball Valves (where Viega ProPress fittings are used)
   f. Kitz Full Port through 2 inch - #868M Lead Free
   h. Milwaukee Full Port ¼ inch-2 inch
   i. Milwaukee Standard Port 2-1/2 inch & 3 inches
   j. Apollo Ball Valve Full Port through 2-1/2-inch 77CALF
   k. Apollo Ball Valve Standard Port 3-inch 70LF
   l. Apollo Butterfly Valve 4 inch and Larger LD141
   m. Apollo Press Bronze Ball valves – 77 WLF
3. Check Valve (All listed must be Lead Free):
   a. Nibco Check Valve: T - 413 - Y -LF (Teflon Seats)
   b. Nibco Check Valve 2-1/2 inch and larger: F - 918 – Y -LF (Buna-N disc.)
   c. Nibco Check Valve 2-1/2 inch and larger: W - 920 -W-LF (Wafer)
   d. Kitz Y & Check: A-22T
   e. Kitz 2-1/2 inch and Larger #778 C.I.
   f. Kitz Wafer Check 2-1/2 inch and Larger #7032
   g. Milwaukee Valve – 509T
   h. Apollo Check Valve: 163TLF
   i. Apollo Check Valve 2-1/2 inch and larger: 910FLF
   j. Apollo Press Check Valve: 163TPR-LF
   k. Apollo Check Valve 2 inch and larger 910WE-LF (Wafer)

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install valves with stems upright or horizontal, not inverted.

B. Install valves for shut-off and isolating service at each piece of equipment, at vertical risers, and where shown on the drawings.

C. Use butterfly valves and ball valves in domestic hot water and domestic cold water systems interchangeable in place of gate and globe valves.

D. Use butterfly valves and ball valves in circulating water systems, for balancing duty.

E. Provide drain valves at main shut-off valves and low points of piping and apparatus so the systems can be entirely drained.
   1. 1 inch valve for pipes 6 inch and larger.
   2. 3/4-inch valve for pipes smaller than 6 inches.
   3. Terminate with pipe plug.
   4. Drain valves shall be ball valves.

F. Provide isolation valves in domestic water lines to isolate all equipment, restrooms, hose bibbs, and where shown on the drawings.

G. Where valves are installed in insulated pipe, valve operator shall have an insert so the lever or handle will not damage the insulation. Install handles so the lever or handles will not damage the insulation.

H. Provide clearance for installation of insulation and access to valves.

I. Provide access where valves are not exposed.

3.2 VALVE TAGS

A. Furnish valves with 1-1/2-inch diameter brass valve tags with stamped, black, or red-filled numbers. Service designations shall be 1/4-inch letters, and valve numbers shall be 2-inch letters. Engineer shall approve Service designations. Secure tags to valves by use of brass "S" hooks or brass chain. Secure chain to valve by use of copper or Monel meter seals. Valve tags are not required if the valve is located within 3 feet of the equipment being served and the service is obvious.

B. Mount charts and drawings listing functions of each valve and its location in a metal and glass frame. Place charts and drawings as directed; in addition, on the record drawings mark the symbols and furnish a valve schedule properly identifying the valve number, service, exact location, the material being piped, and the room number of area that the valve services. This schedule shall be furnished on reproducible drafting paper or film suitable for reproduction on an Ozalid machine. The Owner shall approve the size of drafting paper. Provide a copy of the valve chart in the Operating and Maintenance Manuals.

3.3 PIPE SYSTEMS STRAINERS

A. Provide strainers in supply piping to circulating pumps, thermostatic mixing valves, before solenoid valves and trap primer valves.

END OF SECTION

SECTION 22 07 19 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install piping insulation, jackets, accessories and covering of specified materials. The insulation shall be used for high and low temperature piping applications including domestic hot and cold water, roof and overflow drain sump bodies and rain leaders, horizontal sanitary drain piping which receives condensate, make-up water and pool heating water.

1.2 QUALITY ASSURANCE

A. The intent of insulation specifications is to obtain superior quality workmanship resulting in an installation that is absolutely satisfactory in both function and appearance. Provide insulation in accordance with the specifications for each type of service and apply as recommended by the manufacturer and as specified.

B. An approved contractor for this work under this Division shall be:
   1. A specialist in this field and have the personnel, experience, training, skill, and the organization to provide a practical working system.
   2. Able to furnish evidence of having contracted for and installed not less than 3 systems of comparable size and type that have served their owners satisfactorily for not less than 3 years.

C. All piping insulation used on the project inside the building must have a flame spread rating not exceeding 25 and a smoke developed rating not exceeding 50, as determined by test procedures ASTM E 84, NFPA 255 and UL 723. These ratings must be as tested on the composite of insulation, jacket or facing, and adhesive. Components such as adhesives, mastics and cements must meet the same individual ratings as the minimum requirements and bear the UL label.

D. Condensation on any insulated piping system is not acceptable.

E. Replace insulation damaged by either moisture or other means. Insulation that has been wet, whether dried or not, is considered damaged. Make repairs where condensation is caused by improper installation of insulation. Also repair any damage caused by the condensation.

F. Where existing insulated piping, or other surfaces are tapped, remove existing insulation back to undamaged sections for hot surfaces or to nearest insulation stop for cold surfaces, and replace with new insulation of the same type and thickness as existing insulation. Apply as specified for insulation of the same service.

1.3 APPROVALS

A. Submit product data on each insulation type, adhesive, and finish to be used in the work. Make the submittal as specified in Division 1 General Requirements and obtain approval before beginning installation. Include product description, list of materials and thickness for each service and location and the manufacturer's installation instructions for each product.

B. Make a field application of each type of insulation to display the material, quality and application method. Obtain approval of the sample application before proceeding with installation of the work.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Glass fiber pipe insulation:
   1. Johns-Manville Micro-Lok AP-T
   2. Owens-Corning ASJ/SSL
   3. Knauf ASJ/SSL

B. Cellular Glass Insulation (Foamglass):
   1. Pittsburg Corning
   2. Cell-U-Foam

C. Aluminum Jacketing:
   1. Childers
   2. Pabco
   3. RPR

D. Fiberglass reinforcing cloth mesh:
   1. Perma Glass Mesh
   2. Alpha Glass Mesh
   3. Childers Chil-Glas
   4. Vimasco

E. Mastics and Adhesives
   1. Childers
   2. Foster
   3. Vimasco
   4. Armstrong 520 Adhesive

F. Elastomeric Insulation
   1. Armacell

G. Weather Resistant Coating
   1. WB Armaflex Finish

H. Glass fiber blanket insulation
   1. Manville R-series Microlite FSKL
   2. Owens-Corning eD75 or ED100 RKF
   3. Knauf 0.75 PCF FSK

2.2 FIBERGLASS PIPE INSULATION

A. Heavy density, dual temperature fiberglass insulation with factory applied, all service, reinforced vapor barrier jacket having integral laminated vapor barrier. Provide with a factory applied pressure sensitive tape closure system and matching butt strips. Supply in thickness as shown.
   1. Thermal conductivity 0.23 @ 75°F mean (ASTM 335).

2.3 ELASTOMERIC INSULATION

A. Insulation material shall be flexible, closed-cell elastomeric insulation in tubular or sheet form. Material shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less when tested in accordance with ASTM E84, latest revision. Sheet material with a thickness greater than ¾" shall have a flame spread rating of 25 or less

and a smoke developed rating of 100 or less when tested in accordance with ASTM E84, latest revision. In addition, the product, when tested, shall not melt or drip flaming particles, and the flame shall not be progressive. In addition, all materials shall pass simulated end-use fire test. Minimum ¾" thick.

1. Thermal conductivity 0.27 at 75°F mean (ASTM C177 or C518)

2.4 CELLULAR GLASS INSULATION

A. ASTM C552:
   1. "k" value of 0.35 @ 75°F ("ksi" value of 0.047 @ 24°C);
   2. 8.0 lb./cu.ft. (128 kg/cu.m.) density

2.5 INSULATION/SHIELD AT HANGERS

A. Field fabricated: Use 360° sections of rigid foamglass insulation that will support the bearing area at hangers and supports. Further support insulation at hangers and supports with a shield of galvanized metal covering at least half of the pipe circumference, and conforming to the schedule. Insulation shall extend at least 1" beyond metal shield on each end. When pipe is guided at top and bottom, metal shields shall cover the whole pipe circumference. Adhere metal shield to insulation so that metal will not slide with respect to insulation with ½" aluminum bands (2) per shield.
   1. Sections of foam glass insulation may be used of the same outside diameter of the adjoining pipe insulation.
   2. Minimum thickness of foam glass insulation shall not be less than 1" thick.

B. Pipe saddles: Formed galvanized sheets at each support point for insulated pipe, shaped to fit pipe, and covering bottom half of pipe. Length at saddle shall be not less than twice the insulation outside diameter or more than 22". Provide 18 gauge through 4" pipe and 16-gauge 5" pipe and above.

2.6 SEALANT, ADHESIVE AND FINISH

A. Lap Adhesive. Provide Childers CP-82 adhesive.

B. Vapor Barrier Finish:
   1. Indoors: Provide as insulation coating Childers CP-35, white.
   2. Outdoors: Provide as insulation coating Childers Encacel X.
   3. Underground: Provide Childers CP-22/24 for fittings and areas. Pittwrap cannot be used.

C. Sealant. Provide Childers CP-76 vapor barrier sealant.

D. Lagging Adhesive. Provide Childers CP-50.

E. Other products of equal quality will be acceptable only upon approval.

2.7 ALUMINUM JACKETING

A. Finish insulated piping outdoors with a smooth prefabricated Z-lock aluminum jacket 0.016" thick with factory applied 1 mil polyethylene/40 lb and Fab strap. Kraft moisture barrier. Childers Lock-On or approved equal.

B. Valves, Fittings and Flanges. For finishing valves, fittings, flanges and similar installations, provide formed aluminum covers, 0.024" thick.

C. Straps and Seals. Provide ½" x 0.020 stainless steel strapping and seals for jackets and

covers according to manufacturer's recommendations.

2.8 GLASS FIBER BLANKET INSULATION

A. Minimum density of 1.0 PCF, 2” thick, installed R value to be 6.0 or better at 75°F mean, facing of 0.35 mil foil reinforced with glass yarn mesh and laminated to 40 lbs fire resistant kraft.

PART 3 - EXECUTION

3.1 INTERIOR PIPING

A. Cover all piping with glass fiber, heavy density, dual temperature pipe insulation with a vapor barrier jacket. Apply insulation to clean, dry pipes. Longitudinal seams shall be joined firmly together and sealed with self-sealing lap joints. Butt insulation joints firmly together and seal with a 3” wide ASJ butt strip seal. Longitudinal seams and butt strip laps shall be coated and sealed with CP-35 vapor barrier coating for chilled water piping applications.

B. Install hanger with protective shield, on the outside of all insulation.

C. Where domestic water pipes (1/2” & ¾” pipe sizes) are installed on trapeze type hangers, provide galvanized sheet metal protection shields at these locations. Place insulation jacket directly on hanger. Incompressible, load bearing insulation segments are not required.

D. Pipe Saddles: Formed galvanized sheets at each support point for insulated pipe, shaped to fit pipe, and covering bottom half of pipe. Length at saddle shall be not less than twice the insulation outside diameter. Provide 18-gauge through 4” pipe and 16-gauge for 5” pipe and above.

E. Seal ends of pipe for drinking chilled water insulation with vapor barrier mastic at valves, flanges, fittings and every 21' on straight runs of piping. Mastic should extend on top of ASJ jacket, across the glass, down onto the pipe making a complete seal.

F. Apply a smooth flood coat of white lagging Foster 8142W over all exposed insulation.

G. Piping to be insulated as specified above:
1. All hot and cold water.
2. Make-up water
3. Horizontal sanitary drain piping that receives condensate
4. Exposed to view storm drainage system including roof and overflow drain bodies, vertical piping from drain body and all horizontal rain leaders to first elbow turning down

3.2 PIPING OUTDOORS ABOVE GRADE

A. Insulate all water piping exterior of building above grade with rigid foam insulation and aluminum jacketing.

B. Adhere the vapor barrier jacket longitudinal seam with vapor barrier adhesive.

C. Cover all valves, fittings and flanges with factory made molded or field fabricated segments of pipe insulation of a thickness and material equal to the adjoining insulation. Adhere segments together with no voids, using CP-82 adhesive. Secure fitting insulation covers and segments in place with ½” wide glass filament tape.

D. Apply a tack coat of fitting mastic over the insulation and tape.

E. Neatly embed with 10 x 10 fiberglass cloth into the tack coat.

F. Apply mastic over the fiberglass cloth to a thickness where the fabric is not visible after completion.

G. Seal ends of pipe insulation with vapor barrier mastic at valves, flanges, fittings and every 21' on straight runs of piping. Mastic should extend on top of ASJ jacket, across the foam, down onto the pipe, making a complete seal.

H. Finish with aluminum jacketing as specified.

3.3 FLANGE, VALVE AND FITTING INSULATION

A. Cover valves and flanges with fabricated segments, fittings with two-piece factory molded fittings, and both of matching pipe insulation type and thickness equal to that of the adjoining pipe. Fittings and fabricated segments shall be securely held in place.
   1. Apply a tack coat of insulating mastic to the insulated fitting to produce a smooth surface.
   2. After mastic is dry, apply a second coat of vapor barrier mastic. Neatly embed with 10 x 10 fiberglass cloth into the tack coat.
   3. Overlap mastic and fiberglass cloth by 2” on adjoining sections of pipe insulation.
   4. Apply a second coat of mastic over the fiberglass cloth to present a smooth surface.
   5. Apply mastic to a wet film thickness of 3/64”.
   6. Fabric shall not be visible after completion.
   7. Vapor seal flanges, valves and fittings with Childers CP-35.

B. PVC fitting covers are not acceptable.

3.4 ALUMINUM JACKETING (Insulated Piping Outdoors Above Grade)

A. Apply smooth aluminum jacket on piping, valves, fittings and flange covers according to manufacturer's recommendations, using stainless steel strapping and seals, to provide weather tight covering and to shed water.

B. Aluminum jacketing is not considered as contributing to the vapor barrier or the insulation jacket. The vapor barrier must be sufficient in itself for this function. Lap each adjoining jacket section a minimum of 3” to make a weather tight seal.

C. Install straps on 9” centers and at each circumferential lap joint.

D. Cover and seal all exposed surfaces.

E. The use of screws and rivets is not approved.

F. Provide isolation (30# felt) between the aluminum jacket and the sheetmetal protection shield at each pipe support point.

3.5 MISCELLANEOUS

A. Install materials after piping has been tested and approved.

B. Apply insulation on clean, dry surfaces only.

C. Apply weather protective finish on elastomeric insulation installed in non-conditioned spaces. Provide a minimum of three coats.

3.7 INSULATION THICKNESS

INSULATED UNIT	THICKNESS (Inches)
Domestic Cold Water/Make-Up Water Piping/Drinking Chilled Water	1
Horizontal Sanitary Drain Piping Which Receives Condensate	1
Domestic Hot Water Piping, 1-1/2” Pipe and Smaller	1
Domestic Hot Water Piping, 2” Pipe and Larger	1-1/2

END OF SECTION

SECTION 22 08 00 - PLUMBING COMMISSIONING COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section outlines commissioning requirements and activities of Contractor, Owner, CxA and Design Professionals as related to the Division 22 Plumbing.

B. Related Sections:
1. Division 01 – General Requirements and Specification Section 01 91 13, General Commissioning
2. Division 22 – Plumbing
3. Division 23 – Mechanical
4. Division 26 – Electrical

1.2 DEFINITIONS

A. Refer to Specification Section 01 91 13, General Commissioning for definitions.

1.3 CONTACT INFORMATION

A. The Owner will contract directly for commissioning services.
1. Commissioning Agent fee will be paid for directly by the owner.
2. Cost of contractor coordination with the CxA is specified in this section.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Contractor shall provide all standard and specialized testing equipment required to perform Start-up and Functional Performance Testing. Test equipment required for Functional Performance Testing is listed below. Data logging equipment and software required to test equipment shall be provided by the Contractor.

B. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 1.0ºF and a resolution of + or - 0.2ºF). Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year. All equipment shall be calibrated according to the manufacturer's recommended intervals and following any repairs to the equipment. Calibration tags shall be affixed or certificates readily available.

2.2 OTHER CONTRACTOR PROVIDED EQUIPMENT:

A. Ladders and/or lifts and appropriate fall protection as required by Contractor site requirements.

PART 3 - EXECUTION

3.1 COORDINATION - GENERAL

A. Except for the activities to be performed by the CxA called for herein, all component and system installation work required by the Division 22, 23 and 26 specifications including

specific contractor furnished items indicated by this Section shall be provided by the Contractor.

3.2 SUBMITTALS

A. Plumbing
1. Plumbing Equipment.

3.3 EQUIPMENT START-UP

A. Notification
1. Contractor shall provide ten Owner business days' notice to CxA, Owner and Design Team of start-up dates.

B. Prior to start-up, contractor shall:
1. Verify that equipment and systems are complete, accessible, correctly connected to utilities and ready for operation. Perform all pre-start inspections and tests as called for in Division 22.
2. Comply with pre-start requirements of manufacturer and complete applicable documentation.
3. Complete applicable sections of Pre-functional Checklists.
4. Coordinate start-up attendance by manufacturer or authorized representative as required by specifications or manufacturer.

C. At start-up, contractor shall:
1. Supervise the activities of the authorized start-up technician or manufacturer's representative.
2. Verify proper voltage, phase, drive rotation and any other conditions that may cause damage if not correct.
3. Execute start-up under supervision of qualified contractor and equipment manufacturer personnel and in accordance with the manufacturer's instruction.
4. Complete manufacturer start-up requirements and documentation. Provide a copy of documentation to the CxA for inclusion in the Cx Manual.
5. Complete PFC's and provide documentation to CxA.
6. Provide documentation of any issues noted during start-up to CxA, Owner and Design Team. Outline recommendations for corrective action.

3.4 PRE-FUNCTIONAL CHECKLISTS

A. Contractor shall forward completed copies of PFC's to the CxA for inclusion into the Cx documentation. PFC's will be provided by the CxA. As an alternate, contractor shall submit their versions of the PFC's to the CxA for review and comment.

B. Contractor shall complete PFC for each of the following equipment:
1. Plumbing:
a. Domestic Hot Water Heater/Converter
b. Recirculation Pump
c. Mixing Valve

3.5 FUNCTIONAL TESTING

A. General
1. Contractor shall organize and schedule Construction Team members to execute the functional testing, which will be directed by CxA.

B. Recirculation Pump
   1. Graphics
   2. Start/Stop/Schedule
   3. Pump Operation (On/Off/Hand/Auto)
   4. Temperature Sensor Calibration

C. Domestic Water Heater
   1. Graphics
   2. Start/Stop Schedule
   3. Discharge Temperature

END OF SECTION

SECTION 22 11 16 - DOMESTIC WATER PIPING AND APPURTENANCES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install domestic hot and cold water piping.

1.2 RELATED WORK

A. Division 22 Plumbing
   1. Valves, Strainers and Vents
   2. Pipe and Pipe Fittings - General
   3. Plumbing Piping Insulation
   4. Plumbing Fixtures and Fixture Carriers

PART 2 - PRODUCTS

2.1 PIPING AND FITTINGS

A. Below Slab on Grade Piping for Water Entries:
   1. 2-inch and smaller, provide ASTM B88 Type K (heavy wall) annealed tempered (soft) seamless copper water tube. No joints below slab entries.
   2. 2-1/2-inch and 3-inch, provide ASTM B88 Type K (heavy wall) annealed tempered (soft) seamless copper water tube, 20 ft. straight lengths. One joint allowed below slab entry using wrought copper, solder-joint pressure fittings: ASME B16.22 with an approved brazing filler metal or pipe can be shop bent for no joint installation by using a “bending” temper tubing.
   3. 4-inch and larger, provide ductile iron pipe with mechanical joints, ANSI A21.6.

B. Below Grade Piping Outside Building (beyond 5’-0” of building): Provide PVC water main pipe 4 inch through 12 inch in diameter in conformance with AWWA C900. When using 3” or smaller provide Schedule 40 PVC ASTM D1785 with ASTM D-2466 socket type fittings. Provide fittings in conformance with ASTM 2466. Furnish pipe with a minimum pressure rating of 150 lbs. per square inch. Provide PVC pipe as manufactured by Johns-Manville, CertainTeed, Clow or approved equal.

C. Below Slab on Grade Piping. Furnish ASTM B 88 and ANSI/NSF Standard 61 annealed tempered (soft), Type K copper water tube. Run continuous with no joints under the floor slab. Provide copper pipe corrosion protection as specified in this Section.

D. Above Slab Piping. Provide seamless ASTM B 88 and ANSI/NSF Standard 61 drawn tempered (hard) Type L copper water tube with wrought copper or bronze fittings with solder-joints, ANSI B16.22. Solder material shall be 95-5 (lead free) (Tin-Antimony-Grade 95TA) ASTM B 32.

E. Unions. Provide 150 lb. standard unions with ground joint and bronze seat. Flange joints larger than 2 inches. Provide dielectric isolating unions at junctions or connection between metallic piping of dissimilar metal. Provide pipe threads with standard taper pipe threads ANSI B2.1.

2.2 WATER HAMMER ARRESTORS

A. Provide piston type hydraulic engineered/manufactured water hammer arrestors in cold and hot water supply lines in chases or walls to each fixture branch or battery of fixtures serving quick closing valves of electrical, pneumatic, spring loaded type, or quick hand

closure valves on fixture trim. Provide water hammer arrestors at the end of the branch line between the last two fixtures served. Provide Precision Plumbing Products, Inc., or equal. Size units according to water hammer arrestor's Standard PDI WH-201; refer to schedule on drawings.

B. Install all water hammer arrestors so as to attain 100% effectiveness according to Plumbing and Drainage Institute PDI-WH201 Table 5, 6 and 6-A for water hammer arrestors.

C. All water hammer arrestors shall be installed in a vertical position.

D. All water hammer arrestors shall be accessible and shall have access panels where required. Arrestors located above ceilings in fixture drops will not be acceptable. Refer to sizing and placement data as indicated in PDI Standard PDI-WH-201.

PART 3 - EXECUTION

3.1 DRAINAGE

A. Install water piping systems with uniform horizontal grade of 1/8 inch per 10 foot, minimum, to low points to provide complete system drainage. Where constant pitch cannot be maintained for long runs, establish intermediate low points and rise to new level. Grade branches to drain to mains or risers. Unless otherwise indicated, terminate low points of risers with drain valve piped to nearest hub or floor drain.

3.2 STERILIZATION

A. Sterilize the water system with solution containing not less than 50PPM available chlorine. Allow chlorinating solution to remain in system for period of 8 hours (minimum). Have valves and faucets opened and closed several times during the period. After sterilization, flush the solution from the system with clean water until residual chlorine content is less than 0.2 parts per million.

3.3 UNDERGROUND WATER PIPING SYSTEM PROCEDURES

A. Lay sewer and water lines in separate trenches, separated by 10 foot of undisturbed or compacted soil.

3.4 TESTING

A. Test under a cold water hydrostatic pressure of 1-1/2 times operating pressure (150 psig minimum) and carefully check for leaks. Repair leaks and retest system until proven watertight.

B. Test the domestic water piping system at 150psig hydrostatic pressure, maintained for 6 hours.

C. Use only potable water for the test.

D. Perform the test before fixtures, faucets, trim or final connections are made to equipment.

E. If the system is tested in sections, the entire domestic water piping system shall be submitted to a final test, employing the specified procedure.

F. Do not insulate or conceal piping systems until tests are satisfactorily complete.

G. If any leaks or other defects are observed, suspend the test and correct the condition at once. Repeat testing until leaks are eliminated and the full test period is achieved.

H. The satisfactory completion of testing does not relieve the Contractor of responsibility for ultimate proper and satisfactory operation of piping systems and their accessories.

3.5 COPPER PIPE CORROSION PROTECTION

A. Corrosion protect copper tube piping systems:
   1. In the building slab.
   2. Beneath the building slab.
   3. Buried.
   4. Route plasti-sleeve 0.006 thick material entire length of below slab on grade copper tubing.

B. Cover copper tubing piping system with:
   1. "Tapecoat" TC Primer.
   2. "Tapecoat" CT cold applied coating tape.

C. Install coating system as specified by the manufacturer.

D. Extend the corrosion protection 2 inches above concrete slab on grade.

3.6 TEST OF PIPE CORROSION PROTECTION SYSTEM

A. Test the pipe corrosion protection coating with an approved high voltage tester adjusted to provide sufficient voltage to produce a spark through a pinhole in the coating (at least 15 kv AC).

B. Make repairs to small holes in accordance with the manufacturer's instructions.

C. Retest the repairs using procedures listed above.

D. Furnish certificate of compliance with field testing in Owner's manual.

END OF SECTION

SECTION 22 11 19 - PIPING AND PIPING APPURTENANCES FOR COLD WATER MAKEUP

PART 1 - WORK INCLUDED

1.1 SCOPE

A. Furnish and install piping and piping appurtenances for cold water makeup piping.

1.2 RELATED WORK

A. Division 22 Plumbing
   1. Valves, Strainers and Vents
   2. Plumbing Pipe and Pipe Fittings
   3. Plumbing Piping Insulation

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Provide seamless, hard-drawn, Type L, copper water tube conforming to ASTM B88, and wrought copper fittings.

2.2 BACKFLOW PREVENTER

A. Watts Series 909 reduced pressure principal backflow preventer.

B. Factory assembled components as follows:
   1. Isolating, shutoff, full port ball valves.
   2. Incoming bronze strainer.
   3. Test cocks.
   4. Fixed air gap assembly.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install according to manufacturer's instructions.

3.2 BACKFLOW PREVENTERS

A. Provide backflow preventers at the following locations.
   1. HVAC Systems cold water make-up including chilled water, hot water and condenser water.
   2. Pumping systems including water utility service and water softening equipment.
   3. Where required by Code.

B. Installation according to manufacturer's recommendations.
   1. Connect drain with fixed air gap assembly.
      a. Pipe full size discharge from relief valve of RPZ to nearest floor drain or floor sink of proper size. Reference manufacturer’s suggested sizing of drains.
   2. Provide pipe unions on inlet, outlet and discharge connection of the assembly for complete removal.
   3. Provide isolation valve upstream of backflow assembly to allow complete removal of listed assembly.
   4. Install backflow preventer assembly horizontally in an accessible location for

testing and maintenance at a height not to exceed 60" above finished floor and no lower than 12" from finished floor to air gap outlet.

C. Provide certified testing of all backflow preventers.
   1. Include certificates in O&M Manuals.

END OF SECTION

SECTION 22 13 16 - SOIL, WASTE AND SANITARY DRAIN PIPING, VENT PIPING AND APPURTENANCES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install piping in buildings and underground laterals to 5 foot outside of building.

1.2 RELATED WORK

A. Site Work:
   1. Sanitary Sewers
   2. Excavation, Trenching and Backfilling for Utilities

B. Division 22 Plumbing:
   1. Pipe and Pipe Fittings
   2. Earthwork

1.3 REFERENCES

A. CISPI - Cast Iron Soil Pipe Institute

B. ASTM - American Society for Testing and Materials

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. All No-Hub clamps must have 4 bands minimum. Sizes 5” through 10” shall have six bands minimum.
   1. No-Hub Clamps – Sanitary Waste:
      a. Husky SD 4000
   2. No-Hub Clamps - Vents
      a. Husky SD – 2000
      b. Mission Rubber Co., LLC Heavy Weight Couplings
   3. Clamp-All Hi-TorQ 80 or approved equal

B. Provide Fernco “Pro-flex” shielded couplings Series 3000 with one piece neoprene gasket for all cast iron pipe transitions to Schedule 40 DWV pipe penetrations through slabs. Sizes 1-1/2” through 8” Series 3000.

C. Cast Iron Soil Pipe and Fittings:
   1. AB&I
   2. Charlotte Pipe and Foundry Co.
   3. Tyler Pipe / Soil Division

2.2 DRAIN PIPE AND FITTINGS

A. Above Slab Pipe:
   1. No-hub cast iron soil pipe and fittings shall conform to CISPI 301 and ASTM A888.
   2. Pipe shall conform to ASTM A74.
   3. No-hub couplings shall meet or exceed the latest specification standard CISPI 310 or ASTM C-1540 and conform to FM 1640. CISPI 310 Couplings shall be

listed by NSF International.
4. Rubber Gaskets for cast iron soil pipe and fittings shall conform to ASTM C564
5. All Cast Iron Soil Pipe and Fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute

B. Below Slab on Grade Piping:
1. Schedule 40 PVC plastic pipe and DWV fittings.
2. Solvent welded DWV joints shall conform to IAPMO Installation Standard IS-9.
3. Pipe and fittings shall conform to ASTM D 1784, ASTM D 1785, ASTM D 2665, ASTM D 3311 and NPS Standard 14 & 61.

2.3 VENT PIPE AND FITTINGS

A. Above Slab Pipe:
1. No-hub cast iron soil pipe and fittings shall conform to CISPI 301 and ASTM A888.
2. Pipe shall conform to ASTM A74.
3. No-hub couplings shall conform to CISPI 310 and shall be listed by NSF International
4. Rubber gaskets for cast iron soil pipe and fittings shall conform to ASTM C564

B. Below Slab on Grade Piping:
1. Provide Schedule 40 PVC with DWV fittings with solvent welded joints. Pipe and fittings shall conform to ASTM D1784-82.

C. Above Slab Pipe.
1. Drainage-waste-vent copper pipe and fittings for waste stub-outs for all fixture locations.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All above and below slab soil, waste, sanitary drain and vent piping installation methods shall be in accordance with Cast Iron Soil Pipe Institute Standards.

B. Above ground installation in the horizontal position shall be supported at every hub (hub & spigot or hubless type). Hangers are to be placed within 18” of hub or coupling. For large diameter fittings, 5 inches and larger shall be braced to prevent horizontal movement. Every branch opening or change of direction, braces, blocks, rodding or other suitable method shall be used to prevent movement. Riser clamps to be used for each floor, not to exceed 15’-0”.

C. All above and below slab PVC sanitary waste and vent piping installation methods shall be in accordance with IAPMO Installation Standard 18-9 for Schedule 40 PVC-DWV, per manufacturer’s recommendations and applicable standards.

D. Tracer wires shall be installed on all underground PVC sanitary sewer lines installed outside the building slab.

E. All PVC underground shall be installed in accordance with ASTM D2321.

3.2 GRADE

A. Give horizontal pipe grade of ¼-inch per foot where possible, but not less than 1/8 inch per foot unless otherwise shown.

3.3 DRAIN PIPE AND FITTINGS

A. Offsets and Fittings.
   1. Use reduction fittings to connect two pipes of different diameter.
   2. Change directions by appropriate use of 45-degree wyes, long-sweep quarter-bends, and sixth-, eights-, and sixteenth-bends. Sanitary tees can be used on vertical stacks. Use long sweeps at the base of risers.
   3. Provide a separate trap at each fixture, unless a trap is built into the fixture. Provide a deep seal trap at each floor drain and hub drain. Place traps so that the discharge from any fixture will pass through only one trap before reaching a building drain.
   4. Refer to Sanitary Drainage Code section for acceptable fittings to be used for changes in direction of drainage flow. Double combo sanitary fittings or double wye and 1/8th bend fittings are not allowed for horizontal to horizontal piping systems per Code.

B. Cleanouts. Install cleanouts the same size as the soil waste lines in which the cleanouts are placed; however, no cleanout should be larger than 4 inches in diameter.
   1. Where cleanouts occur in pipe chases, bring the cleanouts through the walls and install covers. Where cleanouts occur in floor slabs, set flush. Reference drawing schedule.
   2. Provide cleanouts where soil lines change direction, every 50 foot on long runs, or as shown on the drawings, at the end of each horizontal waste line, and at the base of each riser (and at each increase in pipe size).
   3. Cleanouts shall occur at the end of each battery of water closets, urinals, lavatories, sinks, and single water closets. Cleanouts shall be installed so as to access the main sanitary or soil line. Extend and offset above flood rim of water closet.
   4. Double sanitary tees and double quarter bends do not allow for easy access to main lines therefore these types of fittings are not allowed.

C. Floor Drains. Locate floor drains 1/2-inch below finish floor elevation unless otherwise shown.

3.4 VENT PIPING

A. Make vent connections to vent stacks with inverted wye fittings. Extend full-size vents through the roof to at least 6 inches above the roof.

B. Flash the roof penetration with 6 lb. lead flashing approximately 24 inches square. Flange the flashing to the lead sleeve. Extend the flashing up and around the vent pipe. Turn the flashing down inside the pipe at least 2 inches to make a watertight joint. Flashing shall comply with the roofing manufacturer's requirements. Reference the Architectural Drawings for exact requirements.

C. Locate vent piping through roof a minimum horizontal distance of not less than 20 feet from any air intake opening or supply fan.

3.5 TESTING

A. Below Slab on Grade and All Floors in Multi-Story Buildings:
   1. Test pipe below slab on grade before backfilling and connecting to city sewers.
   2. Maintain not less than 10 foot of hydrostatic head for1 hour without a leak.
   3. Before acceptance of the work the contractor must ensure the piping is in working order before and after the slab is poured. To ensure this the contractor must test

completed systems in the presence of the Architect, Engineer and authorities having jurisdiction after installation is complete.

4. Maintain the test on the system till after the slab is poured. Provide an accessible connection that may be reviewed by Architect, Engineer and authorities having jurisdiction prior to and after the slab is poured.
5. Test drainage piping systems in accordance with governing codes and the requirements specified. Provide equipment and materials and make test connections required to execute tests.
6. Test drainage and waste piping hydraulically by filling system to its highest point or, whichever is greater, at a static head of 10 feet. Leaks at any joint shall be sufficient cause for rejection.
7. Air tests may be substituted for hydraulic tests by forcing air into the closed system at a uniform pressure sufficient to balance a column of 10 inch hg in height.
8. Under any of the previously described tests, the water height shall remain constant, after stabilization, for not less than 15 minutes without any further addition of water.

B. System Test. After the various sections of soil, waste and vent piping are installed, but before fixtures are connected, test the system by:

1. Plugging outlets.
2. Filling vertical sections of multiple story buildings of not less than three floors at a time with water. Provide wyes as required to facilitate plugging.
3. Test for 6 hours without any drop in the water level.

3.6 RODDING SEWERS

A. All sanitary soil and waste lines, both in the building and out, shall be rodded out and flushed out after completion of construction and prior to finish floor being installed. All work must be completed prior to substantial completion. All floor drains and cleanout locations must be included in this work.

B. All sanitary soil and waste lines below building 3” and larger shall be internally videotaped at time of substantial completion. All videotaping shall include on-screen date and time, and include audio narration. All videotaping shall be provided by experienced individual in videotaping piping systems. An Owner’s Representative shall be present during video-taping. Three copies of the videotape shall be delivered to the Owner for future records.

C. This work shall be done in the presence of the Owner’s Representative, as part of the Contract, to ensure all lines are clear, and any obstruction that may be discovered shall be removed immediately. Rodding shall be accomplished by utilizing the proper rotary head to clear sewer. Pipe sizes 8 inches and larger shall be hydro-flushed.

END OF SECTION

SECTION 22 20 00 - PLUMBING PIPE AND PIPE FITTINGS - GENERAL

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install pipe and pipe fittings for piping systems specified in Division 22 - Plumbing.

1.2 RELATED WORK

A. Division 22 Plumbing
   1. Earthwork
   2. Valves, Strainers and Vents
   3. Insulation
   4. Other Piping Sections

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. The particular type of pipe and fittings for each system is specified in the individual sections.

2.2 JOINTS

A. Make screwed joints using machine cut USASI taper pipe threads. Apply a suitable joint compound to the male threads only. Ream the pipe to full inside diameter after cutting. All-thread nipples are not permitted.

B. Dissimilar Metals. Make joints between copper and steel pipe and equipment using insulating unions or couplings such as Crane Company #1259; EPCO as manufactured by EPCO Sales, Inc.; or an approved equal.

C. Solder joints.
   1. Prior to making joints, cut pipe square and ream to full inside diameter. Clean exterior of pipe and socket. Apply a thin coat of suitable fluxing compound to both pipe and socket, and fit parts together immediately.
   2. Heat assembled joint only as required to cause the solder to flow. Run the joint full, slightly beaded on the outside, and wipe to remove excess solder.
   3. Use silver brazing alloy or Sil-Fos on underground water entry piping. Use lead free solder on all other copper piping.

D. Make welded joints as recommended by the standards of the American Welding Society. Ensure complete penetration of deposited metal with base metal. Provide filler metal suitable for use with base metal. Keep inside of fittings free from globules of weld metal. The use of mitered joints is not approved.

E. Flanged.
   1. Prior to installation of bolts, center and align flanged joints to prevent mechanical pre-stressing of flanges, pipe or equipment. Align bolt holes to straddle the vertical, horizontal or north-south centerline. Do not exceed 3/64" per foot inclination of the flange face from true alignment.
   2. Use flat-face companion flanges only with flat-faced fittings, valves or equipment. Otherwise, use raised-face flanges.
   3. Install gaskets suitable for the intended service and factory cut to proper

dimensions. Secure with manufacturers recommended gasket cement.

4. Use ANSI nuts and bolts, galvanized or black to match flange material. Use ANSI 316 stainless steel nuts and bolts underground. Tighten bolts progressively to prevent unbalanced stress. Draw bolts tight to ensure proper seating of gaskets.
5. Use carbon steel flanges conforming to ANSI B16.5 with pipe materials conforming to ASTM A 105 Grade II or ASTM A 108, Grade II, ASTM A 53, Grade B. Use slip-on type flanges on pipe only. Use welding neck type flanges on all fittings. Weld slip-on flanges inside and outside.
6. Keep flange covers on equipment while fabricating piping. Remove when ready to install in system.

F. No Hub. Hubless joints shall be made with wide body, neoprene sealing sleeve with stainless steel sleeve, coupling joints conforming to ASTM C 1277.

1. 4" pipe size and smaller coupling housing minimum of 3" width; 24 gauge Series 300 stainless steel with hi-torque clamps; neoprene coupling gasket.
2. 6" through 10" pipe size coupling housing minimum of 4" width.
3. Tighten clamps to within manufacturer's tolerances using preset torque wrench.

G. Ring-Tite Joints: Ring-Tite gasketed sewer fittings for sanitary and storm. Furnish joints for installation manufactured per ASTM/CSA, Ipex, and J.M Eagle C900. Provide adequate concrete thrust blocks at changes in direction, as recommended by manufacturer.

2.3 UNIONS

A. Use 150 lb. standard (300 lb. WOG) malleable iron, ground joint unions with bronze seat. Provide flanged joints on piping 2-1/2" and larger.

1. Where pipe materials of different types join, use a dielectric union. Union shall be threaded, solder or as required for its intended use.

2.4 BRANCH CONNECTIONS

A. Pipe 2" and Smaller. For threaded piping, use straight size reducing tee. When branch is smaller than header, a nipple and reducing coupling or swagged nipple may be used.

B. 2-1/2" through 36": For welding piping, when branch size is the same as header size, use welding tee. Use Weld-o-let when branch is smaller than header. For threaded branch connections, use 3000 lb. full coupling or Thread-o-let welded to header.

2.5 GASKETS

A. High Temperature Piping. Provide 1/16" thick ring gaskets of aramid reinforced SBR such as Garlock #3200 or 3400 or equal by Advanced Products and Systems.

B. Other Piping. Provide ring rubber gaskets, Garlock #7992 or equal by Advanced Products and Systems. Use 1/8" thick cloth reinforced neoprene gaskets. For smaller than 6", use 1/16" thick gasket.

2.6 FLOORS AND CEILING PLATES

A. Provide chrome-plated floor and ceiling plates around pipes exposed to view when passing through walls, floors, partitions, or ceilings in finished areas; size plates to fit pipe or insulation and lock in place.

2.7 DOMESTIC MANUFACTURE

A. All piping material, pipe and pipe fittings shall be manufactured in the United States of America unless specifically named in these specifications.

PART 3 - EXECUTION

3.1 PIPE FABRICATION AND INSTALLATION

A. Make piping layout and installation in the most advantageous manner possible with respect to headroom, valve access, opening and equipment clearance, and clearance for other work. Give particular attention to piping in the vicinity of equipment. Preserve the required minimum access clearances to various equipment parts, as recommended by the equipment manufactured, for maintenance.

B. Cut all pipes to measurement determined at the site. After cutting pipe, remove burrs by reaming. Bevel plain ends of ferrous pipe.

C. Install piping neatly, free from unnecessary traps and pockets. Work into place without springing or forcing. Use fittings to make changes in direction. Field bending and mitering is prohibited. Make connections to equipment using flanged joints, unions or couplings. Make reducing connections with reducing fittings only.

D. Install piping without tapping out of the bottom of pipe.

E. Press Connections: Copper and steel press fittings ½” through 4” shall be applied in accordance with the manufacturer’s installation instructions. The tubing/pipe shall be fully inserted into the fitting and the tubing/pipe marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing/pipe to assure the tubing/pipe is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool approved by the manufacturer. If soldering (thread adapters, etc.) near press fittings, take precautions to not damage the O-ring fittings. Maintain three pipe diameters or use a cooling agent. Viega-“Pro-Press”.

3.2 WELD

A. Weld and fabricate piping in accordance with ANSI Standard B31.1, latest edition, Code for Pressure Piping.

B. Align piping and equipment so that no part is offset more than 1/16". Set fittings and joints square and true, and preserve alignment during welding operation. Use of alignment rods inside pipe is prohibited.

C. Do not permit any weld to project within the pipe so as to restrict flows. Tack welds, if used, must be of the same material and made by the same procedure as the completed weld. Otherwise, remove tack welds during welding operation.

D. Do not split, bend, flatten or otherwise damage piping before, during or after installation.

E. Remove dirt, scale and other foreign matter from inside piping before tying into existing piping sections, fittings, valves or equipment.

F. Bevel ends of ferrous pipe.

3.3 OFFSETS AND FITTINGS

A. Due to the small scale of drawings, the indication of offsets and fittings is not possible. Investigate the structural and finish conditions affecting the work and take steps required

to meet these conditions.

B. Install pipe close to walls, ceilings and columns so pipe will occupy minimum space. Provide proper spacing for insulation coverings, removal of pipe, special clearances, and offsets and fittings.

3.4 SECURING AND SUPPORTING

A. Support piping to maintain line and grade, with provision for expansion and contraction. Use approved clevis-type or trapeze-type hangers connected to structural members of the building. Single pipe runs to be supported by approved clevis type hangers. Multiple pipe runs to be supported by approved trapeze type hangers. Do not support piping from other piping or structural joist bridging.

B. Provide supports both sides of elbows for pipe 6" and larger.

C. Support vertical risers with steel strap pipe clamps of approved design and size, supported at each floor. Support piping assemblies in chases so they are rigid and self-supported before the chase is closed. Provide structural support for piping penetrating chase walls to fixtures. On cold water pipe, supports shall be outside the insulation.

D. Where insulation occurs, design hangers to protect insulation from damage. Pipe saddles and insulation shields, where required, are specified in the appropriate insulation section and are sized in accordance with the schedule on the drawings.

E. Install trapeze hangers, properly sized, to support the intended load without distortion.

F. Use electro-galvanized or zinc plated threaded rods, nuts, washers and hangers.

G. At outdoor locations, all supports, brackets and structural members shall be hot-dipped galvanized.

H. Support spacing: As recommended by the project structural engineer and support manufacturer, but not more than listed below. Not to exceed spacing requirements of smallest pipe.

Pipe Size	Copper & Steel Max. Support Spacing, Feet	Cast Iron Max. Support Spacing, Ft.	Minimum Rod Diameter, Inches
1" & smaller	6		3/8
1-1/4" & 1-1/2"	8	5	3/8
2"	10	5	3/8
3"	10	5	1/2
4" & 5"	10	5	5/8
6" and above	10	5	3/4

3.5 PIPE SUPPORTS

A. Provide P1001 or P 5000 Unistrut metal framing members and appurtenances for pipe support. Hot-dip galvanize members and appurtenances when located outside. Sagging of pipes or supports is not acceptable.

B. Adjustable clevis hangers shall be used for single pipe supports; Anvil Fig. 260. When oversized clevis is used, a nipple shall be placed over the clevis bolt as a spacer to assure that the lower U-strap will not move in on the bolt. Provide adjustable clevis with a nut / washer above and below the hanger on the support rod. Ring type clevis hangers

are not acceptable.

C. Provide Anvil Figure 45 galvanized or primed and painted channel assembly for trapeze hangers.

3.6 PIPE SUPPORTS ON ROOF

A. Support gas pipe on roof with Portable Pipe Hanger Model PP-10 with roller and fully adjustable height throughout pipe run. Base material shall be high density / high impact polypropylene with UV inhibitors and anti-oxidants. Provide with hot dip galvanized rod finish and framing. Nuts and washers shall be hot dip galvanized.

3.7 ANCHORS

A. Provide anchors as required. Use pipe anchors consisting of heavy steel collars with lugs and bolts for clamping to pipe and attaching anchor braces. Install anchor braces in the most effective manner to secure desired results. Do not install supports, anchors or similar devices where they will damage construction during installation or because of the weight or the expansion of the pipe. When possible, install sleeves in structural concrete prior to pouring of concrete.

3.8 FLOOR PENETRATIONS

A. At locations where pipe passes through floors, provide watertight concrete curb around penetration.

3.9 PIPE SLEEVES

A. Sleeves through masonry and concrete construction:
   1. Fabricate sleeves of Schedule 40 galvanized steel pipe.
   2. Size sleeve large enough to allow for movement due to expansion and to provide continuous insulation.

B. Sleeves through gypsum wall construction.
   1. Fabricate sleeves of 16 gauge galvanized sheet metal.

C. Sleeves through elevated slab construction.
   1. Fabricate sleeves of Schedule 40 galvanized steel pipe with welded center flange in floor.

D. Extend each sleeve through the floor or wall. Cut the sleeve flush with each wall surface. Sleeves through floors shall extend 2” above floor lines for waterproofing purposes. Slab on grade floors shall not be sleeved except where penetrating waterproofing membrane or insect control is required.

E. Caulk sleeves water and air tight. Seal annular space between pipes and sleeves with mastic compound to make the space water and air tight.

F. For sleeves below grades in outside walls, provide Thunderline Link-Seal or Advance Product and System Interlynx, with 316 stainless steel nuts and bolts, with cast iron pressure plate.

G. Provide chrome plated escutcheon plates on pipes passing through walls, floors or ceilings exposed to view. At exterior walls, stainless steel sheet metal is to be used.

H. For sleeves through fire and smoke rated walls, seal with a UL through-penetration

firestop, rated to maintain the integrity of the time rated construction. Install in accordance with the manufacturer's installation instructions. Comply with UL and NFPA standards for the installation of firestops. Refer to Architectural drawings for all fire and smoke rated partitions, walls, floors, etc.

3.10 ISOLATION VALVES

A. Provide piping systems with line size shutoff valves located at the risers, at main branch connections to mains for equipment, to isolate central plant, and at other locations.

3.11 DRAIN VALVES

A. Install drain valves at low points of water piping systems so that these systems can be entirely drained. Install a line size drain valve for pipes smaller than 2" unless indicated otherwise. For pipes 2-1/2" and larger, provide 2" drain valves unless indicated otherwise. Drain valves shall be plugged when not in use and at completion.

3.12 CLEANING OF PIPING SYSTEMS

A. General cleaning of piping systems. Purge pipe of construction debris and contamination before placing the systems in service. Provide and install temporary connections as required to clean, purge and circulate.

B. Install temporary strainers at the inlet of pumps and other equipment as necessary where permanent strainers are not indicated. Keep strainers in service until the equipment has been tested, then remove either entire strainer or straining element only. Fit strainers with a line size blow down ball valve and pipe to nearest drain. Blow down strainers, remove and clean as frequently as necessary.

C. Phase One: Initial flushing of system. Remove loose dirt, mill scale, weld beads, rust and other deleterious substances without damage to system components. Open valves, drains, vents and strainers at all system levels during flushing procedures. Flush until “potable water clear” and particles larger than 5 microns are removed.

D. Connect dead-end supply and return headers, even if not shown on the drawings, and provide terminal drains in bottom of pipe end caps or blind flanges.

E. Dispose of water in approved manner.

F. Phase Two: Cleaning of Piping Systems. Remove, without chemical or mechanical damage to any system component, adherent dirt (organic soil), oil, grease, (hydrocarbons), soldering flux, mill varnish, piping compounds, rust (iron oxide) and other deleterious substances not removed by initial flushing. Flush system and replace with clean water.

G. Phase Three: Final flushing and rinsing: Flush and rinse until “potable water clear” and particles larger than 5 microns are removed. Operate valves to dislodge any debris in valve body. Dispose of water in approved manner.

H. Submit status reports upon completion of each phase of work on each system.

3.13 TESTING

A. Test piping after installation with water hydrostatic pressure of 1-1/2 times operating pressure (150 psig minimum) and carefully check for leaks. Repair leaks and retest system until proven watertight.

B. Do not insulate or conceal piping systems until tests are satisfactorily complete.

C. If any leaks or other defects are observed, suspend the test and correct the condition at once. Repeat testing until leaks are eliminated and the full test period is achieved.

D. The satisfactory completion of testing does not relieve the Contractor of responsibility for ultimate proper and satisfactory operation of piping systems and their accessories.

3.14 PIPE MARKERS

A. Identify interior exposed piping and piping in accessible chases or plenums with Opti-Code Brady Pressure Sensitive Adhesive Pipe Markers, consisting of pipe marker and direction of flow arrow tape. Clean pipe prior to installation. Background colors of markers, arrows and tape for each type of system shall be the same. Meet ANSI/OSHA standards and clearly identify each system. Provide minimum 2-1/4-inch letters through 4-inch pipe and 4-inch letters for 5-inch pipe and larger.

B. Identify exterior and mechanical room piping with Snap Around pipe markers through 4-inch pipe and Strap Around markers 5-inch pipe and larger. Pipe markers consisting of pipe marker and direction of flow arrow tape; background colors of markers, arrows and type for each type of system shall be the same. Meet ANSI / OSHA standards and clearly identify each system. Provide minimum 2-1/4-inch letters through 4-inch pipe and 4-inch letters for 5-inch pipe and larger.

C. Install identification in the following locations:
1. Both sides of penetrations through walls, floors and ceilings.
2. Close to valves or flanges.
3. Intervals on straight pipe runs not to exceed 50 feet
4. Apply marker where view is obstructed.

D. Pipe markers shall meet or exceed the specifications of the ASME A13.1 “Scheme for Identification of Piping Systems”.

END OF SECTION

SECTION 22 63 11 - GAS PIPING AND APPURTENANCES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install steel gas pipe inside buildings, including the supply line from the meter, service lines to gas equipment and appliances, termination of the service line with a plug valve, drip leg, and final connection to equipment and appliances with unions.

B. Coordinate service line from utility main and extend to meter. Coordinate installation of the service line and meter with Gas Company.

C. Extend steel gas piping from meter to inside the building to all fixtures, appliances and equipment requiring gas.

1.2 RELATED WORK

A. Division 22 Plumbing
   1. Plumbing Pipe and Fittings
   2. Valves and Vents

1.3 UTILITY CONNECTIONS

A. Make arrangements for and pay all fees and connection charges for obtaining service to the building.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS - ABOVE GRADE

A. Pipe 2 inch and Smaller:
   1. Schedule 40 ASTM A 53 black steel pipe
   2. Factory fabricated socket weld fittings.

B. Pipe Larger than 2 inch:
   1. Schedule 40 ASTM A 53 black steel pipe.
   2. Factory fabricated butt weld fittings for welded steel pipes shall conform to ASTM A-234 WPB (seamless weld fittings).

C. Unions:
   1. Standard 150 lb. (300 lb. water, oil or gas) malleable iron.
   2. Ground joint unions, with bronze seat.
   3. Flange joints for pipe larger than 2 inch in diameter.

D. Flanges:
   1. Steel flanges. ANSI B16.5 and ASTM A-105.

2.2 PIPE AND FITTINGS - BELOW GRADE OUTSIDE BUILDING

A. Polyethylene pipe shall be ASTM D3350 Grade PE24 cell classification and ASTM D1248 Class B material classification.

B. Pipe shall be medium density polyethylene PE 2406 and PE 2708 manufactured by Poly Pipe Industries, Inc. or Performance Pipe.

C. Polyethylene yellow molded butt fittings for use with medium density polyethylene pipe

shall meet testing requirements of ASTM D2513 and resin material listing of ASTM D3350 with PPI designation of PE 2406 as manufactured by Central Plastics Co.

2.3 VALVES

A. See Section 22 05 23.

2.4 GAS PRESSURE REGULATOR

A. Size the gas pressure regulator in accordance with the manufacturer's recommendations for flow quantities and reduced pressure as required for all equipment. Coordinate final equipment gas pressure requirements prior to ordering regulators. Provide American Meter Company regulators or approved equal, suitable for outdoor installation. Regulators outside exposed to weather shall be installed with vent in vertical down position.

B. All line pressure regulators shall be listed in accordance with ANSI (American National Standard) Z21.80 and CSA (Canadian Standards Association Standard) 6.22.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation Standards: Install gas piping in accordance with recommendations of the National Fire Protection Association.

B. Drip Legs: Install a capped drip leg 6 inches long at the base of each vertical rise.

C. Coating and Wrapping. Coat and wrap underground piping in accordance with the service utility company standards.

D. Sleeves.
1. Encase gas piping running in or through solid partitions with thin wall metal conduit. Sleeve piping and fittings shall be two pipe sizes, but not less than 1 inch larger than encased gas piping.
2. Encase gas piping running below slab in Schedule 40 PVC, minimum size two pipe sizes larger than gas pipe. Vent sleeve to atmosphere with a 1-1/2 inch vent with 1-1/2 inch return bend above building roof. Seal ends of sleeve with UL fire rated caulk.

E. Do not install gas piping exposed to view inside public area, or occupied spaces, without prior written approval.

F. Weld all gas piping above grade.

G. Provide test ports and isolation valves to enable proper testing of system in the future.

H. Provide isolation valve and unions across regulators for proper removal.

I. Provide transition risers where below grade polyethylene pipe changes to steel pipe above grade.

J. Gas Pressure Regulators / Vents:
1. Piping shall be sized in accordance with the regulator manufacturer’s instructions. Never use pipe sizes smaller than the vent size; smaller pipe sizes restrict the gas flow. Where there is more than one regulator at a location, each regulator shall have a separate vent to the roof / outdoors.

Headers with various installed devices can cause regulator malfunction.

2. Support the vent pipe to eliminate strain on the regulator diaphragm case.
3. Install vent piping from regulators to location to prevent gas smells from entering building. Do not locate the vent line terminus near windows, fans, or other ventilation equipment. See the installation instructions furnished with the regulator.
4. Install double elbows and insect screen at end of piping to prevent moisture and insects from entering. Always point outdoor vent pipes in the downward position to reduce the possibility of rain, snow, sleet, and other moisture entering the pipe.
5. When installed inside building route vents horizontally and terminate through building sidewall. The vent must be piped to the outside atmosphere using the shortest length of pipe, the fewest possible pipe elbows, and a pipe diameter as large as the vent size or larger. If a long gas run must be used, increase the pipe one nominal size every ten feet to keep the flow restriction as low as possible. Vents terminating through roof must have prior approval from Architect before installation. Through roof penetrations shall be minimized.
6. Regulators installed outside or on roof top: Install regulator vent turned downward with insect screen over vent opening. The vent shall be designed to prevent the entry of water, insects, or other foreign materials that could cause blockage.
7. Ensure the end of the vent line is away from ANY potential ignition sources. It is the installer's responsibility to ensure the vent line is exhausting to a safe environment
8. Adhere to all applicable codes and regulations.

3.2 TESTING GAS PIPING

A. Preliminary gas test as required by Code, but minimum test pressure of 50 PSI held for not less than eight hours without noticeable drop.

B. Test joints with a soap solution while lines are under pressure.

C. Repair leaks.

D. Final gas test shall be with a 24 inch column of mercury or a diaphragm gauge with a minimum dial size of 3-1/2 inches with a set hand and a pressure range not to exceed twenty (20) psig with 2/10-pound increments. The minimum test pressure shall not be less than ten (10) psi and the maximum test pressure shall not exceed twelve (12) psig. This test will be observed for no less than (30) thirty minutes with no drop in pressure.

E. Provide copy of gas pressure test reports in Operations & Maintenance Manual.

F. Provide Railroad Commission of Texas Pipeline Safety Form PS-86B.
   1. To find form online, go to: Texas School Gas Test Form

G. School renovations projects shall have all gas piping tested. Report and document gas leaks found to the Architect and Engineer. Repair leaks at no additional cost to the Owner.

3.3 IDENTIFICATION CONDUCTOR

A. Spiral A #12 AWG insulated copper conductor the full length of the thermoplastic piping system. Fasten to the pipe at 3 foot intervals with plastic tie wraps.

B. Terminate at each end in a 12 inch x 12 inch x 4 inch FRP junction box.

1. Bolted gasketed cover with stainless steel screws.
2. Screw type terminal strip.
3. Legend on cover "gas pipe identification conductor."

C. Set in concrete pad.

3.4 PAINT EXPOSED OUTSIDE GAS PIPE

A. Interior and Exterior Gas piping shall be protected from rust.

B. Paint pipe with a flat alkyd coating, clean pipe prior to painting by preparing surface by hand tool cleaning per SSPC-SP2-82, applying one coat of Glidden Y-590 Rustmaster Metal Primer White and top coat of Yellow Alkyd Flat Enamel.

END OF SECTION

SECTION 23 01 00 - HVAC OPERATING AND MAINTENANCE MANUALS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Compilation product data and related information appropriate for Owner's operation and maintenance of products furnished under Contract. Prepare operating and maintenance data as specified.

B. Instruct Owner's personnel in operation and maintenance of equipment and systems.

C. Submit three copies of complete manual in final form.

1.2 SUBMITTALS

A. Thirty (30) days after the Contractor has received the final scheduled identified submittals bearing the Architect/Engineer's stamp of acceptance (including resubmittals), submit for review one copy of the first draft of the Operating and Maintenance Manual. This copy shall contain as a minimum:
   1. Table of Contents for each element.
   2. Contractor information.
   3. All submittals, coordination drawings and product data, reviewed by the Architect/Engineer; bearing the Architect/Engineer's stamp of acceptance. (When submittals are returned from Engineer "Correct as Noted", corrected inserts shall be included.)
   4. All parts and maintenance manuals for items of equipment.
   5. Warranties (without starting dates)
   6. Certifications that have been completed. Submit forms and outlines of certifications that have not been completed.
   7. Operating and maintenance procedures.
   8. Form of Owner's Training Program Syllabus (including times and dates).
   9. Control operations/equipment wiring diagrams.
   10. Schedule of filters for each item of equipment.
   11. Schedule of belts for each item of equipment.
   12. Other required operating and maintenance information that are complete.

B. Copy will be returned to the Contractor within 15 days with comments for corrections.

C. Submit three (3) completed manuals in final form to the Architect/Engineer one day after substantial completion, and prior to Owner's instructions. Include all specified data, test and balance reports, drawings, dated warranties, certificates, reports, along with other materials and information.

D. The Architect/Engineer will review the manuals for completeness within fifteen (15) days.

E. The Contractor shall be notified of any missing or omitted materials. The Manuals shall be reworked by the Contractor, as required, in the office of the Architect / Engineer. The manuals will not be retransmitted.

F. Two (2) complete Manuals will be delivered to the Owner.

PART 2 - PRODUCTS

2.1 BINDERS

A. Commercial quality black three-ring binders with clear overlay plastic covers.

B. Minimum ring size: 1".
Maximum ring size: 3".

C. When multiple binders are used, correlate the data into related groupings.

D. Label contents on spine and face of binder with full size insert. Label under plastic cover.

PART 3 - EXECUTION

3.1 OPERATION AND MAINTENANCE MANUAL

A. Form for Manuals:
1. Prepare data in form of an instructional manual for use by Owner's personnel.
2. Format:
a. Size: 8-1/2" x 11".
b. Text: Manufacturer's printed data or neatly typewritten.
3. Drawings:
a. Provide reinforced punched binder tab and bind in text.
b. Fold larger drawings to size of text pages.
4. Provide flyleaf indexed tabs for each separate product or each piece of operating equipment.
5. Cover: Identify each volume with typed or printed title "Operating and Maintenance Instructions". List:
a. Title of Project
b. Identity of separate structures as applicable.
c. Identity of general subject matter covered in the manual.
6. Binder as specified.

B. Content of Manual:
1. Neatly typewritten Table of Contents for each volume arranged in systematic order as outlined in the specifications.
a. Contractor, name of responsible principal, address and telephone number.
b. A list of each product required to be included, indexed to content of the volume.
c. List with each product, name, address and telephone number of:
1) Subcontractor or installer.
2) Maintenance contractor as appropriate.
3) Identify area of responsibility of each.
4) Local source of supply for parts and replacement.
d. Identify each product by product name and other identifying symbols as set forth in Contract Documents.
2. Product Data:
a. Include those sheets pertinent to the specific product.
b. Annotate each sheet to:
1) Identify specific product or part installed.
2) Identify data applicable to installation.
3) Delete references to inapplicable information. (All options not supplied with equipment shall be marked out indicated in some manner.
3. Drawings:
a. Supplement product data with drawings as necessary to illustrate:
1) Relations of component parts of equipment and systems.
2) Control and flow diagrams.

b. Coordinate drawings with information in Project Record Documents to assure correct illustration of completed installation.
c. Do not use Project Record Documents as maintenance drawings.

4. Written text, as required to supplement product data for the particular installation:
   a. Organize in consistent format under separate headings for different procedures.
   b. Provide logical sequence of instructions for each procedure.
5. Copy of each warranty, bond and service contract issued.
   a. Provide information sheet for Owner's personnel, giving:
      1) Proper procedures in event of failure.
      2) Instances that might affect validity of warranties or bonds.
6. Shop drawings, coordination drawings and product data as specified.

C. Sections for Equipment and Systems.

1. Content for each unit of equipment and system as appropriate:
   a. Description of unit and component parts.
      1) Function, normal operating characteristics, and limiting conditions.
      2) Performance curves, engineering data and tests.
      3) Complete nomenclature and commercial number of replaceable parts.
   b. Operating procedures:
      1) Start up, break-in, routine and normal operating instructions.
      2) Regulation, control, stopping, shut down and emergency instructions.
      3) Summer and winter operating instructions.
      4) Special operating instructions.
   c. Maintenance procedures:
      1) Routine operations
      2) Guide to trouble-shooting.
      3) Disassembly, repair and reassembly.
      4) Alignment, adjusting and checking.
      5) Routine service based on operating hours.
   d. Servicing and lubrication schedule. List of lubricants required.
   e. Manufacturer's printed operating and maintenance instructions.
   f. Description of sequence of operation by control manufacturer.
   g. Original manufacturer's parts list, illustrations, assembly drawings and diagrams required for maintenance.
      1) Predicted life of part subject to wear.
      2) Items recommended to be stocked as spare parts.
   h. As installed control diagrams by controls manufacturer.
   i. Complete equipment internal wiring diagrams.
   j. Schedule of filters for each air handling system.
   k. Schedule of belts for each item of equipment.
   l. Each Contractor's coordination drawings.
   m. As installed color coded piping diagrams.
   n. Charts of valve tag number, with location and function of each valve.
   o. List of original manufacturer's spare parts and recommended quantities to be maintained in storage.
   p. Other data as required under pertinent sections of the specifications.
2. Prepare and include additional data when the need for such data becomes apparent during instruction of Owner's personnel.
3. Additional requirements for operating and maintenance data as outlined in respective sections of specifications.
4. Provide complete information for products specified in Division 23.
5. Provide certificates of compliance as specified in each related section.

6. Provide start up reports as specified in each related section.
7. Provide signed receipts for spare parts and material.
8. Provide training report and certificates.
9. Provide extended compressor warranty certificates.

END OF SECTION

SECTION 23 05 00 - MECHANICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Except as modified in this Section, General Conditions, Supplementary Conditions, applicable provisions of the General Requirements, and other provisions and requirements of the contract documents apply to work of Division 23 Mechanical.

B. Applicable provisions of this section apply to all sections of Division 23, Mechanical.

1.2 CODE REQUIREMENTS AND FEES

A. Perform work in accordance with applicable statutes, ordinances, codes and regulations of governmental authorities having jurisdiction.

B. Mechanical work shall comply with applicable inspection services:
1. Underwriters Laboratories
2. National Fire Protection Association
3. State Health Department
4. Local Municipal Building Inspection Department
5. Texas Department of Licensing & Regulations (ADA)

C. Resolve any code violations discovered in contract documents with the Engineer prior to award of the contract. After Contract award, any correction or additions necessary for compliance with applicable codes shall be made at no additional cost to the Owner.

D. This Contractor shall be responsible for being aware of and complying with asbestos NESHAP regulations, as well as all other applicable codes, laws and regulations.

E. Obtain all permits required.

1.3 CONTRACTOR'S QUALIFICATIONS

A. An approved contractor for the work under this division shall be:
1. A specialist in this field and have the personnel, experience, training, skill, and organization to provide a practical working system
2. Able to furnish evidence of having contracted for and installed not less than 3 systems of comparable size and type that has served their Owners satisfactorily for not less than 3 years

1.4 REFERENCE SPECIFICATIONS AND STANDARDS

A. Materials which are specified by reference to Federal Specifications; ASTM, ASME, ANSI, or AWWA Specifications; Federal Standards; or other standard specifications must comply with latest editions, revisions, amendments or supplements in effect on date bids are received. Requirements in reference specifications and standards are minimum for all equipment, material, and work. In instances where specified capacities, size, or other features of equipment, devices, or materials exceed these minimums, meet specified capacities.

1.5 CONTRACT DRAWINGS

A. Contract drawings are diagrammatic only and do not give fully dimensioned locations of various elements of work. Determine exact locations from field measurements.

1.6 PROJECT RECORD DOCUMENTS

A. Maintain at the job site a separate set of white prints (black line) of the contract drawings for the sole purpose of recording the "as-built" changes and diagrams of those portions of work in which actual construction is at variance with the contract drawings. Mark the drawings with a colored pencil. Prepare, as the work progresses and upon completion of work, reproducible drawings clearly indicating locations of various lines, valves, ductwork, traps, equipment, and other pertinent items, as installed. Include flow-line elevation of sewer lines. Record existing and new underground and under slab piping with dimensioned locations and elevations of such piping.

B. At the conclusion of project, obtain without cost to the Owner, erasable mylars of the original drawings and transfer as-built changes to these. Prior to transmittal of corrected drawings, obtain 3 sets of blue-line prints of each drawing, regardless of whether corrections were necessary and include in the transmittal (2 sets are for the Owner's use and one set is for the Architect/Engineer's records). Delivery of these as-built prints and reproducibles is a condition of final acceptance. Provide record drawings on one set each (reproducible Dayrex mylar film positives) and AutoCad 2014 / Revit CAD files on disk (CD Rom).

C. As-Built drawings should indicate the following information as a minimum:
1. Indicate all addendum changes to documents.
2. Remove Engineer’s seal, name, address and logo from drawings.
3. Mark documents RECORD DRAWINGS.
4. Clearly indicate: DOCUMENT PRODUCED BY
5. Indicate all changes to construction during construction. Indicate actual routing of all piping, ductwork, etc. that were deviated from construction drawings.
6. Indicate exact location of all underground mechanical piping and elevation.
7. Indicate exact location of all underground electrical raceways and elevations.
8. Correct schedules to reflect (actual) equipment furnished and manufacturer.
9. Location and size of all ductwork and mechanical piping above ceiling including exact location of isolation of domestic and mechanical valves.
10. Exact location of all electrical equipment in and outside of the building.
11. Exact location of all roof mounted equipment, wall, roof and floor penetrations.
12. Cloud all changes.

1.7 SPACE REQUIREMENTS

A. Consider space limitations imposed by contiguous work in selection and location of equipment and material. Do not provide equipment or material that is not suitable in this respect.

1.8 RELATION WITH OTHER TRADES

A. Carefully study all matters and conditions concerning the project. Submit notification of conflict in ample time to prevent unwarranted changes in any work. Review other Divisions of these specifications to determine their requirements.

B. Because of the complicated relationship of this work to the total project, conscientiously study the relation and cooperate as necessary to accomplish the full intent of the documents.

C. Provide sleeves and inserts in forms as required for the work. Stub up and protect open ends of pipe before any concrete is placed. Furnish sizes of required equipment pads. Furnish and locate bolts and fittings required to be cast in them.

D. Locate and size openings required for installation of work specified in this Division in sufficient time to prevent delay in the work.

E. Refer to other Divisions of the specifications for the scope of required connections to equipment furnished under that Division. Determine from the Contractor for the various trades, the Owner, and by direction from the Architect/Engineer, the exact location of all items.

1.9 CONCEALED AND EXPOSED WORK

A. When the word "concealed" is used in connection with insulating, painting, piping, ducts and the like, the work is understood to mean hidden from sight as in chases, furred spaces or above ceilings. "Exposed" is understood to mean open to view.

1.10 GUARANTEE

A. Guarantee work for 1 year from the date of substantial completion of the project. During that period make good any faults or imperfections that may arise due to defects or omissions in material, equipment or workmanship. At the Owner's option, replacement of failed parts or equipment shall be provided.

1.11 MATERIAL AND EQUIPMENT

A. Furnish new and unused materials and equipment meeting the requirements of the paragraph specifying acceptable manufacturers. Where two or more units of the same type or class of equipment are required, provide units of a single manufacturer.

1.12 NOISE AND VIBRATION

A. Select equipment to operate with minimum noise and vibration. If objectionable noise or vibration is produced or transmitted to or through the building structure by equipment, piping, ducts or other parts of work, rectify such conditions at no additional cost. If the item of equipment is judged to produce objectionable noise or vibration, demonstrate at no additional cost that equipment performs within designated limits on a vibration chart.

1.13 ACCEPTABLE MANUFACTURERS

A. Manufacturers names and catalog number specified under sections of Division 23 are used to establish standards of design, performance, quality and serviceability and not to limit competition. Equipment of similar design, equal to that specified, manufactured by a named manufacturer will be acceptable on approval. A request for prior approval of equipment not listed must be submitted ten (10) days before bid due date. Submit complete design and performance data to the Engineer.

1.14 OPERATING TESTS

A. After all mechanical systems have been completed and put into operation, subject each system to an operating test under design conditions to ensure proper sequencing and operation throughout the range of operation. Tests shall be made in the presence of the Architect/Engineer. Make adjustments as required to ensure proper functioning of all systems. Special tests on individual systems are specified under individual sections. Submit 3 copies of all certifications and test reports adequately in advance of completion of the work to allow for remedial action as required to correct deficiencies discovered in equipment and systems.

1.15 WARRANTIES

A. Submit 3 copies of all warranties and guarantees for systems, equipment, devices and materials. These shall be included in the Operating and Maintenance Manuals.

1.16 BUILDING CONSTRUCTION

A. It shall be the responsibility of each sub-contractor to consult the Architectural and Engineering drawings, details, and specifications and thoroughly familiarize himself with the project and all job related requirements. Each sub-contractor shall cooperate with the General Contractor to verify that all piping and other items are placed in the walls, furred spaces, chases, etc., so there will be no delays in the job.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 OPENINGS

A. Framed, cast or masonry openings for ductwork, equipment or piping are specified under other divisions. Drawings and layout work for exact size and location of all openings are included under this division.

3.2 AIR FILTERS AND PIPE STRAINERS

A. Immediately prior to substantial completion of the project, inspect, clean and service air filters and strainers. Replace air filters.

3.3 LUBRICATION, REFRIGERANT AND OIL

A. Provide a complete charge of correct lubricant for each item of equipment requiring lubrication.

B. Provide a complete and working charge of proper refrigerant, free of contaminants, into each refrigerant system. After each system has been in operation long enough to ensure completely balanced conditions, check the charge and modify for proper operation as required.

C. Provide a complete charge of special oil for refrigeration use, suitable for operation with refrigerant, in each system.

3.4 HOUSEKEEPING PADS

A. Provide equipment housekeeping pads under all floor mounted and ground mounted HVAC equipment, and as shown on the drawings.

B. Concrete work as specified in Division 3.

C. Concrete pads:
   1. 4" high, rounded edges, minimum 2500 psi unless otherwise indicated on the drawings
   2. Chamfer strips at edges and corner of forms.
   3. Smooth steel trowel finish.
   4. Doweled to existing slab

D. Install concrete curbs around duct penetrations or multiple pipe penetrations.

3.5 INSTRUCTION OF OWNER'S PERSONNEL

A. Prior to final inspection, conduct an on-site training program to instruct the Owner's operating personnel in the operation and maintenance of the mechanical systems.
1. Provide the training during the Owner's regular working day.
2. The Instructors shall each be experienced in their phase of operation and maintenance of building mechanical systems and with the project.

B. Time to be allocated for instructions.
1. Minimum of 40 hours dedicated instructor time.
2. 8 hours on each of 5 days.

C. Before proceeding with the on-site training program, submit the program syllabus; proposed time and dates; and other pertinent information for review and approval.
1. One copy to the Owner.
2. One copy to the Architect/Engineer.

D. The Owner will provide a list of personnel to receive instructions, and will coordinate their attendance at the agreed upon times.

E. Use the operation and maintenance manuals as the basis of instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.

F. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shut down of each item of equipment.

G. Demonstrate equipment functions (both individually and as part of the total integrated system).

H. Prepare and insert additional data in the operating and maintenance manuals when the need for additional data becomes apparent during instructions.

I. Submit a report within one week after completion of the training program that instructions have been satisfactorily completed. Give time and date of each demonstration and hours devoted to the demonstration, with a list of people present.

J. At the conclusion of the on-site training program, have the person designated by the Owner sign a certificate to certify that he/she has a proper understanding of the system, that the demonstrations and instructions have been satisfactorily completed, and the scope and content of the operating and maintenance manuals used for the training program are satisfactory.

K. Provide a copy of the report and the certificate in an appropriately tabbed section of each Operating and Maintenance Manual.

3.6 EQUIPMENT IDENTIFICATION

A. Provide a laminated engraved plastic nameplate on each piece of equipment and starter.
1. Designation approved by Architect/Engineer.
2. Equipment includes, but is not limited to, air handling units, fan coil units, variable volume boxes, fans, pumps, boilers and chillers.
3. Submit schedule of equipment to be included and designations.

B. Provide nameplates with 1/2" high letters and fastened with epoxy or screws.

3.7 OBSTRUCTIONS

A. The drawings indicate certain information pertaining to surface and subsurface obstructions which has been taken from available drawings. Such information is not guaranteed, however, as to accuracy of location or complete information.
   1. Before any cutting or trenching operations are begun, verify with Owner's representative, utility companies, municipalities, and other interested parties that all available information has been provided.
   2. Should obstruction be encountered, whether shown or not, alter routing of new work, reroute existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition.

B. Assume total responsibility for and repair any damage to existing utilities or construction, whether or not such existing facilities are shown.

3.8 PROTECTION

A. Protect work, equipment, fixtures, and materials. At work completion, work must be clean and in original manufacturer's condition.

3.9 INDOOR AIR QUALITY

A. All equipment and ductwork shall be installed to allow sufficient space for testing, maintenance, and commissioning functions. Access doors or panels shall be installed in ventilation equipment, ductwork, and plenum enclosures for inspection and cleaning of outdoor air intakes, mixing plenums, up and downstream of coils, filters, drain pans and fans.

B. Practice source control and eliminate potential contaminants in material selection, installation, and maintenance.

C. Provide installation and disposal instructions for all materials and chemicals that are potential contaminants.

D. Obtain and conform to the requirements of the Material Safety Data Sheets (MSDSs) in the use of materials.

E. Utilize manufacturer’s recommendations and provide installation instructions for all chemicals, compounds, and potential contaminants including pre-installation degassing if required.

F. Ventilate completed building prior to final completion using no less than design outside air for at least 48 hours before occupancy.

G. Make provisions for controls to prevent the entry of air contaminants into the HVAC air distribution system.

H. Steps shall be taken to ensure that the HVAC system continues to function effectively and are not damaged or contaminated during construction activities.

END OF SECTION

SECTION 23 05 10 - HVAC CONTRACT QUALITY CONTROL

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Contract quality control including workmanship, manufacturer's instructions, mock-ups and demonstrations.

1.2 QUALITY CONTROL PROGRAM

A. Maintain quality control over supervision, subcontractors, suppliers, manufacturers, products, services, site conditions and workmanship to produce work in accordance with contract documents.

1.3 WORKMANSHIP

A. Comply with industry standards except when more restrictive tolerances or specified requirements indicate more rigid standards or more precise workmanship.

B. Perform work by persons qualified to produce workmanship of specified quality.

C. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, and racking. Under no conditions shall material or equipment be suspended from structural bridging.

D. Provide finishes to match approved samples. All exposed finishes shall be approved by the Architect. Submit color samples as required.

1.4 MANUFACTURER'S INSTRUCTIONS

A. Comply with instructions in full detail, including each step in sequence.

B. Should instruction conflict with Contract Documents, request clarification from Architect / Engineer before proceeding.

1.5 MANUFACTURER'S CERTIFICATES

A. When required in individual Specification Sections, submit manufacturer's certificate in duplicate, certifying that products meet or exceed specified requirements.

1.6 MANUFACTURER'S FIELD SERVICES

A. When required in individual Specification Sections, manufacturer shall provide qualified personnel to observe:
   1. Field conditions.
   2. Condition of installation.
   3. Quality of workmanship.
   4. Start-up of equipment.
   5. Testing, adjusting, and balancing of equipment.

B. Representative shall make written report of observations and recommendations to Architect / Engineer.

1.7 MOCK-UPS

A. Assemble and erect the specified equipment and products complete, with specified anchorage and support devices, seals and finishes.

B. Do not proceed with any work involving a mock-up, until the related mock-up has been approved in writing.

C. Acceptable mock-ups in place shall be retained in the completed work.

D. Perform tests and submit results as specified.

1.8 SCHEDULING OF MOCK-UPS

A. Schedule demonstration and observation of mock-ups, in phases, with Architect / Engineer.
   1. Rough-in.
   2. Finish with all appurtenances in place.
   3. Insulation installed.
   4. Demonstrations.

PART 2 - PRODUCTS

2.1 REFERENCE APPLICABLE SPECIFICATION SECTIONS.

PART 3 - EXECUTION

3.1 FAN/COIL UNITS (WATER SOURCE HEAT PUMPS)

A. Mock-up a fan/coil unit (water source heat pump) completely installed, including:
   1. Primary, secondary and auxiliary drain pans.
   2. Piping connections; including all piping appurtenances.
   3. Pipe insulation.
   4. Condensate drain piping.
   5. Electrical connections.
   6. Duct connection beyond first transition.
   7. Block valves, balancing valves, and control valves.
   8. Cabinet/internal vibration isolation.
   9. Suspension system.

B. Tests: Air flow at scheduled static pressure.

C. Demonstrate:
   1. Filter accessibility.
   2. Accessibility to drain and components for service.
   3. Controls sequence.

3.2 AIR HANDLING UNIT

A. Mock-up an air handling unit, completely installed, including:
   1. Piping connections; including thermowells, test stations, test wells and other piping appurtenances.
   2. Pipe insulation.
   3. Condensate drain piping.
   4. Electrical connections.
   5. Ductwork beyond the first transition.
   6. Control valves and bypass.
   7. Cabinet/internal vibration isolation.

8. Block valves and balancing valves.
9. Duct insulation.
10. Instrumentation.

B. Tests: Air flow at scheduled static pressure.

C. Demonstrate:
1. Filter accessibility.
2. Accessibility to drain and components for service.
3. Controls sequence.

3.3 CONSTANT VOLUME TERMINAL BOX

A. Mock-up a Constant Volume Terminal Box completely installed, including:
1. Piping connections, including all piping appurtenances.
2. Pipe insulation.
3. Electrical connections.
4. Duct connection beyond first transition.
5. Block valves, balancing valves, and control valves.
6. Cabinet/internal vibration isolation.
7. Suspension system.

B. Tests: Air flow at scheduled static pressure.

C. Demonstrate:
1. Control Sequence.
2. Accessibility to components for service.

3.4 HOT AND CHILLED WATER CIRCULATING PUMPS

A. Mock-up one each system pump, completely installed including:
1. Pump mounted on housekeeping pad.
2. Auxiliary drain pan. (Chilled water only)
3. Piping to a point beyond the complete valve and instrumentation assemblies.
4. Strainers with blowdown.
5. Flexible piping connection.
6. Pipe supports.
7. Pipe insulation.
8. Pump painting.
9. Electrical connections.

3.5 PROTECTION OF EQUIPMENT

A. Do not deliver equipment to the project site until progress of construction has reached the stage where equipment is actually needed or until building is closed in enough to protect the equipment from weather. Equipment allowed to stand in the weather will be rejected, and the Contractor is obligated to furnish new equipment of a like kind at no additional cost to the Owner.

B. Adequately protect equipment from damage after delivery to the project. Cover with heavy tarpaulins, drop cloths or other protective coverings as required to protect from plaster, paint, mortar and/or dirt. Do not cover with plastic materials and trap condensate and cause corrosion.

END OF SECTION

SECTION 23 05 11 - MECHANICAL ALTERATIONS PROJECT PROCEDURES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Inspect and service existing equipment and materials that are to remain or to be reused.

B. Disposal of equipment, materials, or housekeeping pads to be abandoned. Prior to disposal, the Contractor shall verify with the Owner what is to be salvaged by the Owner and what is to become the property of the Contractor.

C. Handling of equipment and materials to be removed.

1.2 QUALITY ASSURANCE

A. Coordination with the Owner prior to the disconnection or shutdown of existing equipment, or to the modification of existing operational systems.

1.3 CONTRACT DRAWINGS

A. There is the possibility that existing conditions and devices are affected by the work indicated on the drawings and called for in the specifications (project manual) which do not appear on the drawings. It is the Contractor’s responsibility to visit the site and determine all of the existing conditions and to consider these existing conditions when making and presenting a proposal, to have a complete proposal.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Material used to upgrade and repair existing equipment shall conform to that specified.

B. Material used to upgrade and repair existing equipment shall not void existing warranties or listings of the equipment to be upgraded or repaired.

C. Material used to upgrade and repair existing equipment shall be new and shall be of the same manufacturer of the existing equipment, shall be acquired through the existing original equipment manufacturer’s approved distribution channels, shall have manufacturer’s warranties for the new material being used, and shall be listed for the use intended.

PART 3 - EXECUTION

3.1 INSPECTION

A. Existing materials and equipment indicated on the drawings or in the specifications to be reused shall be inspected for damaged or missing parts. Contractor shall notify the Architect/Engineer, in writing, accordingly.

B. If using materials specified or shown on the drawing voids or diminishes the warranty or operation of remaining equipment or systems, the Contractor shall notify the Architect/Engineer, in writing.

C. Verify field measurements, above and underground piping connections and flows.

D. Demolition Drawings are based on casual field observation, and when available, existing record documents. Report discrepancies to Architect before disturbing existing installation, and immediately after such discrepancies are discovered.

E. Field verify existing conditions and actual utility uses prior to final connections. Existing drawings may not have been available for all required information. Use pipe inspection camera system to field verify existing sanitary / grease waste connections. Verify actual HVAC supply and return piping connections. Verify flow direction and depth prior to connection to existing plumbing systems.

3.2 APPLICATION

A. Existing materials and equipment indicated on the drawings or in the specifications to be reused shall be cleaned and reconditioned, including cleaning of piping systems and HVAC coils prior to installation and reuse.

B. Material and equipment removed that is not to be salvaged for Owner's use or for reuse on the project shall become the property of the Contractor and be removed from the site.

C. Material or equipment salvaged for Owner's use shall be carefully handled and stored where directed by the Owner or the Architect / Engineer. Relocate material and / or equipment as directed by Owner.

D. Materials and equipment not indicated to be removed or abandoned shall be reconnected to the new system.

E. Materials, equipment and housekeeping pads not to be reused or reconnected shall be removed for Owner’s review and salvaged by Contractor.

F. Prior to start of construction, Contractor shall walk areas to be renovated with Owner to identify and document items to be salvaged for Owner’s use.

G. Clean and repair existing materials and equipment that remain or are to be reused.

H. Contractor shall utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

3.3 SEQUENCE AND SCHEDULE

A. Coordinate utility service outages with Utility Company, Architect and Owner.

B. Provide additional or temporary valves, piping, ductwork and connections to maintain existing systems in service during construction.

C. Existing HVAC and Plumbing Service: Refer to drawings for work in remodeled areas. Where facilities in these areas are to remain in service, any related work to keep the facilities in operation is specified in this Division. Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from Owner at least 48 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area. Maintain acceptable temperature and humidity control within existing building during renovation activities.

D. Remove and replace existing Mechanical systems and appurtenances as occasioned by new or remodeled construction. Re-establish service that may be interrupted by remodeled construction.

E. Refer to other drawings series for work in remodeled areas. Where facilities in these areas are required to remain in service, any related work required to keep these facilities in operation is specified in this Division.

F. Remove and replace existing piping, grilles, boxes and ductwork coincident with the construction.

G. Remove or relocate existing piping, grilles, ductwork or housekeeping pads as occasioned by new or remodeled construction. Cap unused HVAC or domestic piping and duct beyond the new finish line.

H. Relocate all HVAC and or domestic piping, grilles, boxes and ductwork as required to accommodate new work requiring precedence.

I. Remove concrete housekeeping pad where materials or equipment have been removed.

J. Remove all known utilities, which do not provide service to the buildings that remain.

K. Remove existing plumbing or mechanical vent penetrations through roof not to be reused.

3.4 DEMOLITION AND EXTENSION OF EXISTING MECHANICAL WORK

A. The Contractor shall modify, remove, and/or relocate all materials and items so indicated on the drawings or required by the installation of new facilities. All removals and/or dismantling shall be conducted in a manner as to produce maximum salvage. Salvage materials shall remain the property of the Owner, and shall be delivered to such destination as directed by the Owner's representative unless they are not wanted, then it will be the responsibility of this Contractor to remove such items and properly dispose of them. Materials and/or items scheduled for relocation and which are damaged during dismantling or reassembly operations shall be repaired and restored to good operative condition. The Contractor may, at his discretion, and upon approval of the Owner's representative substitute new materials and/or items of like design and quality in lieu of materials and/or items to be relocated.

B. All items to be relocated shall be carefully removed in reverse to original assembly or placement and protected until relocated. The Contractor shall clean, repair, and provide all new materials, fittings, and appurtenances required to complete the relocations and to restore them to good operative order. All relocations shall be performed by workmen skilled in the work and in accordance with standard practice of the trades involved.

C. When items scheduled for relocation and/or reuse are found to be in damaged condition before work has been started on dismantling, the Contractor shall call the attention of the Owner's representative to such items and receive further instructions before removal. Items damaged in repositioning operations are the contractor's responsibility and shall be repaired or replaced by the contractor as approved by the owner's representative, at no additional cost to the Owner.

D. HVAC, Plumbing, piping, ductwork and appurtenances to be removed, salvaged, or relocated shall be removed to points indicated on the drawings, specified, or acceptable to the Owner's representative. Piping and ductwork not scheduled for reuse shall be removed to the points at which reuse is to be continued or service is to remain. Such services shall be sealed, capped, or otherwise tied-off or disconnected in a safe manner acceptable to the Construction Inspector. All disconnections or connections into the existing facilities shall be done in such a manner as to result in minimum interruption of services to adjacent occupied areas. Services to existing areas or facilities that must

remain in operation during the construction period shall not be interrupted without prior specific approval of the Owner's representative hereinbefore specified.

E. Repair adjacent construction and finishes damaged during demolition and extension work.

F. Maintain access to mechanical installations that remain active. Modify installation or provide access panel as appropriate.

G. Extend existing installations using materials and methods compatible with existing mechanical installations, or as specified.

H. Existing mechanical piping and devices found to need additional hangers installed should be added at no additional cost to the Owner.

3.5 PROTECTION OF THE WORK

A. Provide adequate temporary support and auxiliary structure as necessary to ensure structural value or integrity of affected portion of work.

B. Provide devices and methods to protect other portions of work from damage.

C. Execute fitting and adjustment of products to provide a finished installation to comply with specified products, functions, tolerances and finishes.

3.6 IDENTIFICATION OF EQUIPMENT IN RENOVATED AREAS

A. Identification of Equipment: Provide new identification of all existing equipment to be reused and located within the renovated areas. Do not include the description "existing". Provide new nameplates for all existing mechanical equipment in renovated areas as specified in Section 23 05 00 Mechanical General Provisions.

3.7 REFRIGERANT DISPOSAL

A. Contractor shall dispose of refrigerant from all DX equipment including refrigerant piping per OSHA, EPA, Federal, State and Local Codes.

END OF SECTION

SECTION 23 05 12 - SHOP DRAWINGS, COORDINATION DRAWINGS & PRODUCT DATA

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Prepare submittals as required by these specifications as outlined below.

B. The term submittal, as used herein, refers to all:
1. Shop Drawings
2. Coordination Drawings
3. Product data

C. Submittals shall be prepared and produced for:
1. Distribution as specified
2. Inclusion in the Operating and Maintenance Manual, as specified, in the related section

1.2 SHOP DRAWINGS

A. Present drawings in a clear and thorough manner. Identify details by reference to sheet and detail, schedule, or room numbers shown on Contract Drawings.

B. Show all dimensions of each item of equipment on a single composite Shop Drawing. Do not submit a series of drawings of components.

C. Identify field dimensions; show relationship to adjacent features, critical features, work, or products.

D. Submit shop drawings in plan, elevation and sections, showing equipment in mechanical equipment areas.

1.3 COORDINATION DRAWINGS

A. Present in a clear and thorough manner. Title each drawing with project name. Identify each element of drawings by reference to sheet number and detail, or room number of contract documents. Minimum drawing scale: ¼” = 1’-0”.

B. Prepare coordination drawings to coordinate installations for efficient use of available space, for proper sequence of installation, and to resolve conflicts. Coordinate with work specified in other sections and other divisions of the specifications.

C. For each mechanical room and for each outside equipment pad where equipment is located, submit plan and elevation drawings. Show:
1. Actual mechanical equipment and components to be furnished
2. Service clearance
3. Relationship to other equipment and components
4. Roof drains and leader piping
5. Fire protection piping and equipment

D. Identify field dimensions. Show relation to adjacent or critical features of work or products.

E. Related requirements:
1. Ductwork shop drawings
2. Coordination drawing specified in Division 26

F. Submit shop drawings in plan, elevation and sections, showing equipment in mechanical equipment areas.

G. Gas piping sketch indicating proposed location of piping prior to proceeding with the installation.

1.4 PRODUCT DATA AND INSTALLATION INSTRUCTION

A. Submit only pages which are pertinent to the project. All options which are indicated on the product data shall become part of the contract and shall be required whether specified are not.

B. Mark each copy of standard printed data to identify pertinent products, referenced to specification section and article number.

C. Show reference standards, performance characteristics and capacities; wiring and piping diagrams and controls; component parts; finishes; dimensions and required clearances.

D. Modify manufacturer's standard schematic drawings and diagrams to supplement standard information and to provide information specifically applicable to the work. Delete information not applicable.

E. Mark up a copy of the specifications for the product. Indicate in the margin of each paragraph the following: COMPLY, DO NOT COMPLY, or NOT APPLICABLE. Explain all DO NOT COMPLY statements.

F. Provide a separate transmittal for each submittal item. Transmittals shall indicate product by specification section name and number. Separate all submittals into appropriate specification section number. Do not combine specification sections.

1.5 MANUFACTURERS INSTRUCTIONS

A. Submit Manufacturer's instructions for storage, preparation, assembly, installation, start-up, adjusting, calibrating, balancing and finishing.

1.6 CONTRACTOR RESPONSIBILITIES

A. Review submittals prior to transmittal.

B. Determine and verify:
1. Field measurements
2. Field construction criteria
3. Manufacturer's catalog numbers
4. Conformance with requirements of Contract Documents

C. Coordinate submittals with requirements of the work and of the Contract Documents.

D. Notify the Architect/Engineer in writing at time of submission of any deviations in the submittals from requirements of the Contract Documents.

E. Do not fabricate products, or begin work for which submittals are specified, until such submittals have been produced and bear contractor's stamp. Do not fabricate products or begin work scheduled to have submittals reviewed until return of reviewed submittals with Architect / Engineer's acceptance.

F. Contractor's responsibility for errors and omissions in submittals is not relieved whether Architect / Engineer reviews submittals or not.

G. Contractor's responsibility for deviations in submittals from requirements of Contract Documents is not relieved whether Architect/Engineer reviews submittals or not, unless Architect / Engineer gives written acceptance of the specific deviations on reviewed documents.

H. Submittals shall show sufficient data to indicate complete compliance with Contract Documents:
   1. Proper sizes and capacities
   2. That the item will fit in the available space in a manner that will allow proper service
   3. Construction methods, materials and finishes

I. Schedule submissions at least 15 days before date reviewed submittals will be needed.

1.7 SUBMISSION REQUIREMENTS

A. Make submittals promptly in accordance with approved schedule, and in such sequence as to cause no delay in the Project or in the work of any other Contractor.

B. Number of submittals required:
   1. Shop Drawings and Coordination Drawings: Submit one reproducible transparency and three opaque reproductions.
   2. Product Data: Submit the number of copies which the contractor requires, plus those which will be retained by the Architect/Engineer.

C. Accompany submittals with transmittal letter, in duplicate, containing:
   1. Date
   2. Project title and number
   3. Contractor's name, address and contact number.
   4. The number of each Shop Drawing, Project Datum and Sample submitted
   5. Other pertinent data

D. Submittals shall include:
   1. The date of submission
   2. The project title and number
   3. Contract Identification
   4. The names of:
      a. Contractor
      b. Subcontractor
      c. Supplier
      d. Manufacturer
   5. Identification of the product
   6. Field dimensions, clearly identified as such
   7. Relation to adjacent or critical features of the work or materials
   8. Applicable standards, such as ASTM or federal specifications numbers
   9. Identification of deviations from contract documents
   10. Suitable blank space for General Contractor and Architect/Engineer stamps
   11. Contractor's signed and dated Stamp of Approval

E. Coordinate submittals into logical groupings to facilitate interrelation of the several items:
   1. Finishes which involve Architect/Engineer selection of colors, textures or patterns
   2. Associated items which require correlation for efficient function or for installation

1.8 SUBMITTAL SPECIFICATION INFORMATION

A. Every submittal document shall bear the following information as used in the project manual:
   1. The related specification section number
   2. The exact specification section title

B. Submittals delivered to the Architect/Engineer without the specified information will not be processed. The Contractor shall bear the risk of all delays, as if no submittal had been delivered.

1.9 RESUBMISSION REQUIREMENTS

A. Make re-submittals under procedures specified for initial submittals.
   1. Indicate that the document or sample is a re-submittal
   2. Identify changes made since previous submittals

B. Indicate any changes which have been made, other than those requested by the Architect / Engineer.

1.10 CONTRACTOR'S STAMP OF APPROVAL

A. Contractor shall stamp and sign each document certifying to the review of products, field measurements and field construction criteria, and coordination of the information within the submittal with requirements of the work and of Contract Documents.

B. Contractor's stamp of approval on any submittal shall constitute a representation to Owner and Architect/Engineer that Contractor has either determined and verified all quantities, dimensions, field construction criteria, materials, catalog numbers, and similar data or assumes full responsibility for doing so, and that Contractor has reviewed or coordinated each submittal with the requirements of the work and the Contract Documents.

C. Do not deliver any submittals to the Architect/Engineer that do not bear the Contractor's stamp of approval and signature.

D. Submittals delivered to the Architect/Engineer without Contractor's stamp of approval and signature will not be processed. The Contractor shall bear the risk of all delays, as if no submittal had been delivered.

1.11 ARCHITECT / ENGINEER REVIEW OF IDENTIFIED SUBMITTALS

A. The Architect / Engineer will:
   1. Review identified submittals with reasonable promptness and in accordance with schedule
   2. Affix stamp and initials or signature, and indicate requirements for re-submittal or approval of submittal
   3. Return submittals to Contractor for distribution or for resubmission

B. Review and approval of submittals will not extend to design data reflected in submittals which is peculiarly within the special expertise of the Contractor or any party dealing directly with the Contractor.

C. Architect / Engineer's review and approval is only for conformance with the design concept of the project and for compliance with the information given in the contract.
   1. The review shall not extend to means, methods, sequences, techniques or procedures of construction or to safety precautions or programs incident thereto.
   2. The review shall not extend to review of quantities, dimensions, weights or gauges, fabrication processes or coordination with the work of other trades.

D. The review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.

1.12 SUBSTITUTIONS

A. Do not make requests for substitution employing the procedures of this Section.

B. The procedure for making a formal request for substitution is specified in Div. 1.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 23 05 13 - ELECTRICAL PROVISIONS OF HVAC WORK

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Electrical provisions to be provided as mechanical work are indicated in other Division 23 sections, on drawings, and as specified.

B. Types of work, normally recognized as electrical but provided as mechanical, specified or partially specified in this Section, include but are not necessarily limited to the following:
   1. Motors for mechanical equipment.
   2. Starters for motors of mechanical equipment, but only where specifically indicated to be furnished integrally with equipment.
   3. Wiring from motors to disconnect switches or junction boxes for motors of mechanical equipment, but only where specifically indicated to be furnished integrally with equipment.
   4. Wiring of field-mounted float control switches, flow control switches, and similar mechanical-electrical devices provided for mechanical systems, to equipment control panels.
   5. Wiring of smoke detectors for shutdown of air handling equipment when a fire alarm system is not included in the project.
   6. Wiring of oil pump, vibration and oil level limit switches for cooling towers.
   7. Refrigerant monitor/sensor/alarming and field installed visual/audible display alarms.
   8. Pipe heat tracing.
   9. Cooling tower vibration switch/interlock/reset.
   10. Field interlock wiring from chiller: flow switches, pump aux. Contacts, pump start/stop.
   11. Power supply 120 VAC and control signal from chiller control panel to condenser water flow control valve installed in piping leaving chiller.
   12. Wiring of all related circulating water system chemical treatment devices.
      a. Low voltage electric contacting water meter
      b. Solenoid valve/blow-down assembly
   13. Radiant heater timer switches and/or thermostats
   14. Low Voltage thermostat wiring

C. Refer to Division 23 Controls Sections for related control system wiring.

D. Refer to Division 23 sections for specific individual mechanical equipment electrical requirements.

E. Refer to Division 26 sections for motor starters and controls not furnished integrally with mechanical equipment.

F. Refer to Division 26 sections for junction boxes and disconnect switches required for motors and other electrical units of mechanical equipment.

1.2 RELATED WORK

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Specification Sections, apply to work of this Section.

1.3 QUALITY ASSURANCE

A. Wherever possible, match elements of electrical provisions of mechanical work with similar elements of electrical work specified in Division 26 sections for electrical work not otherwise specified.

B. For electrical equipment and products, comply with applicable NEMA standards, and refer to NEMA standards for definitions of terminology. Comply with National Electrical Code (NFPA 70) for workmanship and installation requirements.

1.4 SUBMITTALS

A. Include in listing of motors, voltage, notation of whether motor starter is furnished or installed integrally with motor or equipment containing motors.

PART 2 - PRODUCTS

2.1 MOTORS

A. Provide motors for mechanical equipment manufactured by one of the following:
1. Baldor Electric Company.
2. Century Electric Div., Inc.
3. General Electric Co.
4. Louis Allis Div.; Litton Industrial Products, Inc.
5. Lincoln Electric
6. Marathon Electric Mfg. Corp.
7. Reliance Electric Co.
8. Westinghouse Electric Corp.
9. WEG

B. Motor Characteristics. Except where more stringent requirements are indicated, and except where required items of mechanical equipment cannot be obtained with fully complying motors, comply with the following requirements for motors of mechanical work:

C. Temperature Rating. Rated for 40 Degrees C environment with maximum 50 Degrees C temperature rise for continuous duty at full load (Class A Insulation).

D. Provide each motor capable of making starts as frequently as indicated by automatic control system, and not less than 5 starts per hour for manually controlled motors.

E. Phases and Current Characteristics. Provide squirrel-cage induction polyphase motors for 3/4hp and larger, and provide capacitor-start single-phase motors for 1/2hp and smaller, except 1/6hp and smaller may, at equipment manufacturer's option, be split-phase type. Coordinate current characteristics with power specified in Division 26 sections, and with individual equipment requirements specified in other Division 23 requirements. For 2-speed motors provide 2 separate windings on polyphase motors. Do not purchase motors until power characteristics available at locations of motors have been confirmed, and until rotation directions have been confirmed.

F. Service Factor. 1.15 for polyphase motors and 1.35 for single-phase motors.

G. Motor Construction. Provide general purpose, continuous duty motors, Design "B" except "C" where required for high starting torque.
1. Frames. NEMA #56.
2. Bearings are to be ball or roller bearings with inner and outer shaft seals, regreasable except permanently sealed where motor is inaccessible for regular maintenance. Where belt drives and other drives produce lateral or axial thrust in motor, provide bearings designed to resist thrust loading. Refer to individual

section of Division 23 for fractional-hp light-duty motors where sleeve-type bearings are permitted.

3. Except as indicated, provide open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation, and provide guarded drip-proof motors where exposed to contact by employees or building occupants. Provide weather-protected Type I for outdoor use, Type II where not housed. Refer to individual sections of Division 23 for other enclosure requirements.
4. Provide built-in thermal overload protection and, where indicated, provide internal sensing device suitable for signaling and stopping motor at starter.
5. Noise Rating: Provide "Quiet" rating on motors.

H. All motors shall be premium efficiency.

I. Provide an inverter duty motor on all equipment that utilizes a variable frequency drive.

2.2 EQUIPMENT FABRICATION

A. Fabricate mechanical equipment for secure mounting of motors and other electrical items included in work. Provide either permanent alignment of motors with equipment, or adjustable mountings as applicable for belt drives, gear drives, special couplings and similar indirect coupling of equipment. Provide safe, secure, durable, and removable guards for motor drives. Arrange for lubrication and similar running-maintenance without removal of guards.

2.3 GENERAL REQUIREMENTS – SHAFT GROUNDING RINGS

A. All motors operated on variable frequency drives shall be equipped with a maintenance-free, conductive microfiber shaft grounding ring to meet NEMA MG-1, 3.4.4.4.3 requirements, with a minimum of two rows of circumferential microfibers to discharge damaging shaft voltages away from the bearings to ground. SGR’s Service Life: Designed to last for service life of motor. Provide AEGIS SGR Conductive MicroFiber Shaft Grounding Ring, or approved equal.

B. Application Note: Motors up to 100 HP shall be provided with one shaft ground ring installed on either the drive end or non-drive end. Motors over 100 HP shall be provided with an insulated bearing on the non-drive end and a shaft grounding ring on the drive end of the motor with the exception of line contact bearings in the drive end of the machine. In this instance the line contact bearing must be electrically insulated and the AEGIS Bearing Protection Ring installed on the opposite drive end of the motor. Grounding rings shall be provided and installed by the motor manufacturer’s recommendations.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install motors on motor mounting systems in accordance with motor manufacturer’s instructions, anchored to resist torque, drive thrusts, and other external forces inherent in mechanical work. Secure sheaves and other drive units to motor shafts with keys and Allen set screws on flat surface of shaft. Unless otherwise indicated, set motor shafts parallel with machine shafts.

B. Verify voltage with Electrical Plans.

END OF SECTION

SECTION 23 05 14 - HVAC CONDENSATE DRAIN PIPING SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide and install air conditioning condensate drains.

1.2 RELATED WORK

A. Division 23 - Mechanical
   1. Insulation
   2. Fan/Coil Units
   3. Air Handling Units
   4. Chilled Water Pumps
   5. Air Compressor Storage Tanks
   6. Equipment Drain Pans
   7. Heat Pump Units

PART 2 - PRODUCTS

2.1 PIPE MATERIAL

A. Type “L” copper with drainage pattern fittings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install the system to facilitate easy removal.
   1. Use threaded plugged tee at each change of direction to permit cleaning.
   2. Install a cleanout every 50 feet of straight run piping
   3. Maintain a positive slope on all piping

B. Install a water seal trap leg based on the fan pressure.
   1. Size the length of the trap leg 1 inch larger than the actual system pressure.

C. Install traps and cleanout as shown in the drawing details.
   1. Confirm requirements with manufacturer's installation instructions

3.2 SIZE PIPE AS SHOWN ON DRAWINGS.

A. Do not install piping sized smaller than the unit drain connection size.

3.3 SECONDARY DRAINS

A. Provide secondary drains where required by code, shown on the drawings, or where equipment has secondary drain connections.

END OF SECTION

SECTION 23 05 17 - HVAC ACCESS DOORS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install access doors in wall or ceiling locations as required or shown for access to valves, controls, fire dampers, air distribution devices and other equipment requiring maintenance, adjustment or operation.

PART 2 - PRODUCTS

2.1 NON-FIRE RATED ACCESS DOORS

A. 16-Gauge frames

B. 14-gauge steel panels

C. Continuous fully concealed hinges

D. Flush screwdriver cam lock & cylinder lock for Owner selection

E. Automatic closing and latching mechanism

F. Prime coat finish

G. Brushed satin stainless steel finish for restroom, kitchen or cafeteria installation

H. Material suitable for wall and/or ceiling mounting

2.2 FIRE RATED ACCESS DOORS

A. UL listed, 1-1/2 hour Label “B”, access doors

B. 16-Gauge stainless steel

C. 20-Gauge insulated sandwich-type door panel.

D. Two inch thick with fire rated insulation

E. Continuous fully concealed hinge

F. Automatic closing and latching mechanism

G. Knurled knob and recessed key operation for Owner selection

H. Interior latch release slide for opening from inside

I. Prime coat finish

J. Material suitable for wall and/or ceiling mounting

2.3 ACCEPTABLE MANUFACTURERS

A. Milcor

B. MIFAB

C. Acudor

D. Elmdor

PART 3 - EXECUTION

3.1 INSTALLATION

A. Access doors specified in Division 23 will be installed by other crafts. Not all required access doors are shown. Coordinate with the Contractor to locate access doors for ease of operation and maintenance of concealed equipment.

B. Installation shall be in accordance with the manufacturer's printed instructions.

C. Minimum size required:
1. 36" x 24" for Mechanical HVAC equipment related items
2. 18" x 18" for electrical related items

END OF SECTION

SECTION 23 05 18 - VARIABLE FREQUENCY INVERTER

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install a variable frequency inverter for the following equipment items.
   1. Variable Volume Air Handling Units.
   2. Pumps.

1.2 RELATED WORK

A. Division 23 Mechanical
   1. Electrical Provisions of Mechanical Work.
   2. Air Handling Units
   3. Pumps
   4. Building Management Control System Sequences

1.3 COOPERATION WITH OTHER TRADES

A. Coordinate this work with work under Division 26 Electrical to ensure that intended functions are achieved.

B. Coordinate the size of the variable frequency inverter with the equipment being served by the inverter. The rated current output amps are to be equal to or greater than motor rated full load amps.

1.4 SUBMITTALS

A. Submit manufacturer's information and shop drawings as specified.
   1. Complete technical details.
   2. Dimensions and manufacturer's installation manual.
   3. Schematic diagrams of the circuitry and field connections.
   4. Manufacturer's start-up manual.

1.5 STANDARDS

A. UL.

B. CSA.

C. ISO 9001

D. NEC.

E. FCC.

1.6 WARRANTY

A. The manufacturer shall provide a full parts and labor warranty for a period of five (5) years from substantial completion.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. ABB

B. Danfoss Graham

2.2 CABINET

A. The inverter and all accessories shall be provided within a wall mounted UL Listed NEMA 1 enclosure in interior AHU mechanical rooms and in NEMA 12 enclosure with deadsides and removable hinged, gasketed doors with provisions for locking in all Plant locations. Cabinet shall be constructed of metal for reduction of radio frequency interference (RFI) and electromagnetic frequency interference.

2.3 INTERFERENCE WITH OTHER SYSTEMS

A. The inverter shall be designed and constructed to comply with IEEE Standard 519-1993 with respect to line noise and RFI generation. All units shall generate less than 3% total harmonic distortion back to the incoming power line at the point of common connection with sensitive equipment. A harmonic analysis shall be submitted with the approval drawings to verify compliance with the latest version of IEEE-519 voltage and current distortion limits as shown in Table 1.2 and 10.3 at the point of common coupling (PCC). The PCC shall be defined as the consumer-utility interface or primary side of the main distribution transformer.

B. Dual DC Bus filtered chokes (factory installed and wired in the drive enclosure) equivalent to 5% input line reactors shall be provided to minimize harmonics reflected onto the input line.
   1. Shall not interfere with computer and other electronic systems in the building.
   2. If not inherently protected, provide a suitable isolation transformer.
   3. The system shall not produce spikes on the incoming line.

C. Any inverter that generates sufficient electrical line noise to interfere with the operation of sensitive building equipment shall be field modified or replaced by the inverter supplier at no additional cost to the Owner.

2.4 PROTECTIVE CIRCUITS

A. Provide the following protection:
   1. Input line fuses or molded case circuit breaker rated at 100 AIC.
   2. Input line noise suppression with MOV's (metal oxide varistors) and snubber circuits. MOV's shall be provided across incoming line terminals, AC input reactors, DC choke filters, and transistors to protect inverter from voltage surges and spikes.
   3. Protection of solid state inverter devices by limiting output current to 110% of inverter rating, automatically prevent overcurrent trip due to momentary overload conditions.
   4. Current limiting DC buss fuse between input and output sections of inventor.
   5. Input overvoltage trip at 480 vac + 10% trip.
   6. Input undervoltage at 480 vac – 10% trip
   7. Instantaneous overcurrent protection of solid state inverter devices.
   8. Individual overcurrent protection of solid state inverter devices.
   9. Output overvoltage trip.
   10. Loss of input phase, phase reversals, or blown fuse.
   11. Thermal overload trip for overload protection of solid state devices.
   12. Ground fault protection on start-up.
   13. Output line to line short circuit protection.
   14. Phase to phase short circuit or severe overload conditions of output.

15. Overload of motor.
16. Frequency stall.
17. DC buss high voltage.
18. Control function error.
19. Heatsink over temperature (Max. operating ambient: 122 degrees F)
20. Controller able to operate without a motor or any other equipment connected to the output (To facilitate startup and troubleshooting).
21. Capable of restarting into a rotating motor without component damage.
22. Shut down safely without component failure in the event of a sustained power loss, and will automatically return to normal operation, if start is "on" and power is restored.
23. Shut down safely without component failure in the event of a momentary power loss. Automatically return to normal operation if the start is "on", and normal power is restored. Capable of establishing speed control without shutdown or component failure.
24. Designed for input power contactor opening or closing while control is activated, without damage to the controller.
25. Automatically reset trip resulting from overcurrent, undervoltage, overvoltage, or over temperature, and automatically restart after removal, or correction of the faulty condition.
26. Provide status lights or digital display for indication of failure conditions, and form C relay provided for remote indication. Digital display or status lights to indicate power on, at speed, and drive enabled.
27. Operation and fault diagnostic function circuits shall be built into each inverter that provides information in determining the cause and source of a fault. Diagnostics to provide the following information:
    a. Operating mode at trip (Accel, Decel, Constant speed).
    b. Output current at trip.
    c. Output voltage at trip.
    d. Additional faults that occurred simultaneously of immediately before displayed tripped.

    Any drive requiring separate card to provide this information shall provide a diagnostic card for each drive.
28. DC link reactor.
29. Input power disconnect, lockable type.
30. Input power disconnect switch / circuit breaker, with lockable type handle.

2.5 OPERATOR DEVICES

A. The following operator devices shall be door or remote mounted:
    1. Digital keypad and LCD provided to perform all parameter adjustments, operation monitoring, and operation programming.
    2. Power on indication light.
    3. Flush mounted meters or digital display to indicate output voltage, output frequency, and output current, in percent of maximum 0 to 100%.
    4. Manual/Off/Auto 3 position selector switch (hand-off-auto) and manual speed setting control to provide the following control sequences:
        a. In automatic mode, controller shall follow an external control signal and respond to remote start-stop contact.
        b. In manual (hand) mode, controller shall follow speed signal set via door mounted keypad and start/stop switch. Switching from “hand” to “auto” and vice versa shall require a single keystroke to a dedicated changeover key. Inverters requiring multiple keystrokes and/or reprogramming of internal parameters to accomplish changeovers are not acceptable.
        c. An integral "safety interlock" protection shutdown circuit shall be provided for interface with firestats, smoke detectors, high static pressure limit

switches, vibration switches, etc.

5. Programmable lockout code to prevent unauthorized programming.
6. Critical frequency avoidance capability (up to 3 resonant points).

2.6 FIELD ADJUSTMENTS

A. The following shall be adjustable in the field:
1. Maximum Speed: 0 to 125% adjustable.
2. Minimum Speed: 0 to 100% adjustable.
3. Acceleration/deceleration rates: 0 to 3600 sec.
4. Instantaneous overcurrent trip: 50% to 2000%.
5. Volts/hertz ratio: Field adjustable to 16 patterns or set for automatic selection of proper V/F load profile to operate motor without overdriving or overloading.
6. Current limit circuit: 60 to 100%.
7. Carrier frequency: 6 to 16 KHZ.
8. Control interface: selectable to follow a 0-5 VDC, 0-10 VDC, 4-20 MA, either direct or indirect acting.
9. Control signal Bias: 0 to 80 HZ.
10. Control signal gain: 0 to 80 HZ.
11. Calibration of remote speed signal: 0 to 80 HZ.

2.7 ELECTRICAL CONSTANT SPEED BYPASS

A. Provide all components and circuitry necessary to provide manual bypass of the inverter. The bypass package shall be mounted in a cabinet common with the inverter and shall be constructed in such a manner that the inverter can be removed for repair while still operating the motor in the "bypass" mode. Manual bypass shall contain the following:
1. Two contactors mechanically interlocked via a three position through the door selector switch to provide the following control:
a. "Inverter" Mode connects the motor to the output of the inverter.
b. "Bypass" Mode connects the motor to the input sine wave power. Transfer must occur with input disconnect open. Motor is protected via thermal overload.
c. "Off" Mode disconnects motor from all input power.
2. A molded case circuit breaker or fused disconnect switch with door interlocked handle (lock out type) that interrupts input power to both the bypass circuitry and the drive.
3. An input contactor, interlocked with both the thermal motor overload and external safeties which disconnects power to the motor regardless of the mode of operation (either "inverter" or "bypass" mode).
4. A thermal overload to provide protection of motor in the bypass mode.
5. A safety interlock circuit that disconnects power to the motor (regardless of the mode of operation – “inverter” or “bypass”) in response to a signal from the thermal overload and/or external safety circuits.
6. Line voltage to 24 volt DC power source, fused per NEC, shall provide power to all bypass control circuits.

2.8 SERIAL COMMUNICATIONS

A. The VFD shall have the capability of communicating with the EMS control system via an RS-485 serial port.

B. VFD shall be provided with protocol information specific to the selected EMS control manufacturer and shall be pre-configured at the factory to automatic communications, without the need for field programming.

C. Serial communications capabilities shall be included, but not limited to: run/stop control, speed set adjustment, proportional/integral or PID control adjustments, current limit and accel/decel time adjustments. The drive shall also have the capability of allowing the DDC system to monitor the following feedback signals: process variable, output speed/frequency, current, torque, power (KW), operating hours, kilowatt hours; relay outputs, and diagnostic warning and fault information.

D. The VFD shall allow the DDC system to control the drive's digital and analog outputs and monitor all drive digital and analog inputs via the serial interface.

E. Provide BACnet interface card.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation as per manufacturer's recommendations and requirements.
   1. Inverter chassis is properly grounded.
   2. Line, Load, Control, and Fire/Safety wiring are installed in separate conduits.
   3. Both ends of conduit entering and leaving VFD into AHU cabinets and motors must be sealed air tight.

3.2 MANUFACTURER START-UP SERVICE

A. Factory trained personnel shall be provided for start-up assistance, minimum (1) day per unit.
   1. The manufacturer shall provide start-up commissioning of the VFD and its optional circuits by a factory certified service technician who is experienced in start-up and repair services. Sales personnel and other agents who are not factory certified shall not be acceptable as commissioning agents.
   2. Start-up services shall include checking for verification of proper operation and installation for the VFD, its options and its interface wiring to the building automation system.
   3. Adjustable devices, components, and assemblies to assure optimum performance.
   4. Make final adjustments to the installed drive to assure proper operation of the fan system. Obtain performance requirements from installer of driven loads.
   5. Assistance will be provided to the Owner (upon request) to determine the optimum capacitance for per factory correction and avoidance of potential resonance problems and will determine optimum line filter required.
   6. A written report, duly signed by the technician detailing set points of adjustable devices, amperages recorded, and any other pertinent data. This information is to be included in the operation and maintenance manual.

B. Input DC voltage to dry motor windings when fan is not in operation at the following locations:
   1. Cooling tower fan motor
   2. Motors downstream of coils
   3. Rooftop unit motors

3.3 DEMONSTRATION AND TRAINING

A. Provide system demonstration to personnel, Owner, and/or Owner's selected representatives.

B. Demonstrate operation of controllers in the automatic and manual modes.

C. Provide a minimum of two days of technical training for the owner's operating and technical staff. Schedule training with owner's authorized representatives, during normal business hours and not less than 30 days prior to planned session.

D. Training may be consecutive or random, at Owner's option.

END OF SECTION

SECTION 23 05 19 - HVAC PRESSURE AND TEMPERATURE INSTRUMENTS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section specifies gauges, thermometers, wells and/or pressure and temperature test stations to be installed as specified.

1.2 RELATED WORK

A. Division 23, Mechanical
   1. 23 05 00 - Mechanical General Provisions
   2. 23 20 00 - Pipe and Pipe Fittings, General
   3. 23 05 23 - Valves, Strainers and Vents
   4. 23 21 13 - Hot Water and Chilled Water Piping, Valves and Appurtenances

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS - GAUGES AND THERMOMETERS

A. Trerice

B. Taylor

C. Marsh

D. Weksler

E. Marshalltown

F. Weiss

G. Miljoco

2.2 PRESSURE GAUGES

A. Case and Ring: 4" type 304 stainless steel; liquid filled case with stainless steel bayonet ring.

B. Dial: White aluminum with black markings

C. Window: Clear acrylic

D. Tube: Phosphor bronze and forged brass socket.

E. Gauge accuracy: +/- 1% over operating range.

F. For pulsating service, provide impulse dampers.

G. Without flange for pipe mounting.

H. With flange for wall mounting.

I. Weiss Model: LF44S-1B or equal.

2.3 THERMOMETER WELLS

A. Brass or type 300 stainless steel. Machined bar stock, 1-piece construction.

B. Where installed in insulated piping or vessels, provide with extension neck to match insulation thickness.

C. Provide metal-to-metal contact with bulb chamber for maximum sensitivity.

D. Wells shall be sized to extend a minimum of 50% into pipe.

2.4 THERMOMETERS IN PIPING SYSTEMS OR VESSELS

A. Die cast aluminum case with baked epoxy finish.

B. Adjustable angle 9" scale length.

C. Clear acrylic window.

D. Brass stem, length to match well.

E. Red reading organic spirit filled-in magnifying glass column.

F. White background with black figures and markings.

G. Brass stems and union connections.

H Accuracy: +/- 1% of scale range.

I. Range:
1. Hot water lines: 30°F to 240°F.
2. Chilled water lines: 0°F to 100°F or 120°F
3. Condenser water: 0°F to 100°F.

2.5 PRESSURE AND TEMPERATURE TEST STATIONS

A. "Test Station" fitting to receive either a temperature or pressure probe. Fitting shall be solid brass with two valve cores of Nordel.
1. Fitted with a color coded cap strap with gasket.
2. Acceptable Manufacturer: Peterson Equipment Company.
3. Provide with extension neck to match insulation thickness.

B. Provide to the Owner a fitted case with:
1. Two 0-100 psi pressure gauges as specified and adapters with 1/8" OD probe.
2. Four 5" stem pocket testing thermometers.
   a. Two with range 25°F to 125°F for chilled water and condenser water.
   b. Two with range 0°F to 220°F for hot water.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with drawing details and manufacturer's recommendations.

B. Provide a ball valve at each gauge.

C. Locate gauges and thermometers to be easily readable from the floor at a 5'-6" eye level. Use adjustable angle or rigid stem as required. Install gauges in upright position.

D. Install gauges in the following locations: across pumps, chiller cooler and condenser, storage tanks, heat exchangers.

E. Test wells for automatic temperature controls shall be furnished by Building Management Control Section and installed by Mechanical Contractor.

F. Install thermometer in the following locations: Across chiller cooler and condenser, storage tanks, across heat exchangers, across boiler, leaving side of water heater, leaving water side of tempered water valves, common chilled and hot water lines.
   1. Hot water lines: 30°F to 240°F.
   2. Chilled water lines: 0°F to 100°F or 120°F
   3. Condenser water 0°F to 100°F.

END OF SECTION

SECTION 23 05 23 - HVAC VALVES, STRAINERS AND VENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. HVAC Valves

B. Pipe strainer and suction diffusers.

PART 2 - PRODUCTS

2.1 VALVES

A. Pressure Ratings:
1. Unless otherwise indicated, use valves suitable for 125 minimum psig working steam pressure (WSP) and 450°F.
2. The pressure temperature rating of valves shall be not less than the design criteria applicable to components of the system.

B. Butterfly Valves
1. Butterfly valves shall conform to MSS-SP67.
2. Liners, inserts and discs shall be suitable for the intended service.
3. Valves shall have a full lug type body designed for installation between ANSI standard flanges, and shall be rated at full working pressure with downstream flange removed.

C. Balancing Valves
1. Provide balancing valves with:
   a. Corrosion resistant plug with resilient seal when required.
   b. O-ring stem seal.
   c. Permanently lubricated, corrosion resistant bearings.
2. Connections
   a. Through 2" pipe size use threaded connections.
   b. For valves 2-1/2" pipe size and larger shall be provided with 150 psig flange connections.
3. Provide each valve with:
   a. Memory stop.
   b. Plastic drip cap.
   c. 1/8" gauge tap.

D. Ball Valves
1. Provide ball valves with:
   a. Blowout proof stem.
   b. Full size port, 316 stainless steel ball and stem.
   c. Cast bronze body.
   d. Threaded ends.
2. Seat, seals, thrust washers and packing shall be suitable for the intended service.
3. Service rating:
   a. 150 psi saturated steam.
   b. 600 psi WOG.
4. Where piping is insulated, ball valves shall be equipped with 2” extended handles of non-thermal conductive material. Provide a protective sleeve that allows operation of the valve without breaking the vapor seal or disturbing the insulation.
5. Provide with memory stop for balancing valves.

E. Valve Connections
   1. Provide valves suitable to connect to adjoining piping as specified for pipe joints. Use pipe size valves. Sweated joints are not allowed.
   2. Thread pipe sizes 2" and smaller.
   3. Flange pipe sizes 2-1/2" and larger.
   4. Use screw to solder adapters for copper tubing.
   5. Use grooved body valves with mechanical grooved jointed piping.

F. Valve Operators
   1. Where butterfly valves are provided:
      a. Provide gear operators on valves 6" and larger.
      b. Where valves are located 7' or more above the finished floor in equipment room areas provide chain-operated sheaves. Extend chains to about 5' above floor and hook to clips, arrange to clear walking space.
      c. Lever lock handle with toothed plate for shut-off service and infinitely adjustable handle with lock and nut and memory stop for throttling service on valves 4" and smaller.
      d. Provide worm gear operators on discharge side of pumps for balancing, for all sizes of valves.
      e. All valves 2-1/2” and larger provided by Milwaukee Valve shall be provided with gear operators.

G. Acceptable Manufacturers
   1. Dezurik
   2. Crane
   3. Nibco
   4. Keystone
   5. Milwaukee Valve

H. Check Valves
   1. Bronze body, 2" and smaller, bronze disc (Teflon disc for steam service), regrinding swing check, screw-in cap, threaded connection.
   2. Iron body, 2-1/2" and larger, bronze trim, non-slam: stainless steel pins and springs, and bronze plate or bronze mounted, regrind-renew check, bronze seat ring and disc. Provide either wafer or threaded lug.
   3. Acceptable Manufacturers
      a. Mission Duochek
      b. Nibco
      c. Keystone
      d. Milwaukee Valve

I. Provide valves of same manufacturer throughout where possible.

J. Provide valves with manufacturer's name and manufacturing location, duty and pressure rating clearly marked on outside of body.

K. Where valves are installed in insulated piping, provide with extended neck so valve operator and stop plate clears the full thickness insulation.

L. Provide valve, seat and trim materials suitable for the intended service.

M. Provide memory stops for all valves used for throttling service. Valves for throttling service shall be butterfly, plug, caged or ball type.

N. Condenser Water Basin Float Valve:
   1. Ductile Iron valve, body and cover

2. Stainless steel trim
3. Fully adjustable high and low level settings
4. Stainless steel float, float linkage and float rod
5. Flow clean strainer
6. CV Flow Control for opening and closing
7. ASTM A 536, B16.42, 150# Class
8. Stilling well
9. Acceptable Manufacturer: CLA-VAL

2.2 PIPE SYSTEMS STRAINERS

A. Body:
1. "Y" pattern or basket as shown on the drawings.
2. Line size.
3. Threaded strainer blow down port.
4. ASTM A #126 Class B Cast Iron Body.

B. Construction:
1. 2" size and smaller with screw connections rated 400 psi WOG.
2. Over 2" size with flanged connections, rated 125 psi WOG.

C. Fabricate screens of Monel or type 304 stainless steel:
1. With 20 mesh woven wire in piping systems through 2".
2. With 0.45 perforations in piping systems 2-1/2" and 3".
3. With 0.125 perforations in piping systems 4" and larger.

D. Start-up:
1. Provide an additional fine mesh disposable screen for use during start-up operations.
2. Remove after 30 days.
3. Attach to piping for owners review.

E. Acceptable Manufacturers
1. Crane
2. Keckley
3. Zurn
4. Mueller
5. McAlear
6. Muesco

2.3 SUCTION DIFFUSER

A. For each pump as shown on the drawing, provide an angle type suction diffuser. Body is to fit both the pump inlet and suction pipe size.

B. Components:
1. Inlet straightening vanes.
2. Removable end cap.
3. Gauge ports.
4. Threaded strainer blow down port.
5. Adjustable support foot.
6. Removable magnetic insert.

C. The screen shall be as specified for pipe system strainers.

D. Provide an additional fine mesh disposable strainer for use during start up operations.

1. Remove after 30 days operation and all flushing is complete.
2. Attach to piping for owners review.

E. Construction:
1. 2" size and smaller with screw connections rated 400 psi WOG.
2. Over 2" size with flanged connections, rated 125 psi WOG.

F. Fabricate screens of Monel or type 304 stainless steel:
1. With 20 mesh woven wire in piping systems through 2".
2. With 0.045 perforations in piping systems 2-1/2" and 3".
3. With 0.125 perforations in piping systems 4" and larger.

2.4 VALVE SCHEDULE

A. Hydronic Service
1. Chilled Water Service
   a. Ball Valves up to 2": Nibco T-585-70-66 w/Nib-Seal insulated Handle
   b. Butterfly Valve 2-1/2" and larger: Nibco LD - 2000
      Keystone Figure 222
2. Heating & Condenser Water Service
   a. Ball Valves up to 2": Nibco T-585-70-66
   b. Butterfly Valve 2-1/2" and larger: Nibco LD - 2000
      Keystone Figure 222
3. Check Valve:
   a. Nibco Check Valve: T - 413 - B
   b. Nibco Check Valve 2-1/2" and larger: F - 918 - B
   c. Nibco Check Valve 2-1/2" and larger: W - 920 -W (Wafer)
   d. Keystone Check 2-1/2" and larger: FIQ 810

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install valves with stems upright or horizontal, not inverted.

B. Install valves for shut-off and isolating service at each piece of equipment, at vertical risers, and where shown on the drawings.

C. Use butterfly valves and ball valves in circulating water systems, for balancing duty. Provide infinite position gear operator with memory stop.

D. Provide drain valves at main shut-off valves and low points of piping and apparatus so the systems can be entirely drained.
1. 1" valve for pipes 6" and larger.
2. 3/4" valve for pipes smaller than 6".
3. Terminate with pipe plug.
4. Drain valves shall be ball valves.

E. Where valves are installed in insulated pipe, valve operator shall have an insert so the lever or handle will not damage the insulation. Install handles so the lever or handles will not damage the insulation.

F. Provide clearance for installation of insulation and access to valves.

G. Provide access where valves are not exposed.

H. Provide float valves / stilling wells in cooling tower or condenser water basins for water level control. Provide stilling wells around float valve to prevent turbulence ripples or wind interference.

I. Butterfly valves shall be installed per ASME B31.3 Process Piping, and ASME B16.5 Pipe Flanges and Flanged.

3.3 PIPE SYSTEMS STRAINERS

A. Provide an additional fine mesh disposable strainer for use during start up operations.
   1. Remove after 30 days operation and all flushing is complete.
   2. Attach to piping for owners review.

B. Provide strainer in supply piping for all coil connections.

C. Provide strainer in condenser water piping entering chiller.

3.4 WATER SYSTEM AIR VENTS

A. Provide manual air vents at high points and at any other air pockets of closed circulating pipe systems. Extend 3/8" hard drawn copper tubing discharge drains to nearest floor or hub drain. Provide 1/4" Ball Valve as specified.

B. Where high point vents are not readily accessible provide additional valves at vent termination.

END OF SECTION

SECTION 23 05 33 - HVAC PIPE HEAT TRACING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install a complete industrial, constant wattage, UL listed system of electric pipe heat tracing and controls on all make-up water piping outdoors above grade to prevent freezing. The heat tracing system shall conform to ANSI/IEEE Standard 515-1989.

B. Protect the pipe, valves, fittings, meters and appurtenances. Apply sufficient cable and overheat thermostat to protect the entire system.

1.2 SUBMITTALS

A. Submit shop drawings and product data as specified in Section 23 05 12

B. Submit detailed calculations for length of heat tracing cable per foot of pipe, based on actual length of piping installed.

C. Submit manufacturer's certified capacity charts with selections plotted thereon.

D. Submit manufacturer's installation instructions.

E. Submit full load ampere requirement and voltage for branch circuit.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Raychem Corporation

B. Thermon Manufacturing Company

2.2 COMPONENTS

A. Self-regulating heater.
   1. The self-regulating heater shall consist of two 16 AWG tinned-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature all along its length, allowing the heater to be crossed itself without overheating and to be cut in the field. The heater shall be covered by a radiation cross-linked modified polyolefin dielectric jacket.
   2. In order to provide energy conservation, and to prevent overheating, the heater shall have a self-regulating factor of at least 90%.
   3. The heater shall operate on a line voltage of 120 VAC without the use of transformers.
   4. The heater shall be sized according to the following. The required heater output rating is in watts per foot at 50°F (heater selection based on 1-1/2 inch fiberglass insulation on metal piping).
   5. The heater shall be XL-Trace as manufactured by Raychem Corporation or XL-Econotrace as manufactured by Thermon Manufacturing Company.
   6. Power connection, end seal, splice and tee kits components shall be applied in the field.
   7. The system shall be controlled by an ambient sensing thermostat set at 40°F either directly or through an appropriate contactor.
   8. Provide an end-of-circuit voltage indicating light

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and start up the pipe heat tracing system in accordance with the manufacturer's Installation, Start-up and Service Instructions.

B. Install the pipe heat tracing cable under the pipe insulation.

C. Apply “Electrically Traced” signs to the outside of the thermal insulation.

D. Ground fault protection of the equipment shall be provided per the 1996 National Electrical Code, Article 427-22.

E. Provide a cast aluminum weatherproof NEMA-4 rated junction box for installation of the cable, with pilot light to indicate operation of the cable.

F. Use only electrical components as recommended by the manufacturer.

3.2 ELECTRICAL WORK

A. Furnish and install the wire, conduit and raceway systems required for the automatic operation of the pipe heat tracing system. Conform to the National Electrical Code.

B. The specified wiring work includes:
1. Wiring of control instruments between thermostat and junction boxes
2. Installation of thermostat and junction boxes
3. Wiring from the heat tracing cable to the junction boxes

C. Related branch circuit power wiring from the junction box to ground fault type circuit is specified to be provided in Division 26.

D. Provide devices and appurtenances as specified in Division 26.

E. Identify each circuit at each terminal with a separate tag.

F. Color code wires in accordance with IPCEA Standards.

G. Make all joints and connections with approved mechanical connectors.

3.3 TESTING OF THE PIPE HEAT TRACING SYSTEM

A. Test the pipe heat tracing system:
1. Simulate freezing outside air conditions
2. Measure the amperage draw of the heat tracing system
3. Compare to the manufacturer's capacity rating of the actual system
4. After installation and before and after installing the thermal insulation, subject heat to testing using a 1000 VDC megger. Minimum insulation resistance should be between 20 to 1000 megohms regardless of the length.

B. Submit records of test for approval prior to substantial completion; insert in the Owner's Manual.

END SECTION

SECTION 23 05 48 - VIBRATION ISOLATION

PART 1 - GENERAL

1.1 SCOPE

A. Furnish, install, and adjust vibration isolation.

1.2 RELATED WORK

A. Division 23 Mechanical.
   1. Refer to the Section on Ductwork for flexible connections between fans and ducts.
   2. Refer to the Section on Equipment Supports for equipment foundation pads.

1.3 SUBMITTALS

A. Submit product data showing type, size, load, deflection and other information required. Include clearly outlined procedures for installing and adjusting isolators.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Amber Booth
B. Kinetics
C. Mason
D. Korfund
E. VSI.
F. Vibration Eliminator Co., Inc.
G. Metraflex

2.2 ISOLATOR TYPES

A. Neoprene mountings shall have a minimum static deflection of 0.35 inches (9mm). All metal surfaces shall be neoprene covered and have friction pads both top and bottom. Bolt holes shall be provided on the bottom and a tapped hole and cap screw on top. Steel rails shall be used above the mountings under equipment such as small vent sets to compensate for the overhang.

B. Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or ¼ inch (6mm) neoprene acoustical friction pad between the base plate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Installed and operating heights shall be equal. The ratio of the spring diameter divided by the compressed spring height shall be no less than 0.8. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflection, compressed spring height and solid spring height.

C. Hangers shall consist of rigid steel frames containing minimum 1-1/4 inch (32mm) thick neoprene elements at the top and a steel spring with general characteristics as in specification B seated in a steel washer reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. In order to maintain stability the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30-

degree arc from side to side before contacting the cup bushing and short circuiting the spring. Submittals shall include a hanger drawing showing the 30-degree capability.

2.3 ISOLATOR APPLICATION

EQUIPMENT	ISOLATOR TYPE	MINIMUM DEFLECTION
Pump (Above Grade)	B	1.5”
Suspended Fan Coil Units	C	0.5”
Floor Mounted Fan Coil Units	A	0.35”
Condensing Units	A	0.35”
In-Line Fans	C	0.5”

2.4 PIPING ISOLATOR APPLICATIONS

EQUIPMENT	ISOLATOR TYPE
Floor Mounted Pumps	J
Suspended Pumps	J

2.5 FLEXIBLE CONNECTIONS IN PIPING AT PUMPS

A. Provide flexible connections at suction and discharge of chilled water, and hot water pumps, piping connections on chillers and where indicated on drawings. Refer to schedule above.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Stock Requirements. The isolation manufacturer's representative shall maintain an adequate stock of springs and isolators of type used so that changes required during construction and installation can be made.

B. Factory Representation. After installation, furnish factory-trained representative of the isolation manufacturer to check various isolators and report measured versus anticipated deflection on all isolators. Have the representative certify that isolators have been installed in accordance with manufacturer's recommendations and approved submittals. Provide written report to Engineer indicating compliance prior to final acceptance.

END OF SECTION

SECTION 23 05 93 - TESTING, BALANCING AND ADJUSTING (TAB) OF ENVIRONMENTAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Balance, adjust and test the air distribution system including the exhaust system.

B. Balance, adjust and test the hydronic system.

C. Verify and record the duct test results performed by the mechanical contractor.

1.2 RELATED SECTIONS

A. COORDINATION OF TESTING AND BALANCING

1.3 PAYMENT PROCEDURES

A. The work of this Section of the Specifications shall bid the project directly to the General Contractor.

1.4 SUBMITTALS

A. History of the TAB organization.

B. Agency certification.

C. Personnel qualifications.

D. TAB data forms.

E. Instrumentation list.

F. Name of the project supervising engineer.

G. Name and address and contact person of five successfully completed projects of similar size and scope.

H. To perform required professional services, the balancing agency shall have a minimum of one test and balance engineer certified by the Associated Air Balance Council.

1.5 TAB FIRM QUALIFICATIONS

A. The organization performing the work shall be a Certified member in good standing of the (AABC) Associated Air Balance Council.

B. Able to furnish evidence of having contracted for and completed not less than five systems of comparable size and type that have served their Owners satisfactorily for not less than five years.

C. A specialist in this field and have the personnel, experience, training, skill, and the organization to perform the work.

D. The balancing agency shall furnish all necessary calibrated instrumentation to adequately perform the specified services. An inventory of all instruments and devices in possession of the balancing agency may be required by the engineer to determine the balancing

agency's performance capability.

E. The balancing agency shall have operated for a minimum of five years under its current name.

F. Personnel:
1. The project supervisor shall be a Professional Engineer registered in Texas.
   a. Extensive knowledge of the work involved.
   b. At least five years experience conducting tests of the type specified.
   c. This test and balance engineer shall be responsible for the supervision and certification of the total work herein specified.
2. All work shall be conducted under the direct supervision of the supervising engineer.
3. Technicians shall be trained and experienced in the work they conduct.

1.6 WARRANTY

A. Provide (AABC) guarantee in writing.

B. Extended warranty.
1. Include an extended warranty of 2 years after completion of test and balance work, during which time the Architect/Engineer may request a retest or resetting of any outlet or other items as listed in the test report.
2. Provide technicians and instruments to assist the Architect/Engineer in making any tests he may require during this period.
3. The balancing agency shall perform an inspection of the HVAC system during the opposite season from that which the initial adjustments were made. The balancing agency shall make any necessary modifications to the initial adjustments to produce optimum system operation.

PART 2 - PRODUCTS

2.1 PREFFERED PROVIDER

A. Costal Air Balance

B. Engineered Air Balance

C. Tab Technologies

PART 3 - EXECUTION

3.1 TAB TOLERANCES

A. The water, outside air, supply air, return air, and exhaust air for each system shall be adjusted to within +/- 5% of the value scheduled on the drawings.

3.2 SITE VISITS

A. During construction, the balancing agency shall inspect the installation of the piping systems, sheetmetal work, temperature controls, energy management system, and other component parts of the heating, ventilating, and air conditioning systems. One inspection shall take place when 60% of the ductwork is installed and another inspection shall take place when 90% of the equipment is installed. The balancing agency shall submit a brief written report of each inspection to the architect and engineer.

B. Upon completion of the installation and start-up of the mechanical equipment by the

mechanical contractor, the balancing agency shall test and balance the system components to obtain optimum conditions in each conditioned space of the building. If construction deficiencies are encountered that preclude obtaining optimum conditions, and the deficiencies cannot be corrected by the mechanical contractor within a reasonable period of time, the balancing agency shall cease testing and balancing services and advise the architect, engineer, general contractor and owner, in writing, of the deficiencies.

C. Note proper piping installation, location of valves, and flow measuring instruments.

D. Make one series of visits, phased as required by construction progress, prior to installation of the ceiling. Note proper installation of balancing dampers.

E. Continue the site visits up to completion of project. In each succeeding report, list corrections made from previous reports.

3.3 TESTING INSTRUMENTS

A. Submit a list of all instruments to be used for the test and balance procedures.
   1. Catalog sheets
   2. Certificate of last calibration
   3. Calibration within a period of six months prior to balancing

B. Testing equipment shall be in good working order and tested for accuracy prior to start of work.

3.4 COORDINATION WITH OTHER SPECIFICATION SECTIONS

A. Review the related ductwork shop drawings and piping shop drawings. Make recommendations concerning suitability with respect to the testing, balancing and adjusting work.

B. Make tests to verify proper placement of the static pressure sensors for the variable air volume fan system control.

C. In cooperation with the work specified in Building Management and Control System section, a systematic listing of the testing and verification shall be included in the final TAB report. The TAB firm shall provide a laptop computer to operate with the Building Management and Control System. Building Management and Control System shall provide all necessary software and special interface cables, as required, to communicate with the DDC system:
   1. Work with the temperature control contractor to ensure the most effective total system operation within the design limitations, and to obtain mutual understanding of the intended control performance.
   2. Verify that all control devices are properly connected.
   3. Verify that all dampers, valves, and other controlled devices, are operated by the intended controller.
   4. Verify that all dampers and valves are in the position indicated by the controller (open, closed or modulating).
   5. Verify the integrity of valves and dampers in terms of tightness of close-off and full open positions. This includes dampers in multizone units, terminal boxes and fire/smoke dampers.
   6. Observe that all valves are properly installed in piping system in relation to direction of flow and location.
   7. Observe the calibration of all controllers.
   8. Verify the proper application of all normally opened and normally closed valves.
   9. Observe the locations of all thermostats and humidistats for potential erratic

operation from outside influences such as sunlight, drafts or cold walls.

10. Observe the location of all sensors to determine whether their position will allow them to sense only the intended temperatures or pressures of the media. Control contractor will relocate as deemed necessary by the Engineer.
11. Verify that the sequence of operation for any control mode is in accordance with the approved shop drawings and specifications. Verify that no simultaneous heating and cooling occurs.
12. Verify the correct operation of all interlock systems and installation is per the manufacturer recommendations.
13. Check all dampers for free operation.
14. Verify that all controller setpoints meet the design intent.
15. Perform variable volume system verification to assure the system and its components track with changes from full flow to minimum flow.

D. Upon completion of the testing and balancing, submit three days prior notice that the systems are ready for a running test. A qualified representative of the test and balance organization shall be present, with a representative from the engineers office, to field verify TAB report readings. Specific and random selections of data recorded in the certified test and balance report will be reviewed.

3.5 INSTRUMENT TEST HOLES

A. When it is required to make holes in the field to measure temperature, static pressure or velocity in the ducts:
   1. Drill holes, plug and tape external duct insulation.
   2. Repair damaged insulation to Engineer’s approval.

3.6 TESTING THE AIR DISTRIBUTION SYSTEM

A. The TAB agency shall verify that all ductwork, dampers, grilles, registers, and diffusers have been installed per design and set full open. The TAB agency shall perform the following TAB procedures in accordance with the AABC National Standards and all results shall be recorded in the TAB report:
   1. Supply Fans:
      a. Fan speeds: Test and adjust fan RPM to achieve design CFM requirements.
      b. Current and Voltage: Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure fan motor is not in or above the service factor.
      c. Pitot-Tube Traverse: Perform a Pitot-Tube traverse of the main supply and return ducts, as applicable, to obtain total CFM. If a Pitot-Tube traverse is not practical, an explanation of why a traverse was not made must appear on the appropriate data sheet. Measurements must be recorded with an Inclined Manometer or an Inclined/Vertical Manometer.
      d. Outside Air: Test and adjust the outside air on applicable equipment using a Pitot-Tube traverse. If a Pitot-Tube traverse is not practical, an explanation of why a traverse was not made must appear on the appropriate data sheet. If a traverse is not practical, use the mixed air temperature method, if the inside and outside temperature difference is at least 20°F, or use the difference between Pitot-tube traverse of the supply and return ducts.
      e. Static Pressure: Test and record system static pressure, including the static pressure profile of each supply fan.
   2. All Other Fans:
      a. Fan speeds: Test and adjust fan RPM to achieve design CFM requirements.
      b. Current and Voltage: Test and record motor voltage and amperage, and

compare data with the nameplate limits to ensure fan motor is not in or above the service factor.

c. Pitot-Tube Traverse: Perform a Pitot-Tube traverse of the main return ducts, as applicable, to obtain total CFM. If a Pitot-Tube traverse is not practical, an explanation of why a traverse was not made must appear on the appropriate data sheet. Measurements must be recorded with an Inclined Manometer or an Inclined/Vertical Manometer.

d. Static Pressure: Test and record system static pressure, including the static pressure profile of each return fan.

3. VAV Terminal Units:
   a. Set and record volume regulators on all terminal boxes to meet design maximum and minimum CFM requirements.
   b. Identification: Identify the type, location, and size of each terminal unit. This information must be recorded on the terminal box data sheets.
4. Diffusers, Registers and Grilles:
   a. Tolerances: Test, adjust, and balance each diffuser, grille, and register to within 5% of design requirements. Minimize drafts. Observe throws are in direction as indicated on drawings.
5. Coils (including electric coils):
   a. Air Temperature: Once air flows are set to acceptable limits, take wet bulb (cooling coil only) and dry bulb air temperatures on the entering and leaving side of each coil. Calculate the sensible and latent (cooling coil only) capacity of the coil. Provide information in TAB report.

B. Record preliminary air handler data, including fan RPM and static pressures across filter, fans and coils.

C. Perform a velocity traverse of the main supply ducts using a pitot-tube and inclined manometer to establish initial air delivery. Perform a Pitot-tube traverse of main supply and return ducts, as applicable, to obtain total CFM. If a pitot-tube traverse is not practical, a detailed explanation of why a traverse was not made must appear on the appropriate data sheet.

D. Where air measuring stations are installed, use pitot tube traverse readings to verify and record the correct calibration of the stations output.

E. Make adjustments in fan RPM and damper settings, as required, to obtain design supply air, return air, and outside air.

F. Measure and adjust all supply and return branches to design air delivery.

G. Measure and adjust all diffusers to design air delivery to +/- 5% of design requirements.

H. Make a set of recordings showing final system conditions.

3.7 TESTING THE HYDRONIC SYSTEMS

A. The TAB agency shall, as applicable, verify that all hydronic equipment, piping, and coils have been filled and purged; that strainers have been cleaned; that water has been flushed and is in a clean condition, and that all balancing valves (except bypass valves) are set full open. As applicable, check air vents and expansion or compression tank for proper operation. The TAB agency shall perform the following testing and balancing functions in accordance with the AABC National Standards and all results shall be recorded in the TAB report:

1. Record preliminary pump data.
   a. Pump RPM.
   b. Pump shut-off differential head.

c. Pump operating differential head.
d. Check and verify pump alignment.
e. Verify impeller diameter.

B. Adjust balancing valves in the pump discharge lines to obtain design water quantity as read from the manufacturer's pump curve and from a flow meter.

C. In variable flow systems, the water flow of the pump shall be set at the scheduled gpm, not the total of all the valves. Determine the diversity of the system and balance the individual coils with the maximum pump water quantity flowing in the system.

D. Balance flow through:
1. Chillers.
2. Coils.
3. Boiler.
4. Pumps
5. Condensers.
6. Cooling tower.
7. Heat Exchanger.

E. Use flow meters, differential pressures and temperature relationships as required.

F. Balance by-pass lines to obtain the same pressure drop with systems on by-pass as full flow through the coil including the valve.

G. Repeat steps, as required, to obtain a final systems balance and make a set of recordings showing final systems conditions.

H. Pumps:
1. Test and adjust pumps to meet design water flow requirements. Check pumps for proper operation. Pumps shall be free of vibration and cavitation Record appropriate gauge readings for final TDH and Block-Off\Dead head calculations. Check and verify pump alignment.
2. Current and Voltage: Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure pump motor is not in or above the service factor.

I. Coils:
1. Tolerances: Test, adjust, and balance all chilled water and hot water coils within 5% of design flow requirements.
2. Verification: Verify the type, location, final pressure drop and water quantity (GPM) of each coil. Calculate the actual capacity of all coils. This information shall be recorded on coil data sheets.

J. Boilers:
1. Verify that boilers have been filled and started by others, and are in operation.
2. Current and Voltage: As applicable, test and record motor voltage and amperage, and compare data with the nameplate limits to ensure motor is not in or above the service factor.
3. Test, adjust and record water flows through water boilers.
4. Test and record water temperature profiles of each boiler.

K. Chillers:
1. Verify that chillers have been started by the manufacture and are in operation. Test and adjust chiller water flows to within 5% of the design requirements by using a U-TUBE manometer and setting balancing valves.
2. Current and Voltage: Test and record motor voltage and amperage, and compare

data with the nameplate limits to ensure compressor motor is not in or above the service factor.
3. Test and record temperature profiles of each chiller at design water flow.

L. Cooling towers:
1. Verify that cooling towers have been filled and started by others and are in operation.
2. Current and Voltage: Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure cooling tower fan motor is not in or above the service factor.
3. Test and adjust water flows to balance tower cells and flows between towers.
4. Test and record water temperature profiles of each condenser at design water flow for water and air side operation.

M. Heat exchangers:
1. Verify that heat exchangers have been filled and started by others, and are in operation.
2. Test and record temperature and pressure profiles of water and steam heat exchangers.

3.8 EQUIPMENT POWER READINGS

A. Record the following information for each motor:
1. Equipment designation.
2. Manufacturer.
3. Unit model number and serial number and frame.
4. Motor nameplate horsepower; nameplate voltage; phase and full load amperes.
5. Heater coil in starter.
a. Rating in amperes.
b. Manufacturer's recommendation.
6. Motor RPM/driven equipment RPM.
7. Power reading (voltage, amperes of all legs at motor terminals).

3.9 BOILERS

A. Check for proper operation and with operation at near design conditions, record the following:
1. Manufacturer, model number, serial number and nameplate.
2. If water type, water flow in GPM, entering and leaving water temperature and water pressure drop in feet.
3. Type of fuel and heating value.
4. Rate of fuel consumption.
5. Capacity in MBH.
6. Efficiency.
7. Flue gas analysis.
8. Motor data.

B. Observe demonstration that all controls and safety devices are functioning properly. Record observations.

3.10 CHILLERS (Water Cooled)

A. Balance flow of water thru each evaporator and condenser to be within a range of 100% to 110% of design flow with all pumps operating. With only one pump operating, the maximum flow shall not exceed the maximum tube velocity recommended by the manufacturer.

B. Verification of safety interlocks and controls are the responsibility of the manufacturer.

C. With each chiller operating at near design temperature and water flow conditions, measure and record the following:
   1. Manufacturer, model number, serial number and all nameplate data.
   2. Evaporator water entering temperature, leaving temperature, pressure drop (ft.) and water quantity (GPM).
   3. Condenser water entering temperature, leaving temperature, pressure drop (ft.) and water quantity (GPM).
   4. Evaporator and condenser refrigerant temperatures and pressures (using instruments furnished with the machine by the manufacturer).
   5. Volts and amps for each phase.
   6. Power factor.
   7. KW input.
   8. Tons of cooling.
   9. KW per ton of cooling.

D. Reference chiller specification for additional requirements.

3.10 CHILLERS (Air Cooled)

A. Balance flow of water through each evaporator to be within a range of 100% to 110% of design flow with all pumps operating. With only one pump operating, the maximum flow shall not exceed the maximum tube velocity recommended by the manufacturer.

B. Verification of safety interlocks and controls are the responsibility of the manufacturer.

C. With each chiller operating at near design temperature conditions, measure and record the following:
   1. Manufacturer, model number, serial number and all nameplate data.
   2. Evaporator water entering temperature, leaving temperature, pressure drop (ft.) and water quantity (GPM).
   3. Condenser air entering temperature, leaving temperature.
   4. Evaporator and condenser refrigerant temperatures and pressures (using instruments furnished with the machine by the manufacturer).
   5. Volts and amps for each phase.
   6. Power factor.
   7. KW input.
   8. Tons of cooling.
   9. KW per ton of cooling.

D. Reference chiller specification for additional requirements.

3.11 TESTING THE VARIABLE AIR VOLUME SYSTEM

A. All VAV boxes used are to be calibrated to produce the rated air quantity.

B. Set and record the supply air static pressure controller to provide actual design air flow at the most resistive terminal.

C. Measure and adjust the design air delivery at the inlet of each VAV box.

D. Measure and record the air quantity from each VAV box at its maximum flow. Manipulate the controller to achieve maximum flow.

E. Reset each box to yield and record minimum primary air flow.
   1. DDC controllers record the correction factor required to establish actual desired

air quantity as designed.

2. Pneumatic controllers adjust velocity controller as required to establish actual desired air quantity as designed.

F. If the box is operating with inlet static pressure in excess of the minimum cataloged pressure specified by the manufacturer and is not producing rated air quantity, field adjust the box to produce rated air quantity. Retest until approved results are obtained.

G. Position the VAV boxes to the proportion of maximum fan air volume to total installed box maximum volume.

H. Set the fan to deliver the AHUs scheduled design airflow.

I. Perform and record a total air traverse.

J. With the system terminal boxes set for full flow or diversity, the system will be delivering the scheduled design CFM with the most restrictive box in control. Make a speed increase if either or both static and volume are low.

K. Set the boxes to minimum and adjust the inlet vanes and or speed controllers to prevent excessive static in the system.

L. Coordinate with the work specified in Building Management and Control System on the final location of the sensors for the static pressure controller. Locate in the supply duct far enough from the fan discharge to be truly representative of the average static pressure in the system.

M. Modulate the fan speed on the supply fan. Adjust as required to coordinate with the static pressure sensing network.

N. Make a set of recordings showing final system conditions including system duct static pressures and control system setpoint.

3.12 DUCT TEST

A. Test and Balancing Contractor shall verify and record the duct test results. A copy of the duct test results, as completed, shall be submitted to the engineer for review within five days. Provide a complete report of all the duct test results in the final TAB report.

3.13 DIRECT EXPANSION EQUIPMENT

A. With each unit operating at near design conditions, measure and record the following:
   1. Manufacturer, model number, serial number and all nameplate data.
   2. Ambient temperature, condenser discharge temperature.
   3. Amperage and voltage for each phase.
   4. Leaving and entering air temperatures.
   5. Suction and discharge pressures and temperatures.
   6. Tons of cooling.
   7. Verification that moisture indicator shows dry refrigerant.

3.14 COOLING TOWERS

A. A complete CTI certified test of the cooling tower will be performed by others at the expense of the cooling tower manufacturer. A copy of this test (provided by others) shall be included in the final TAB Report. Balance the flow over and through bypass connections of the tower.

3.15 TAB REPORT

A. The activities described in this specification shall be recorded in a report form; and four individually bound copies shall be provided to the Architect and Engineer. Neatly type and arrange data. Include with the data the date tested, personnel present, weather conditions, nameplate record of the test instruments used and list all measurements taken after all corrections are made to the system. Record all failures and corrective action taken to remedy any incorrect situation. The intent of the final report is to provide a reference of actual operating conditions for the Owner's operations personnel. Provide a "Preface" which shall include a general discussion of the system and any abnormalities or problems encountered.

B. All measurements and recorded readings (of air, water, electricity, etc.) that appear in the report must have been recorded on site by the permanently employed technicians or engineers of the TAB firm.

C. Submit reports on forms approved by the engineer that will include the following data as a minimum:
   1. Title Page
      a. Company Name
      b. Company Address
      c. Company telephone number
      d. Project name
      e. Project location
      f. Project Manager
      g. Project Engineer
      h. Project Contractor
      I. Project Identification Number
   2. Summary of the TAB report data
   3. Index
   4. Instrument List
      a. Instrument
      b. Manufacturer
      c. Model
      d. Serial Number
      e. Range
      f. Calibration Date
      g. What test instrument is to be used for:
   5. Fan Data
      a. Location
      b. Manufacturer
      c. Model
      d. Air flow, specified and actual
      e. Total static pressure (total external) specified and actual
      f. Inlet pressure
      g. Discharge pressure
      h. Fan RPM
   6. Return Air/Outside Air Data
      a. Identification/location
      b. Design return air flow
      c. Actual return air flow
      d. Design outside air flow
      e. Actual outside air flow
      f. Return air temperature
      g. Outside air temperature
      h. Required mixed air temperature
      I. Actual mixed air temperature

7. Electric Motors
    a. Manufacturer
    b. HP/BHP
    c. Phase, voltage, amperage, nameplate, actual
    d. PM
    e. Service Factor
    f. Starter size, heater elements, rating
8. V-Belt Drive
    a. Identification/location
    b. Required driven RPM
    c. Drive sheave, diameter and RPM
    d. Belt, size and quantity
    e. Motor sheave, diameter and RPM
    f. Center-to-center distance, maximum, minimum and actual
9. Duct Traverse
    a. System zone/branch
    b. Duct size
    c. Area
    d. Design velocity
    e. Design air flow
    f. Test velocity
    g. Test air flow
    h. Duct static pressure
    I. Air correction factor
10. Air Monitoring Station Data
    a. Identification/location
    b. System
    c. Size
    d. Area
    e. Design velocity
    f. Design air flow
    g. Test velocity
    h. Test air flow
11. Air Distribution Test Sheet
    a. Air terminal number
    b. Room number/location
    c. Terminal type
    d. Terminal size
    e. Correction factor
    f. Design velocity
    g. Design air flow
    h. Test (final) velocity
    i. Test (final) air flow
12. Pump Data
    a. Identification/number
    b. Manufacturer
    c. Size/model
    d. Impeller
    e. Service
    f. Design flow rate, pressure drop, BHP
    g. Actual flow rate, pressure drop, BHP
    h. Discharge pressure
    I. Suction pressure
    j. Total operating head pressure
    k. Shut off, discharge and suction pressures
    l. Shut off, total head pressure
    m. Pressure differential settings

13. Cooling Coil Data
    a. Identification/number
    b. Location
    c. Service
    d. Manufacturer
    e. Entering air DB temperature, design and actual
    f. Entering air WB temperature, design and actual
    g. Leaving air DB temperature, design and actual
    h. Leaving air WB temperature, design and actual
    i. Water pressure flow, design and actual
    j. Water pressure drop, design and actual
    k. Entering water temperature, design and actual
    l. Leaving water temperature, design and actual
    m. Air pressure drop, design and actual
    n. Capacity - sensible and latent
14. Heating Coil Data
    a. Identification/number
    b. Location
    c. Service
    d. Manufacturer
    e. Entering air DB temperature, design and actual
    f. Leaving air DB temperature, design and actual
    g. Water pressure flow, design and actual
    h. Water pressure drop, design and actual
    i. Entering water temperature, design and actual
    j. Leaving water temperature, design and actual
    k. Air pressure drop, design and actual
    l. Capacity
15. Electric Coil Data
    a. Identification/number
    b. Location
    c. Service
    d. Manufacturer
    e. Entering air DB temperature, design and actual
    f. Leaving air DB temperature, design and actual
    g. Electrical Characteristics
    h. Capacity
16. Sound Level Report
    a. Location (Location established by the design engineer)
    b. N C curve for eight (8) bands-equipment off
    c. N C curve for eight (8) bands-equipment on
17. Vibration Test on equipment having 10 HP motors or greater in size.
    a. Location of points:
        1) Fan bearing, drive end
        2) Fan bearing, opposite end
        3) Motor bearing, center (if applicable)
        4) Motor bearing, drive end
        5) Motor bearing, opposite end
        6) Casing (bottom or top)
        7) Casing (side)
        8) Duct after flexible connection (discharge)
        9) Duct after flexible connection (suction)
    b. Test readings:
        1) Horizontal, velocity and displacement
        2) Vertical, velocity and displacement
        3) Axial, velocity and displacement
    c. Normally acceptable readings, velocity and acceleration

d. Unusual conditions at time of test
e. Vibration source (if non-complying)

18. Control verification indicating date performed and any abnormalities identified.
    a. Point Location/Description
    b. EMS Readout (Setpoint and Actual)
    c. Actual Readout of all points
    d. Interlocks
    e. Safeties
    f. Variable speed drive tracking with EMS input
    g. Variable speed drive Bypass operation
    h. Sequence of operation

END OF SECTION

SECTION 23 05 94 - COORDINATION OF TESTING AND BALANCING

PART 1 - TESTING, BALANCING AND ADJUSTING

1.1 WORK INCLUDED

A. Balancing and adjusting of the environmental systems is specified in Section 23 05 93.

B. Coordination of the work is specified in this Section.

PART 2 - PRODUCTS / NOT USED

PART 3 - EXECUTION

3.1 COORDINATION

A. Bring the work to a state of readiness for testing, balancing, and adjusting.
1. Install air terminal devices.
2. Provide specified filters in air handling equipment. Install clean filters just prior to the start of the test and balance work.
3. Verify lubrication of equipment.
4. Install permanent instrumentation.
5. Clean piping systems and fill with clean water.
6. Complete "Start-up" of equipment.
7. Check rotation and alignment of rotating equipment and tension of belted drives.
8. Verify ratings of overload heaters in motor starters.
9. Verify that safety and operating control set points are as designed and automatic control sequences have been checked.
10. Provide control diagrams and sequence of operation.
11. Collect material for maintenance manuals and prepare one manual especially for use in testing and balancing.
12. Verify that graphic operational data such as start/stop instructions, valve tag schedules, and piping identification schedules have been provided where needed.
13. Verify that equipment and piping identification work has been completed with valve tags, schedules, and piping identification system.
14. Comb out fins on extended-surface heat transfer coils where damaged.
15. Clean all strainers as required.
16. Remove construction strainers after water is cleaned and treated.
17. Remove all temporary filters from HVAC equipment.
18. Provide start-up reports listing all start-up information and manufacturer’s information attached.

B. Provide and install new pulleys and belts as required to effect the correct speed ratio. Adjustments where no belt or pulley change is required, is specified in Section 23 05 93.

C. Verify that the systems are ready for balancing and adjusting.

D. Submit a letter stating:
1. The specified pieces of equipment have been checked, started, and adjusted by the manufacturer.
2. Other equipment has been checked and started.
3. The systems have been operated for the specified period of time.
4. The automatic controls system has been adjusted, calibrated, and checked, and is operating as specified.

E. Provide the services of a technician full time at all times at the project when testing,

balancing and adjusting work is being conducted.

F. Provide instrumentation and services to take readings of the required data for the refrigerant circuits.

G. Provide and install volume dampers required for balancing by the TAB Contractor.

3.2 START-UP OF EQUIPMENT

A. Pre-start & Start-up equipment using the procedures as recommended by the manufacturers.

B. Complete start-up of equipment prior to start of testing & balancing.

C. Submit start-up procedures as outlined by the manufacturers and complete the "HVAC FAN / AIR HANDLING / START-UP REPORT FORM" to Engineer.

HVAC FAN / AIR HANDLING UNIT / START-UP REPORT FORM														
Equipment Description	*Actual*			*Disc. Switch Wired*	*Rotation Correct*	*Belt*		*RPM Correct Submittal*	*Vibration Isolation Correct*	*Attachment To Roof Curb*	*List Of Damage Parts*	*Bearings Lubricated*	*Filter Installed*	*Interlocks & Dampers Operational*
	Voltage	*Amps*	*HP*			*Condition & Part #*	*Tension Correct*							

END OF SECTION

SECTION 23 07 13 - EXTERNAL DUCT INSULATION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install external insulation on supply, return, exhaust and outside air ductwork.

B. External insulation of concealed and exposed ducts is included in this Section. Internal acoustic duct lining is specified under ductwork and not included in this Section.

1.2 RELATED WORK

A. Division 9 - FINISHES. Painting and Color Coding.

B. Division 23 - MECHANICAL.
1. Air Handling Units. Internal insulation for air units is specified in the sections on air handling units. The units do not require external insulation.
2. Internal Duct Liner. Internal duct liner is specified in the section on ductwork.
3. Insulation. Refer to specific sections on individual insulation types.
4. Refer to insulation and liner plan detail.

1.3 QUALITY ASSURANCE

A. The intent of insulation specifications is to obtain superior quality workmanship, resulting in an installation that is absolutely satisfactory in both function and appearance. Provide insulation in accordance with the specifications for each type of service and apply as recommended by the manufacturer and as specified.

B. An approved contractor for this work under this Division shall be:
1. A specialist in this field and have the personnel, experience, training, skill, and the organization to provide a practical working system.
2. Able to furnish evidence of having contracted for and installed not less than 3 systems of comparable size and type that have served their Owners satisfactorily for not less than 3 years.

C. All duct insulation used on the project inside the building must have a flame spread rating not exceeding 25 and a smoke developed rating not exceeding 50 as determined by test procedures ASTM E84, NFPA 255 and UL 723. These ratings must be as tested on the composite of insulation, jacket or facing, and adhesive. Components such as adhesives, mastics and cements must meet the same individual ratings as the minimum requirements and bear the UL label.

D. Condensation on any insulated system is not approved.

E. Replace insulation damaged by either moisture or other means. Insulation that has been wet, whether dried or not, is considered damaged. Make repairs where condensation is caused by improper installation of insulation. Also repair any damage caused by the condensation.

F. Where existing insulated ductwork or other services are tapped, remove existing insulation back to undamaged sections and replace with new insulation of the same type and thickness as existing insulation. Apply as specified for insulation of the same service.

1.4 APPROVALS

A. Submittals. Submit product data on each insulation type, adhesive, and finish to be used in the work. Make the submittal as specified in Division 1 General Requirements and obtain approval before beginning installation. Include product description, list of materials and thickness for each service and location, and the manufacturer's installation instructions for each product.

B. Sample Application. Make an application of each type of insulation to display the material, quality and application method. Obtain approval of the sample application before proceeding with installation of the work.

PART 2 - PRODUCTS

2.1 INSULATION

A. Glass fiber rigid duct insulation.
   1. Minimum density of 3 pcf, installed R value to be 6.0 (when located in a conditioned plenum) and minimum density of 0.75 pcf, installed R value to be 8.0 (when located in an unconditioned plenum) at 75°F mean, facing of 0.7 mil aluminum foil reinforced with glass yarn mesh and laminated to 40 lbs. fire-resistant Kraft. R-value to be indicated on exterior side of insulation to be verified by City inspector.
   2. Acceptable Manufacturers
      a. Schuller 814 spin-glas FSK.
      b. Owens-Corning Type 703 board RKF.
      c. Knauf 3 PCF FSK.

B. Glass fiber blanket duct insulation.
   1. Minimum density of 1.0 pcf, installed R value to be 6.0 (when located in a conditioned plenum) and minimum density of 0.75 pcf, installed R value to be 8.0 (when located in an unconditioned plenum) at 75°F mean, facing of 0.35 mil foil reinforced with glass yarn mesh and laminated to 40 lbs. fire resistant Kraft. R-value to be indicated on exterior side of insulation to be verified by City inspector.
   2. Acceptable Manufacturers
      a. Manville R-series Microlite FSKL.
      b. Owens-Corning ED100 RKF.
      c. Knauf 1.0 PCF FSK.

C. Fiberglass reinforcing cloth mesh.
   1. Acceptable Manufacturers
      a. Perma Glass Mesh.
      b. Alpha Glass Mesh.
      c. Childers Chil-Glas #10
      d. Foster Mast a Fab
      e. Vimasco.

D. Mastics, sealants, coatings and adhesives.
   1. Acceptable Manufacturers
      a. Childers.
      B. Foster.
      c. Vimasco.

E. Fireboard Insulation
   1. Totally encapsulated with foil facing.
   2. Two hour rated fire protection.
   3. Zero clearance to combustible protection.

4. System shall be listed and labeled by an NRTL.
5. Tested per ISO 6944, Type A Duct and achieve a 2 hour rating for stability, integrity and insulation.
6. Provided system is subject to the approval of the Local Authority Having Jurisdiction.
7. Acceptable Manufacturers
    a. Unifrax ON Fyrewrap Elite 1.5
    b. Partak Insulation, Inc. Paroc Fireboard
    c. Thermal Ceramics FireMaster 3M
    d. Premier Refractories International, Pyroscat.

F. Rigid Closed Cell Insulation
1. Acceptable Manufacturers
    a. Dow Trymer.
    b. Phenolic Foam.

G. Reinforced Foil Tape
1. Acceptable Manufacturers
    a. Venture 1525CW
    b. 3” FSK
2. Thickness 6.5 mils
3. Color: silver

2.2 COATING AND ADHESIVE

A. Coating. Provide Childers CP-38 or Foster 30-80 vapor barrier coating. Coating must meet MIL Spec C-19565C, Type II and be QPL Listed. Permeance shall be 0.013 perms or less at 43 mils dry. Tested at 100ºF and 90% RH per ASTM E96.

B. Outdoors: Provide as insulation coating Childers Encacel X or Foster Monolar 60-90. Permeance shall be 0.03 perms or less at 30 mils dry. Tested at 100ºF and 90% RH per ASTM F 1249.

C. Adhesive. Provide Childers CP-82 or Foster 85-20 vapor barrier adhesive.

D. Reinforcing Mesh. Provide 10 x 10 white glass or polyester reinforcing mesh.

2.3 OUTDOOR DUCT LAMINATED JACKETING

A. Rubberized bitumen compound material:
1. Ultraviolet resistant
2. Weatherproof
3. Vapor retarding jacketing
4. Laminated jacketing
5. Cross-laminated high strength polyethylene film
6. Laminated to aluminum foil
7. Minimum 60-mil thickness

B. Acceptable Manufacturers:
1. Alumaguard 60
2. Flex Clad 400
3. Venture Clad 1577CW

PART 3 - EXECUTION

3.1 FIRE SAFETY REQUIREMENTS

A. Do not extend duct coverings through walls or floors required to be fire-stopped or required to have a fire resistance rating. Interrupt duct coverings in the immediate vicinity of heat sources such as electric resistance or fuel-burning heater.

3.2 CONCEALED DUCT

A. Provide flexible glass fiber insulation with factory-applied, reinforced UL labeled Foil-Skrim-Kraft (FSK) facing.

B. Standing Seams. Insulate standing seams and stiffeners, which protrude through the insulation with 0.6 lb. per cubic foot density, 1-1/2" thick, faced, flexible blanket insulation. Insulation shall not prevent adjustment of damper operators.

C. Insulation shall be wrapped tightly on the ductwork with all circumferential joints butted and longitudinal joints overlapped a minimum of 2". In addition, secure insulation to the bottom of rectangular ductwork by the use of either weld pins with washers or cup-head pins welded to the ductwork or perforated based insulation hangers glued to the duct on twelve inch centers to prevent sagging of insulation.

D. On circumferential joint, the 2" flange on the facing shall be stapled with 9/16" outward clinch steel staples on 2" centers and taped using 3" wide foil tape applied with additional adhesive of Foster 85-75. Cover all seams, joints, pin penetrations and other breaks with foil tape and glue.

E. Ductwork in mechanical rooms is considered concealed spaces.

3.3 EXPOSED DUCT INSULATION

A. Ductwork in exposed locations is to be insulated with fiberglass rigid / semi-rigid board insulation.
   1. Apply fabric and mastic to provide a smooth surface for painting.

B. Standing Seams: Insulate standing seams and stiffeners which protrude through the insulation with 0.6 lb per cubic foot density, 1-1/2 inch thick, faced insulation. As a vapor seal, use reinforcing mesh with vapor barrier coating. Insulation shall not prevent adjustment of damper operators.

C. Insulation shall be wrapped tightly on the ductwork. Adhere insulation to ductwork with adhesive. In addition, secure insulation to the bottom of rectangular ductwork by the use of either weld pins with washers or cup-head pins welded to the ductwork or perforated based insulation hangers glued to the duct on 12 inch centers to prevent sagging of insulation.

D. Cover all seams, joints, pin penetrations and other breaks with coating reinforced with reinforcing mesh. Fabric shall not be visible after coating.

3.4 OUTDOOR DUCTWORK COVERING

A. Cover all supply and return ductwork outdoors:
   1. 1-1/2" thick, rigid closed cell insulation with reinforced foil facing.

B. Install a high point in center and slope in both directions so water will not stand on horizontal surfaces.

C. Impale the insulation over mechanical fasteners and washers.

1. A minimum of 2 rows of fasteners per side on 12-inch centers.
2. Seal all breaks, joints and punctures by applying a 1/8” thick vapor barrier mastic coating, embedded in open mesh reinforcing mesh.

D. Standing S, or flanged connections shall be covered with the same thickness of insulation overlapped a minimum of 4”.

E. Apply a tack coat of Childers CP-10/11 or Foster 46-50 weather barrier mastic over the entire surface.
1. While this coat is still tacky, Childers #5 glass fiber reinforcing mesh shall be smoothly applied and pressed into the mastic. The cloth shall be taut with adjacent edges overlapped a minimum of 4”.
2. After the first coat of mastic has taken its set, the second coat shall be applied over the cloth by palm, trowel, or spray to sufficient thickness that, when dried, the combined thickness of mastic and cloth is not less than 1/8”.
3. Upon completion, the openings in the cloth shall be completely sealed and the yarn shall not be visible. The completed work shall be completely smooth and present a plane surface.
4. Aluminum gray or white finish as approved by the Architect.

F. Standing water on horizontal surfaces is not approved.

G. Apply outdoor duct laminated jacketing protection over entire insulation surface. Apply rubberized bitumen compound, applied to a cross-laminated high strength polyethylene film, laminated to aluminum foil.

3.5 KITCHEN GREASE EXHAUST DUCTWORK / KILN DUCTWORK / FUME HOOD DUCT

A. Secure fireboard insulation to duct with impaling pins and 3” square speed clips. In addition, provide a wire mesh support system and additional sealing or support as required by the code enforcing authority. The insulation support system shall include framed access to allow the insulation to be removed and replaced without damage at the access doors in the duct system for inspection and cleaning. Coordinate location of access openings to correspond accurately. Provide stainless steel banding on 12” centers.

3.6 GENERAL INSTALLATION

A. Install materials in accordance with manufacturer's instructions.

B. Apply insulation on clean, dry surfaces only.

C. Continue insulation with vapor barrier through penetrations.

D. Neatly finish insulation at supports, protrusions and interruptions.

E. Install insulation on clean, dry surfaces, and only after building is weatherproofed sufficiently to preclude any rainwater on insulation.

F. Apply mastic over the fiberglass reinforcing mesh to a thickness where fabric is not visible after completion.

G. Install fiberglass blanket duct insulation on top of supply air grilles not fire rated.

END OF SECTION

SECTION 23 07 16 - VESSEL INSULATION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install insulation for both high and low temperature vessels.

B. Low temperature installations include expansion tanks, air eliminators, chiller nozzles, chiller heads and other vessels containing liquids 60°F and below.

C. High temperature installations include expansion tanks, air eliminators, domestic water storage tanks, boiler stack / transition and other vessels containing liquids above 60°F.

1.2 QUALITY ASSURANCE

A. The intent of insulation specifications is to obtain superior quality workmanship resulting in an installation that is absolutely satisfactory in both function and appearance. Provide insulation in accordance with the specifications for each type of service and apply as recommended by the manufacturer and as specified.

B. An approved contractor for this work under this Division shall be:
   1. A specialist in this field and have the personnel, experience, training, skill, and the organization to provide a practical working system.
   2. Able to furnish evidence of having contracted for and installed not less than 3 systems of comparable size and type that have served their owners satisfactorily for not less than 3 years.

C. All vessel insulation used on the project inside the building must have a flame spread rating not exceeding 25 and a smoke developed rating not exceeding 50, as determined by test procedures ASTM E 84, NFPA 255 and UL 723. These ratings must be as tested on the composite of insulation, jacket or facing, and adhesive. Components such as adhesives, mastics and cements must meet the same individual ratings as the minimum requirements and bear the UL label.

D. Condensation on any insulated vessel system is not acceptable.

E. Replace insulation damaged by either moisture or other means. Insulation that has been wet, whether dried or not, is considered damaged. Make repairs where condensation is caused by improper installation of insulation, also repair any damage caused by the condensation.

F. Where existing insulated vessel, or other surfaces are tapped, remove existing insulation back to undamaged sections for hot surfaces or to nearest insulation stop for cold surfaces, and replace with new insulation of the same type and thickness as existing insulation. Apply as specified for insulation of the same service.

1.3 APPROVALS

A. Submit product data on each insulation type, adhesive, and finish to be used in the work. Make the submittal as specified in Division 1 General Requirements and obtain approval before beginning installation. Include product description, list of materials and thickness for each service and location and the manufacturer's installation instructions for each product.

B. Make an application of each type of insulation to display the material, quality and application method. Obtain approval of the sample application before proceeding with installation of the work.

1.4 RELATED WORK

A. Division 9 Finishes. Painting and color-coding

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Glass fiber pipe & tank insulation:
   1. Schuller Type 817
   2. Owens-Corning Type 705
   3. Knauf 2.8 PCF

B. Aluminum Jacketing:
   1. Childers
   2. Pabco
   3. RPR

C. Monel Staples
   1. Bostich Monel
   2. Duo-Fast Monel
   3. Markwell Monel

D. Fiberglass reinforcing cloth mesh:
   1. Perma Glass Mesh
   2. Alpha Glass Mesh
   3. Childers Chil-Glas
   4. Foster Mast a Fab

2.2 CEMENT, MASTICS, SEALANTS, ADHESIVES AND COATINGS

A. Adhesive: Provide Childers CP-127 or Foster 85-60 fiberglass adhesive to seal insulation for low temperature vessels.

B. Lagging Adhesive / Coating: Furnish Childers CP50AHV2 or Foster 30-36 lagging adhesive / coating to provide a finish coat and to secure finish cloth for high temperature vessels.

C. Insulation Joint Sealant: Use Childers CP-76 or Foster 95-50 to seal the joints of insulation on low temperature vessels.

D. Metal Jacketing Sealant: Use Childers CP-76 or Foster 95-44 on all metal jacketing laps outdoors.

E. Vapor Barrier Coating: Indoors - Use Childers CP-38 or Foster 30-80 vapor barrier coating finish to coat the canvas finish on low temperature vessels. Permeance shall be 0.013 perms or less as tested by ASTM E96. Coating must comply with MIL-C-19565C, Type II and be QPL listed. Permeance shall be 0.03 perms or less at 30 mils, dry. Tested at 100°F and 90% RH per ASTM F 1249 and by Hypalon rubber based.

F. Weather Barrier Mastic: Furnish Childers CP-10/11 or Foster 46-50 weather barrier mastic and reinforcing mesh for outdoor finish.

G. Reinforcing Mesh: Furnish 10 X 10 white glass or polyester reinforcing mesh.

PART 3 - EXECUTION

3.1 LOW AND HIGH TEMPERATURE VESSELS (FIBERGLASS)

A. Apply a first layer of insulating board. Band the board on immediately after application, using bands on 12” centers, drawn tight and securely fastened.

B. Apply successive layers of insulation as specified for the first layer, with joints staggered. After insulation has been applied, finish with Childers CP-38 or Foster 30-80 vapor barrier coating reinforced with glass or polyester reinforcing mesh per manufacturer's recommendations. Provide a flood coat of Childers CP-10/11 or Foster 46-50 with Foster Mast a Fab polyester or Chil Glas #10 reinforcing mesh.

C. To insulate removable heads, provide two equal sections of heavy-gauge, galvanized sheet metal covers, angle reinforced and lined with insulation board. Make covers easily removable to allow free access to the heads for inspection, cleaning and dismantling. Provide suitable flanges on the sections with neoprene gaskets between them, permitting a tight seal when the two sections are bolted together. Fill the voids with glass fiber wall cavity insulation.

3.2 ALUMINUM JACKETING (Insulated vessels outdoors above grade)

A. Apply aluminum jacket on vessels according to manufacturer's recommendations using aluminum strapping and metal jacketing sealant to provide weather tight covering.

B. Aluminum jacketing is not considered as contributing to the vapor barrier or the insulation jacket. The vapor barrier must be sufficient in itself for this function.

C. Install straps on 12” centers.

3.3 VESSEL INSULATION REQUIREMENTS

A. Insulate all low and high temperature vessels located exterior (outside) of the building, including the following:
   1. Air separators
   2. Expansion Tanks
   3. Chemical feeders
   4. Chilled water system volume tanks
   5. Insulation thickness shall match thickness of adjoining pipe insulation

B. Insulate all low temperature vessels located interior (inside of the building, including the following:
   1. Air separators
   2. Chemical feeders
   3. Chilled water system volume tanks
   4. Insulation thickness shall match thickness of adjoining pipe insulation

C. Insulate the following high temperature vessels located interior (inside the building).
   1. Air Separators

2. Insulation thickness shall match thickness of adjoining pipe insulation

D. As indicated on the drawings

END OF SECTION

SECTION 23 07 19 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install piping insulation, jackets, accessories and covering of specified materials. The insulation shall be used for high and low temperature piping applications including hot water, refrigerant lines, condensate piping and make-up water.

1.2 QUALITY ASSURANCE

A. The intent of insulation specifications is to obtain superior quality workmanship resulting in an installation that is absolutely satisfactory in both function and appearance. Provide insulation in accordance with the specifications for each type of service and apply as recommended by the manufacturer and as specified.

B. An approved contractor for this work under this Division shall be:
   1. A specialist in this field and have the personnel, experience, training, skill, and the organization to provide a practical working system.
   2. Able to furnish evidence of having contracted for and installed not less than 3 systems of comparable size and type that have served their owners satisfactorily for not less than 3 years.

C. All piping insulation used on the project inside the building must have a flame spread rating not exceeding 25 and a smoke developed rating not exceeding 50, as determined by test procedures ASTM E 84, NFPA 255 and UL 723. These ratings must be as tested on the composite of insulation, jacket or facing, and adhesive. Components such as adhesives, mastics and cements must meet the same individual ratings as the minimum requirements and bear the UL label.

D. Condensation on any insulated piping system is not acceptable.

E. Replace insulation damaged by either moisture or other means. Insulation that has been wet, whether dried or not, is considered damaged. Make repairs where condensation is caused by improper installation of insulation. Also repair any damage caused by the condensation.

F. Where existing insulated piping, or other surfaces are tapped, remove existing insulation back to undamaged sections for hot surfaces or to nearest insulation stop for cold surfaces, and replace with new insulation of the same type and thickness as existing insulation. Apply as specified for insulation of the same service.

1.3 SUBMITTALS

A. Submit product data on each insulation type, adhesive, and finish to be used in the work. Make the submittal as specified in General Requirements and obtain approval before beginning installation. Include product description, list of materials and thickness for each service and location and the manufacturer's installation instructions for each product.

B. Make a field application of each type of insulation to display the material, quality and application method. Obtain approval of the sample application before proceeding with installation of the work.

1.4 RELATED WORK

A. Finishes. Painting and color-coding

B. Pipe Heat Tracing

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Glass fiber pipe insulation:
   1. Johns-Manville Micro-Lok AP-T
   2. Owens-Corning ASJ/SSL
   3. Knauf ASJ/SSL

B. Cellular Glass Insulation (Foamglass):
   1. Pittsburg Corning
   2. Cell-U-Foam

C. Rigid Foam Insulation:
   1. Kingsapan Tarec
   2. Dow Trymer
   3. Tarec Ecophen – Phenolic Foam

D. Aluminum Jacketing:
   1. ITW Lock-on (Childers)
   2. ITW Z-lock (Pabco)

E. Fiberglass reinforcing cloth mesh:
   1. Perma Glass Mesh
   2. Alpha Glass Mesh
   3. Childers Chil-Glas
   4 Foster Mast a Fab
   5. Vimasco

F. Mastics, Sealants, Coatings and Adhesives
   1. Childers
   2. Foster
   3. Vimasco
   4. Armacell 520 Adhesive

G. Elastomeric Insulation
   1. Armacell

H. Weather Resistant Coating
   1. WB Armaflex Finish
   2 Foster 30-64

I. Glass fiber blanket insulation
   1. Manville R-series Microlite FSKL
   2. Owens-Corning eD75 or ED100 RKF
   3. Knauf 0.75 PCF FSK

2.2 RIGID FOAM PIPE INSULATION

A. Polyisocyanurate pipe insulation or phenolic foam pipe insulation, with all service reinforced vapor barrier jacket having integral laminated vapor barrier.
   1. Polyisocyanurate: Thermal conductivity 0.14 @ 75°F mean (ASTM C518).

2. Phenolic Foam: Thermal conductivity 0.13 @ 75°F mean (ASTM C 518); minimum 2.5# density.
3. Polyisocyanurate is not to be used inside of buildings without 25/50 rating.

2.3 FIBERGLASS PIPE INSULATION

A. Heavy density, dual temperature fiberglass insulation with factory applied, all service, reinforced vapor barrier jacket having integral laminated vapor barrier. Provide with a factory applied pressure sensitive tape closure system and matching butt strips. Supply in thickness as shown.
1. Thermal conductivity 0.23 @ 75°F mean (ASTM 335).

2.4 ELASTOMERIC INSULATION

A. Insulation material shall be flexible, closed-cell elastomeric insulation in tubular or sheet form. Material shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less when tested in accordance with ASTM E84, latest revision. Sheet material with a thickness greater than ¾" shall have a flame spread rating of 25 or less and a smoke developed rating of 100 or less when tested in accordance with ASTM E84, latest revision. In addition, the product, when tested, shall not melt or drip flaming particles, and the flame shall not be progressive. In addition, all materials shall pass simulated end-use fire test.
1. Thermal conductivity 0.27 at 75°F mean (ASTM C177 or C518)

2.5 CELLULAR GLASS INSULATION

A. ASTM C552:
1. "k" value of 0.35 @ 75°F ("ksi" value of 0.047 @ 24°C);
2. 8.0 lb/cu.ft. (128 kg/cu.m.) density

2.6 INSULATION/SHIELD AT HANGERS

A. Field fabricated: Use 360° sections of rigid foamglass insulation that will support the bearing area at hangers and supports. Further support insulation at hangers and supports with a shield of galvanized metal covering at least half of the pipe circumference, and conforming to the schedule. Insulation shall extend at least 1" beyond metal shield on each end. When pipe is guided at top and bottom, metal shields shall cover the whole pipe circumference. Adhere metal shield to insulation so that metal will not slide with respect to insulation with ½" aluminum bands (2) per shield.
1. Sections of foam glass insulation may be used of the same outside diameter of the adjoining pipe insulation.
2. Minimum thickness of foam glass insulation shall not be less than 1" thick.

B. Pipe saddles: Formed galvanized sheets at each support point for insulated pipe, shaped to fit pipe, and covering bottom half of pipe. Length at saddle shall be not less than twice the insulation outside diameter or more than 22". Provide 18 gauge through 4" pipe and 16-gauge 5" pipe and above.

2.7 SEALANT, ADHESIVE AND FINISH

A. Lap Adhesive. Provide Childers CP-82 or Foster 85-20 adhesive.

B. Vapor Barrier Finish:
1. Indoors: Provide as insulation coating Childers CP-38 or Foster 30-80, white. Coating must meet MIL Spec C-19565C, Type II and be QPL Listed. Permeance shall be 0.013 perms or less at 43 mils dry. Tested at 100ºF and 90% RH per

ASTM E96.

2. Outdoors: Provide as insulation coating Childers Encacel X or Foster 60-90. Permeance shall be 0.03 perms or less at 30 mils dry. Tested at 100ºF and 90% RH per ASTM F 1249 and must be Hypalon rubber based.
3. Underground: Provide Childers CP-22/24 or Foster 60-25/26 for fittings and areas. Pittwrap cannot be used.

C. Insulation Joint Sealant. Provide Childers CP-76 or Foster 95-50 vapor barrier sealant.

D. Metal Jacketing Sealant. Provide Childers CP-76 or Foster 95-44 metal jacketing sealant for all outdoor metal jacketing laps.

E. Lagging Adhesive. Provide Childers CP-50AMV1 or Foster 30-36.

F. Other products of equal quality will be acceptable only upon approval.

2.8 ALUMINUM JACKETING

A. Finish insulated piping outdoors with a smooth prefabricated Z-lock aluminum jacket 0.016" thick with factory applied 1 mil polyethylene/40 lb and Fab strap. Kraft moisture barrier.

B. Valves, Fittings and Flanges. For finishing valves, fittings, flanges and similar installations, provide formed aluminum covers, 0.024" thick.

C. Straps and Seals. Provide ½" x 0.020 stainless steel strapping and seals for jackets and covers according to manufacturer's recommendations.

2.9 GLASS FIBER BLANKET INSULATION

A. Minimum density of 1.0 PCF, 2" thick, installed R value to be 6.0 or better at 75°F mean, facing of 0.35 mil foil reinforced with glass yarn mesh and laminated to 40 lbs fire resistant kraft.

PART 3 - EXECUTION

3.1 INTERIOR PIPING

A. Cover all piping with glass fiber, heavy density, dual temperature pipe insulation with a vapor barrier jacket. Apply insulation to clean, dry pipes. Longitudinal seams shall be joined firmly together and sealed with self-sealing lap joints. Butt insulation joints firmly together and seal with a 3" wide ASJ butt strip seal. Longitudinal seams and butt strip laps shall be coated and sealed with CP-38 or Foster 30-80 vapor barrier coating for chilled water piping applications.

B. Install hanger with protective shield, on the outside of all insulation.

C. Where domestic water pipes (1/2" & ¾" pipe sizes) are installed on trapeze type hangers, provide galvanized sheet metal protection shields at these locations. Place insulation jacket directly on hanger. Incompressible, load bearing insulation segments are not required.

D. Pipe Saddles: Formed galvanized sheets at each support point for insulated pipe, shaped to fit pipe, and covering bottom half of pipe. Length at saddle shall be not less than twice the insulation outside diameter. Provide 18-gauge through 4" pipe and 16-gauge for 5" pipe and above.

E. Seal ends of pipe for chilled water insulation with vapor barrier mastic at valves, flanges, fittings and every 21' on straight runs of piping. Mastic should extend on top of ASJ jacket, across the glass, down onto the pipe making a complete seal.

F. Apply a smooth flood coat of white lagging adhesive Foster 30-35 or Childers CP-35 over all exposed insulation within mechanical rooms.

G. Piping to be insulated as specified above:
1. Chilled water and heating water
2. Domestic hot and cold water
3. Make-up water
4. Horizontal sanitary drain piping that receives condensate
5. Exposed to view storm drainage system including roof and overflow drain bodies, vertical piping from drain body to elbow, all horizontal rain leaders, and first elbow turning down
6. Condenser water

3.2 REFRIGERANT AND CONDENSATE PIPING

A. Cover all pipe with elastomeric insulation by slitting tubular sections or sliding unslit sections over the open ends of piping or tubing. Seams and butt joints shall be adhered and sealed using Foster 85-75, Childers CP-82 or Armstrong 520 Adhesive.

B. All fittings shall be insulated with the same insulation thickness as the adjacent piping. All seams and mitered joints shall be adhered with Foster 85-75, Childers CP-82 or 520 Adhesive.

C. Pipe Saddles: Formed galvanized sheets at each support point for insulated pipe, shaped to fit pipe, and covering bottom half of pipe. Length at saddle shall be not less than twice the insulation outside diameter.

D. Outdoor exposed piping shall be painted with two coats of either WB or SB Armaflex finish or Foster 30-64 elastomer foam coating. All seams shall be located on the lower half of the pipe.

E. Outdoor exposed piping after being sealed as noted above apply aluminum jacketing to protect piping insulation exposed to weather, from damage from sunlight, moisture, equipment maintenance, wind, and shall provide shielding from solar radiation. Adhesive Tape shall not be permitted.

3.3 PIPING OUTDOORS ABOVE GRADE

A. Insulate all water piping exterior of building above grade with rigid foam insulation and aluminum jacketing.

B. Adhere the vapor barrier jacket longitudinal seam with vapor barrier adhesive.

C. Cover all valves, fittings and flanges with factory made molded or field fabricated segments of pipe insulation of a thickness and material equal to the adjoining insulation. Adhere segments together with no voids, using Childers CP-82 or Foster 85-20 adhesive. Secure fitting insulation covers and segments in place with ½" wide glass filament tape.

D. Apply a tack coat of fitting vapor barrier coating over the insulation and tape.

E. Neatly embed with 10 x 10 fiberglass or polyester reinforcing mesh into the tack coat.

F. Apply coating over the fiberglass cloth to a thickness where the mesh is not visible after completion.

G. Seal ends of pipe insulation with vapor barrier coating at valves, flanges, fittings and every 21' on straight runs of piping. Mastic should extend on top of ASJ jacket, across the foam, down onto the pipe, making a complete seal.

H. Finish with aluminum jacketing as specified.

3.4 UNDERGROUND PIPE COVERING

A. Cover chilled and hot water piping underground with cellular glass insulation.

B. Butter insulation joints with Childers CP-76 or Foster 95-50 vapor barrier sealant. Secure with stainless steel bands or ½" fiberglass reinforced tape on 9" centers.

C. Cover valves and flanges with fabricated fittings of thickness and material equal to the adjoining insulation. Fasten fittings in place with stainless steel bands or ½" fiberglass reinforced tape.

D. Apply a tack coat of fitting mastic Childers CP-22/24 or Foster 60-25/26 over the insulation and bands.

E. Neatly embed with 10 x 10 fiberglass or polyester reinforcing mesh into the tack coat.

F. Apply mastic over the fiberglass cloth to a thickness where the fabric is not visible after completion.

G. Seal ends of pipe insulation with vapor barrier mastic at all valves, fittings, flanges and every 21' on straight run piping. Mastic should extend on top of ASJ jacket, across the glass, down onto the pipe, making a complete seal.

H. Finish with 125 mil thickness Pittwrap jacket applied in accordance with manufacturer's instructions. At contractor's option, cover insulation with Servi-Wrap P-500 installed in accordance with manufacturer's instructions.

3.5 FLANGE, VALVE AND FITTING INSULATION

A. Cover valves and flanges with fabricated segments, fittings with two-piece factory molded fittings, and both of matching pipe insulation type and thickness equal to that of the adjoining pipe. Fittings and fabricated segments shall be securely held in place.
   1. Apply a tack coat of insulating coating/mastic to the insulated fitting to produce a smooth surface.
   2. After mastic is dry, apply a second coat of vapor barrier coating/mastic. Neatly embed with 10 x 10 fiberglass or polyester reinforcing mesh into the tack coat.
   3. Overlap coating/mastic and fiberglass/polyester reinforcing mesh by 2" on adjoining sections of pipe insulation.
   4. Apply a second coat of coating/mastic over the fiberglass/polyester reinforcing mesh to present a smooth surface.
   5. Apply coating/mastic to a wet film thickness of 3/64".
   6. Fabric shall not be visible after completion.
   7. Vapor seal flanges, valves and fittings with Childers CP-38 or Foster 30-80. Coating must meet MIL Spec C-19565C, Type II and be QPL Listed. Permeance shall be 0.013 perms or less at 43 mils dry. Tested at 100ºF and 90% RH per ASTM E96.

B. PVC fitting covers are not acceptable.

3.6 ALUMINUM JACKETING (Insulated Piping Outdoors Above Grade)

A. Apply smooth aluminum jacket on piping, valves, fittings and flange covers according to manufacturer's recommendations, using stainless steel strapping and seals, to provide weather tight covering and to shed water.

B. Aluminum jacketing is not considered as contributing to the vapor barrier or the insulation jacket. The vapor barrier must be sufficient in itself for this function. Lap each adjoining jacket section a minimum of 3” to make a weather tight seal with the application of 1/8” bead of Childers CP-76 or Foster 95-44 metal jacketing sealant.

C. Install straps on 9” centers and at each circumferential lap joint.

D. Cover and seal all exposed surfaces.

E. The use of screws and rivets is not approved.

F. Provide isolation (30# felt) between the aluminum jacket and the sheetmetal protection shield at each pipe support point.

3.7 MISCELLANEOUS

A. Insulate pumps.

B. Install materials after piping has been tested and approved.

C. Apply insulation on clean, dry surfaces only.

D. Apply weather protective finish on elastomeric insulation installed in non-conditioned spaces. Provide a minimum of three coats.

3.8 INSULATION THICKNESS

INSULATED UNIT	THICKNESS (Inches)
Refrigerant Piping	1-1/2
Condensate Drains	1
Heating Water Piping 2” Pipe and Larger	2
Heating Water Piping 1-1/2” Pipe and Smaller	1-1/2
Exterior Chilled and Hot Water Piping, 5” Pipe and Larger	2
Exterior Chilled and Hot Water Piping 4” Pipe and Smaller	1-1/2

END OF SECTION

SECTION 23 08 00 - MECHANICAL COMMISSIONING COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section outlines commissioning requirements and activities of Contractor, Owner, CxA and Design Professionals as related to the Division 23 Mechanical.

B. Related Sections:
1. Division 01 – General Requirements and Specification Section 01 91 13, General Commissioning
2. Division 22 – Plumbing
3. Division 23 – Mechanical
4. Division 26 – Electrical

1.2 DEFINITIONS

A. Refer to Specification Section 01 91 13, General Commissioning for definitions.

1.3 CONTACT INFORMATION

A. The Owner will contract directly for commissioning services.
1. Commissioning Agent fee will be paid for directly by the owner.
2. Cost of contractor coordination with the CxA is specified in this section.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Contractor shall provide all standard and specialized testing equipment required to perform Start-up and Functional Performance Testing. Test equipment required for Functional Performance Testing including, but not limited to equipment listed below. Data logging equipment and software required to test equipment shall be provided by the Contractor.

B. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 1.0ºF and a resolution of + or - 0.2ºF). Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year. All equipment shall be calibrated according to the manufacturer's recommended intervals and following any repairs to the equipment. Calibration tags shall be affixed or certificates readily available.

C. Test equipment includes:
1. Air flow measuring devices (hoods, anemometers, etc.)
2. Water flow measuring devices
3. Temperature measuring devices (air and water)
4. Humidity sensors
5. Pressure gauges (air and water)
6. CO2 sensors

2.2 OTHER CONTRACTOR PROVIDED EQUIPMENT

A. Ladders and/or lifts and appropriate fall protection as required by Contractor site

requirements.

PART 3 - EXECUTION

3.1 COORDINATION - GENERAL

A. Except for the activities to be performed by the CxA called for herein, all component and system installation work required by the Division 22, 23 and 26 specifications including specific contractor furnished items indicated by this Section shall be provided by the Contractor.

3.2 SUBMITTALS

A. Mechanical
1. Ductwork Layouts
2. Piping Layouts
3. Equipment Room Layouts
4. Mechanical Equipment as needed

3.3 EQUIPMENT START-UP

A. Notification
1. Contractor shall provide ten Owner business days' notice to CxA, Owner and Design Team of start-up dates.

B. Prior to start-up, contractor shall:
1. Verify that equipment and systems are complete, accessible, correctly connected to utilities and ready for operation. Perform all pre-start inspections and tests as called for in Division 23.
2. Comply with pre-start requirements of manufacturer and complete applicable documentation.
3. Complete applicable sections of Prefunctional Checklists.
4. Coordinate start-up attendance by manufacturer or authorized representative as required by specifications or manufacturer.

C. At start-up, contractor shall:
1. Supervise the activities of the authorized start-up technician or manufacturer's representative.
2. Verify proper voltage, phase, overcurrent protection, drive rotation and any other conditions that may cause damage if not correct.
3. Execute start-up under supervision of qualified contractor and equipment manufacturer personnel and in accordance with the manufacturer's instruction.
4. Complete manufacturer start-up requirements and documentation. Provide a copy of documentation to the CxA for inclusion in the Cx Manual.
5. Complete PFC's and provide documentation to CxA.
6. Provide documentation of any issues noted during start-up to CxA, Owner and Design Team. Outline recommendations for corrective action.

3.4 PIPE AND DUCT PRESSURE/LEAKAGE TESTING

A. General
1. The following procedures are meant as general procedures and do not alleviate Contractor of more stringent procedures specified elsewhere in Division 23.

B. Notification
1. Contractor shall provide adequate notice to CxA, Owner and Design Team of

testing dates.

C. Duct Pressure Testing:
   1. Prior to testing, contractor shall:
      a. Select duct sections with approval by Design Team.
      b. Calculate duct areas and acceptable leakage rates.
      c. Verify that test equipment is of appropriate capacity for duct sections tested. Ideally, the pressure testing equipment will be at the midpoint of the system tested.
      d. Verify that test equipment has been calibrated with NIST traceable certificates within the past 12 months or shorter time span if specified elsewhere in Division 23.
      e. Isolate and seal duct sections.
   2. During testing, contractor shall:
      a. Conduct testing in a safe manner.
      b. Operate test equipment at a minimum of 3" wg for ductwork between AHU and terminal unit, or as specified elsewhere in Division 23.
      c. Operate test equipment at a minimum of 2" wg for ductwork downstream of terminal units and exhaust ductwork, or as specified elsewhere in Division 23.
      d. Record all applicable test data.
   3. Upon completion of testing, contractor shall:
      a. Remedy sections that do not pass and schedule a retest.
      b. Submit test results to Owner, Design Team and CxA for review.

D. Pipe Pressure Testing
   1. Prior to testing, contractor shall:
      a. Verify that test equipment has been calibrated with NIST traceable certificates within the past 12 months or shorter time span if specified elsewhere in Division 23.
      b. Isolate and seal pipe sections to be tested.
      c. Isolate equipment or apparatus connected to the piping system that may be damaged during the testing.
      d. Clean and flush piping sections and fill with clean water, venting all air.
      e. Allow adequate time for water and piping to reach ambient temperature.
   2. During testing:
      a. Maintain a safe condition in the area surrounding the test system.
      b. Pressurize piping to 150% of design working pressure, but not greater than piping design pressure.
      c. Pipe shall hold pressure for minimum of 2 hours.
      d. Record temperature of piping and ambient air at beginning and end of test.
      e. Record pressure on piping system at beginning and end of test.
   3. Upon completion of testing, contractor shall:
      a. Remedy sections that do not pass and schedule a retest.
      b. Submit test results to Owner, Design Team and CxA for review.

3.5 PRE-FUNCTIONAL CHECKLISTS

A. Contractor shall forward completed copies of PFCs to the CxA for inclusion into the Cx documentation. PFCs will be provided by the CxA. As an alternate, contractor shall submit their versions of the PFCs to the CxA for review and comment.

B. Contractor shall complete PFC for each of the following equipment:
   1. Mechanical:
      a. Air Handling Units
      b. Energy Recovery Units

c. Terminal Units
d. Pumps
e. Fans
f. Heaters
g. Split Systems
h. Heat Exchanger/Converter
i. Chiller
j. Boiler
k. Valves

3.6 TEST AND BALANCE

A. Contractor shall forward the T&B Execution Plan to the CxA prior to performing the field T&B activities. CxA will review and comment on Plan.

B. Contractor shall notify CxA a minimum of three (3) days prior to conducting field T&B activities. Failure to provide CxA with adequate notification may result in additional field time by T&B Contractor to demonstrate T&B results.

C. Key T&B activities that CxA requires notification on:
1. Terminal Units.
2. Air Handling Unit.
3. Energy Recovery Unit.
4. Heat Exchanger/Converter.
5. Pumps.

3.7 FUNCTIONAL TESTING

A. General
1. Contractor shall organize and schedule Construction Team members to execute the functional testing, which will be directed by CxA. Construction Team members may include Mechanical Sub, T&B Sub, Controls Sub, Electrical Sub, Fire Alarm Sub or Plumbing Sub. Contractor shall note that certain activities, such as sensor calibration, can be organized so that the T&B Sub is scheduled efficiently.

C. Air Cooled Chillers
1. Graphics
2. Start/Stop/Schedule
3. Compressor Operation (On/Off/Hand/Auto)
4. Entering/Leaving Temperature
5. Safeties
6. Alarms
7. Temperature Reset Sequences

D. Boilers
1. Graphics
2. Start/Stop/Schedule
3. Firing Operation (On/Off/Hand/Auto)
4. Entering/Leaving Temperature
5. Safeties
6. Alarms
7. Temperature Reset Sequences

E. Air Handling Units
1. Graphics
2. Start/Stop/Schedule

3. Fan Operation (On/Off/Hand/Auto)
4. Temperature Calibration (Air/Water)
5. Damper Positions (Off/On/Safety)
6. Valve Positions (Off/On/Safety)
7. Safeties (Low Limit/Smoke Detectors/Fire Alarm/Static Pressure)
8. Alarms (Filter/Temperature/etc.)
9. Damper Operation (Normal/Economizer)
10. Valve Operation (Normal Heating & Cooling/Economizer)
11. Fan Speed Control (VFD)
12. Temperature Reset Sequences
13. Static Reset Sequences

F. Energy Recovery Units
1. Graphics
2. Start/Stop/Schedule
3. Fan Operation (On/Off/Hand/Auto)
4. Temperature Calibration (Air/Water)
5. Air Flow Station Calibration
6. Damper Positions (Off/On/Safety)
7. Valve Positions (Off/On/Safety)
8. Safeties (Low Limit/Smoke Detectors/Fire Alarm/Static Pressure)
9. Alarms (Filter/Temperature/etc.)
10. Damper Operation (Normal/Economizer)
11. Valve Operation (Normal Heating & Cooling/Economizer)
12. Fan Speed Control (VFD)
13. Temperature Reset Sequences
14. Static Reset Sequences

G. Terminal Units
1. Graphics
2. Start/Stop/Schedule
3. Fan Operation (On/Off/Hand/Auto)
4. Temperature Calibration (Air/Water)
5. Thermostat Operation
6. Damper Positions (Off/On/Safety)
7. Valve Positions (Off/On/Safety)
8. Safeties (Smoke Detectors/Fire Alarm)
9. Alarms (Temperature/etc.)
10. Unoccupied Overrides

H. Pumps
1. Graphics
2. Start/Stop/Schedule
3. Pump Operation (On/Off/Hand/Auto)
4. Flow Station Calibration
5. Pressure Sensor Calibration
6. Pump Speed Control (VFD)
7. Sequencing and Alarms

I. Fans
1. Graphics
2. Start/Stop/Schedule
3. Thermostat Operation
4. Flow Station Calibration
5. Pressure Sensor Calibration
6. Speed Control (VFD)

7. Sequencing and Alarms

J. Heaters
1. Graphics
2. Start/Stop/Schedule
3. Thermostat Operation
4. Flow Station Calibration
5. Sequencing and Alarms

K. Split Systems
1. Graphics
2. Start/Stop/Schedule
3. Fan Operation (On/Off/Hand/Auto)
4. Temperature Calibration
5. Thermostat Operation
6. Safeties (Low Limit/Smoke Detectors/Fire Alarm/Static Pressure)
7. Alarms (Filter/Temperature/etc.)
8. Fan Speed Control (VFD)

L. Recirculation Pump
1. Graphics
2. Start/Stop/Schedule
3. Pump Operation (On/Off/Hand/Auto)
4. Temperature Sensor Calibration

3.8 TREND DATA

A. Contractor shall enable trend data as indicated herein and as specified by contract documents and Owner's requirements. Trends shall be stored to a repository device that can be recalled at any time period. Sampling rate shall vary based upon the trend and may range from change of value (COV) to a maximum of 15 minutes.

B. Ambient (Outdoor) Conditions
1. Dry Bulb Temperature
2. Wet Bulb Temperature
3. CO2 Level

C. Building Loop Chilled Water System
1. Chilled Water Flow.
2. Chilled Water Supply Temperature.
3. Chilled Water Return Temperature.
4. Chilled Water Pressure Differential.
5. Chilled Water Pressure Setpoint.
6. Pump 1 Speed.
7. Pump 2 Speed.

D. Building Loop Hot Water System
1. Hot Water Flow.
2. Hot Water Supply Temperature.
3. Hot Water Return Temperature.
4. Hot Water Pressure Differential.
5. Hot Water Pressure Setpoint.
6. Pump 1 Speed.
7. Pump 2 Speed.

E. Air Handling Unit Supply Air

1. Supply Air Temperature.
2. Supply Air Temperature Setpoint.
3. Mixed Air Temperature.
4. Mixed Air Temperature Setpoint.
5. Chilled Water Valve Position.
6. Hot Water Valve Position.
7. Critical Terminal Unit Air Valve and Heating Position

F. Air Handling Unit Static Pressure
1. Duct Static Pressure.
2. Duct Static Pressure Setpoint.
3. Fan Speed
4. Critical Terminal Unit Air Valve Position

G. Air Handling Unit Economizer
1. Supply Air Temperature.
2. Supply Air Temperature Setpoint.
3. Mixed Air Temperature.
4. Mixed Air Temperature Setpoint.
5. Return Air Temperature.
6. Return Air Enthalpy.
7. Outside Air Temperature.
8. Outside Air Enthalpy.
9. Chilled Water Valve Position.
10. Hot Water Valve Position.
11. Return Damper Position
12. Relief Damper Position
13. Outside Air Damper Position

H. Terminal Units
1. Room Temperature.
2. Room Temperature Setpoint.
3. Supply Air Temperature.
4. Inlet Air Flow.
5. Inlet Air Valve Position.
6. Heating Coil Valve Position.
7. Fan Status.
8. Room CO2.

I. Split System Units
1. Room Temperature.
2. Room Temperature Setpoint.
3. Supply Air Temperature.
4. Fan Status.
5. Cooling/Heating Mode.

J. Fans
1. Room Temperature.
2. Room Temperature Setpoint.
3. Fan Status/Speed.

K. Heaters
1. Room Temperature.
2. Room Temperature Setpoint.
3. Status.

END OF SECTION

SECTION 23 09 33 - BUILDING MANAGEMENT AND CONTROL SYSTEM

PART 1 - GENERAL

1.1 SCOPE

A. The existing campus is controlled by an Automated Logic Control system installed by UES Houston. The area of work shall be provided with a completely new control system by ALC. All new equipment and modifications to existing systems shall be fully integrated into the existing control system including new graphics for all new equipment and is a part of this scope. Upon competition of this projects the resulting control system shall have all new controllers for the systems being replaced including sensors, valves, dampers, valve and damper operators, DDC panels, relays, terminal equipment controllers, mounting brackets and thermowell, etc. Integrate all components to provide a complete and functioning system.

B. Temperature Control System components:
   1. Electronic instruments as specified
   2. Electric instruments as specified
   3. Microcomputer instruments as specified

C. All control devices of the same type product shall be of a single manufacturer.

D. Control, power and interlock wiring necessary to accomplish sequences specified in this Section shall be provided and installed by the Control Subcontractor. Materials and methods of execution as specified in Division 26, Electrical.
   1. Coordinate current characteristics of all electrical instruments and equipment with Division 26 of the specifications and related electrical drawings.

E. The entire Building Management and Control System (BMCS) shall be installed by the Automation System Manufacturer or Authorized Distributor.
   1. All components and elements
   2. The testing and acceptance procedure

F. The manufacturer of the building automation system shall provide documentation supporting compliance with ISO-9002 (Model for Quality Assurance in Production, Installation, and Servicing). The intent of this specification requirement is to ensure that the products from the manufacturer are delivered through a Quality System and Framework that will assure consistency in the products delivered for this project.

G. The entire Building Management and Control System (BMCS) shall be installed, Commissioned, and tested; all performed by the Automation System Manufacturer or Authorized Distributor if approved by engineer.
   1. All components and elements.
   2. Start-up and point verification.
   3. The testing and acceptance procedure.

1.2 RELATED WORK

A. Division 23, Mechanical

B. Division 26, Electrical

1.3 SUBMITTALS

A. Submit items of the Building Management and Control System (BMCS).

1. Temperature control equipment & Field devices.
2. Wiring & Flow diagrams.
3. Sequence of operation.
4. Complete, detailed, control and interlock-wiring diagram.
5. Indicate mechanical and electrical equipment furnished and electrical interlocks, indicating terminal designation of equipment. Respective equipment manufacturers shall furnish through the Mechanical Contractor, approved drawings of equipment to be incorporated in this diagram.
6. Submit Input / Output summary of all points.
7. Submit an outline of testing procedures from section Testing and Acceptance.
8. Mark up a copy of the specifications for the product. Indicate in the margin of each paragraph the following: “Comply, “Do Not Comply”, or “Not Applicable”. Explain all “Do Not Comply” statements.
9. Submit sample of space temperature sensor and guards for review prior to purchase or installation.

1.4 COOPERATION WITH OTHER TRADES

A. Furnish control valves, temperature sensing element wells, flow and pressure sensing devices, dampers and other similar devices to the Mechanical Contractor in a timely manner for installation under the Building Management and Control System (BMCS), Subcontractor's supervision.

1.5 WARRANTY

A. Provide with a manufacturer’s parts and labor warranty for a period of two years from substantial completion.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Automated Logic Branch Office - WebCTRL

2.2 SYSTEM ARCHITECTURE

A. The Building Management and Control System (BMCS) shall consist of an information-sharing network of stand-alone Direct Digital Control Panels (DDCP) to monitor and control equipment as specified of the control sequence and input/output summary.

B. "Information sharing" shall be defined as: The function of each DDCP to exchange data on the network trunk with other DDCP's without the need for additional devices such as network managers, gateways or central computers.

C. "Stand-alone" shall be defined as: The function of each DDCP to independently monitor and control connected equipment through its own microcomputer.

2.3 COMMUNICATIONS PROCESSING

A. The BMCS shall operate as a true token-pass peer-to-peer communication network. Resident processors in each DDCP shall provide for full exchange of system data between other DDCP's on the network trunk. Systems that limit data exchange to a defined number of system points are not acceptable.

B. Systems that operate via polled response or other types of protocols that rely on a central processor or similar device to manage DDCP to DDCP communications may be

considered only if a similar device is provided as a stand-by. Upon a failure of malfunction of the primary device, the stand-by shall automatically, without any operator intervention, assume all BMCS network management activities.

C. The failure of any DDCP on the network shall not affect the operation of other DDCP's. All DDCP failure shall be annunciated at the specified alarm printers and terminals.

D. Network shall support a minimum communications speed of 115.2 Kbps.

E. The network shall support a minimum of 100 DDC controllers and PC workstations.

F. Each PC workstation shall support a minimum of 4 peer-to-peer networks, either by hardwired connection or dial up.

G. The system shall support integration of third party systems (fire alarm, security, lighting, PCL, chiller, boiler) via panel mounted open protocol processor. This processor shall exchange data between the two systems for inter-process control. All exchange points shall have full system functionality as specified herein for hardwired points. Provide examples of 5 reference projects utilizing gateways required for this project.

2.4 DDCP HARDWARE

A. Each DDCP shall consist of a 32-bit microprocessor and controller, power supply, input / output boards and communication board. All program and point databases shall be stored in battery-backed RAM. Provide a minimum of 1.2 MEG RAM in each DDCP to allow for point expansion and trend data storage.

B. Each DDCP shall incorporate a real-time clock.

C. Each DDCP shall be provided with two RS232 communications port. Connecting an operator terminal, whether portable or stationery, shall allow the user to communicate with the entire network.

D. Each DDCP shall provide for input / output connections to field equipment. The following point types shall be supported:
1. Analog inputs - for measuring sensed variables. Inputs shall be capable of accepting voltage, resistance, current or pressure signals.
2. Analog outputs - for controlling end devices. Outputs shall be capable of producing voltage, resistance, current or pressure signals. Pneumatic outputs shall be provided with a manual override for adjusting outputs in the event of a power loss at the DDCP.
3. Digital inputs - for monitoring dry contacts such as relays, switches, pulses, etc.
4. Digital outputs - to control two position devices such as starters, actuators, relays, etc.

E. Each DDCP shall be listed under UL916 (Energy Management Systems), and shall be tested to comply with sub-part J of Part 15 FCC rules for Class A computing equipment.

F. Each DDC Controller shall have sufficient memory to support its own operating system and databases, including:
1. Control processes
2. Energy management applications
3. Alarm management applications including custom alarm messages for each level alarm for each point in the system.
4. Historical/trend data for points specified
5. Maintenance support applications

6. Custom processes
7. Operator I/O
8. Dial-up communications
9. Manual override monitoring

G. Operator shall have the ability to manually override automatic or centrally executed commands at the DDC Controller via local, point discrete, on-board hand/off/auto operator override switches for digital control type points and gradual switches for analog control type points.
   1. Switches shall be mounted either within the DDC Controllers key-accessed enclosure, or externally mounted with each switch keyed to prevent unauthorized overrides.
   2. DDC Controllers shall monitor the status of all overrides and inform the operator that automatic control has been inhibited. DDC Controllers shall also collect override activity information for reports.

H. DDC Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Graduated intensity LEDs or analog indication of value shall also be provided for each analog output. Status indication shall be visible without opening the panel door.

I. In the event of the loss of normal power, there shall be an orderly shutdown of all DDC Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.
   1. Upon restoration of normal power, the DDC Controller shall automatically resume full operation without manual intervention.
   2. Should DDC Controller memory be lost for any reason, the user shall have the capability of reloading the DDC Controller via the local RS-232C port, via telephone line dial-in or from a network workstation PC.
   3. Upon restoration of normal power, the DDC Controller shall automatically resume full operation without manual intervention.

2.5 PROGRAMMING FUNCTIONS

A. Resident software in each DDCP shall provide custom programming of control strategies.
   1. Point database
   2. Operator interface
   3. Network communications
   4. Facilities and energy management functions

B. Programming of control and energy management strategies shall be accomplished via a high-level computer language such as BASIC, JC BASIC, C, or Powers Process Control Language. A standard math processor shall be part of the programming language. All analog loops shall be capable of proportional, integral and derivative control.

C. Each DDCP shall incorporate an operator interface program (OIP) that provides an English language user interface. The OIP shall allow the user to program, interrogate, command and edit the BMCS via a self-prompting method. Operator terminals, whether textual or graphical, shall be able to access the entire network from any DDCP. Access shall be accomplished in a transparent fashion; that is, the operator shall not be required to address specific DDCP's in order to display or command system points.

2.6 FACILITY MANAGEMENT SOFTWARE

A. The BMCS shall be provided with standard and custom report generation functions that include:
   1. Alarm summaries
   2. Motor status summaries
   3. Point displays by type, system, status, overrides, failures, location, equipment and enabled/disabled.
   4. Program listings

B. All reports shall be either displayed or printed by:
   1. Operator request.
   2. Time of day.
   3. Event conditions (such as in response to an alarm, interlock, etc.).

C. All reports shall be time and date stamped.

D. An alarm-processing program shall be provided to annunciate those points designated as alarmable. Alarm points shall, upon alarm occurrence, be displayed or printed at designated terminals.

E. Historical trend data shall be collected and stored at each DDCP for later retrieval. Retrieval shall be manual or automatic. Any point, physical or calculated, may be designated for trending. The system shall allow for two methods of trend collection: Either by a pre-defined time interval sample or upon a pre-defined change of value. Trend data shall be presented in a columnar format. Each sample shall be timed stamped. Trend reports may be a single point or may be a group of points, up to a maximum of (8) points in any single group. Any point, regardless of physical location in the system may become part of a multiple point group.

F. Each BMCS network shall provide a point-monitoring function that can display single or multiple points in a continuous updated fashion for dynamic displays of point values.

G. A database and configuration report program shall be provided that allows the user to interrogate BMCS status. As a minimum, the user shall be able to: Verify available RAM at each DDCP, verify DDCP status (on-line, off-line, and failed) and set the system clock.

H. Any invalid operator entry shall result in an error message.

I. DDCP's shall contain a password access routine that will assign an operator to one of three level of access. Level 1 shall permit display function only, level 2 shall additionally permit commanding of system points and level 3 shall additionally permit full program and database editing.

J. DDCP's shall provide for the accumulation of totalized values for the purposes of run-time or energy totalization. Totalized values may be displayed or printed automatically or by operator request.

2.7 ENERGY MANAGEMENT SOFTWARE

A. The BMCS shall be provided with an optimal start program such that the building may be divided into ten zones for optimum start. Warm-up and cool-down shall occur in sequence with succeeding zones starting only after the preceding zone has completed its warm-up or cool-down.
   1. The optimum start-up time of assigned equipment shall be determined based on a software calculation that takes into consideration outdoor air conditions, space conditions, and building thermal characteristics ("U" factor).
   2. The optimum start program shall control start-up of the cooling and heating

equipment to achieve the target occupancy space temperature at the precise time of building occupancy.

3. A built-In "learning" technique shall cause the BMCS to automatically adjust itself to the most affective time to start equipment based on historical data.

B. The BMCS shall be provided with an operator interactive time of day (TOD) program. TOD programming and modifying shall be accomplished in a calendar-like format that prompts the user in English language to specify month, year, day and time and associated point commands. It shall be possible to assign single points or groups of points to any on or off time. Appropriate time delays shall be provided to "stagger" on times.

1. TOD shall incorporate a holiday and special day schedule capability, which will automatically bring up a pre-defined holiday or special day schedule of operation. Holidays or special days can be scheduled up to one year in advance.
2. In addition to the time dependent two-state control, TOD also provides time dependent setpoint control. This control provides the capability to output assignable, proportional setpoint values in accordance with the time of day and day of week. This program shall be used to accomplish night setback, morning warm-up and normal daily operating setpoints of all control system loops controlled by the BMCS. As with the two-state control, time dependent setpoint control shall be subject to the holiday schedule. The setpoints desired shall be user definable at any operator terminal.
3. The operator shall be capable of reading and/or altering all sorted data pertaining to time of day, day of week, on/off times, setpoint values, and holiday designation.
4. The TOD program shall also provide an override function that allows the user to conveniently change a start or stop time for any point up to one week in advance. The override command shall be temporary. Once executed the TOD program shall revert to its original schedule.
5. The TOD program shall interface with the optimal start program (OSP) such that stop times may be assigned by OSP.

C. Additional Program functions required are to be installed and programmed as requested by end user at no additional cost:

1. Enthalpy optimization.
2. Supply air reset.
3. Hot water reset.
4. Chilled water reset.
5. Volumetric control.
6. Dead band control. Install dual set points as requested by user.
7. All specified energy management programs, whether or not applicable to this project shall be provided such that the owner may enable the program at a future date without the need to purchase additional software or modify existing software.

2.8 WEB SERVER ACCESSIBILITY

A. Industry leading encryption technology to provide accessibility through a web browser.

B. Building Manager’s ability to access, view and command critical building information in real time over the intranet or internet.

1. Alarm Display
2. Point Commanding
3. Graphic Display
4. Scheduling
5. Running Reports

6. Point Details

2.9 REMOTE NOTIFICATION

A. Remote notification sends Alarm and System Event information to various notification devices as indicated below but not limited to. Operators can receive their building automation system alarms without restricting them to dedicated workstations.
   1. Alphanumeric pagers
   2. Numeric pagers
   3. Email
   4. Phones via voice or short message service (SMS)

2.10 POINT EXPANSION MODULES

A. Capable of extending its input/output capabilities via special purpose modules.
   1. Modules may be mounted remote from the DDCP.
   2. Shall communicate with the DDCP over a pair of twisted cables.

2.11 TERMINAL EQUIPMENT CONTROLLERS

A. Provide for control of each piece of equipment, including, but not limited to, the following:
   1. Variable Air Volume (VAV) boxes
   2. Constant Air Volume (CAV) boxes
   3. Dual Duct Terminal Boxes
   4. Unit Conditioners
   5. Heat Pumps
   6. Unit Ventilators
   7. Room Pressurization
   8. Fan Coil Units

B. Include the following items:
   1. All input and outputs necessary to perform the specified control sequences.
      a. Analog outputs shall be industry standard signals such as 24V floating control.
   2. Sufficient memory to accommodate point database, operating programs, local alarming and local trending.
   3. All databases and programs shall be stored in non-volatile EEPROM, EPROM and PROM, or minimum of 100-hour battery backup shall be provided.
   4. Return to full normal operation without user intervention after a power outage of unlimited duration.
   5. Operation programs shall be field selectable for specific applications.
   6. Specific control strategy requirements, allowing for additional system flexibility.
   7. Controllers that require factory changes of all applications are not acceptable.

2.12 ELECTRONIC DAMPER ACTUATORS

A. Two position damper operators:
   1. Spring return to full travel position.
   2. Built in auxiliary switches (motor end switches)
      a. Switch shall be fully adjustable so that cut-in/cut-out points may be preset at any point within angular travel of the motor.
   3. Minimum torque 60-in-lb

B. Modulating damper operators:
   1. Sized with sufficient reserve power to provide smooth modulating action and tight close off against the system pressure

2. Select the operator with available torque to exceed the maximum required operating torque by not less than 100%
3. Minimum torque 100 in-lb

2.13 ETHERNET CARD

A. Ethernet Card:
1. Local area network connection interface card.

2.14 CONTROL CABINETS

A. Fully enclosed NEMA 1 for indoors, NEMA 4 for outdoors.
1. Powder coat painted on all sides
2. Cabinet with continuously piano type hinged door
3. Locking latch
4. All locks shall use a common key
5. Devices on the panel face must be identified with engraved nameplates.
6. Panels or termination panels must be identified with engraved nameplates.
7. Provide enamel beige finish and extruded aluminum alloy frame UL 50 certified.

2.15 AUTOMATIC CONTROL VALVES

A. Pressure ratings: Minimum 125 psig or 1.25 times maximum system operating pressure.

B. Construction:
1. 2" and smaller:
a. Screwed.
b. Bodies and internal parts: Bronze, stainless steel or other approved corrosion-resistant metal.
2. 2-1/2" and larger:
a. Flanged.
b. Bodies: Cast iron or cast steel.
c. Seats and parts exposed to fluid: Bronze, stainless steel or other approved corrosion-resistant metal.
3. Characterized port ball valves are acceptable for VAV terminal units only.

C. Modulating straight through water valves: Equal percentage contoured throttling plugs.

D. Three Way Mixing Valves: Linear throttling plugs allowing total flow through valve to remain constant regardless of position.

E. Sizes: By Automatic Control System Manufacturer for fully modulating operation.
1. Minimum pressure drop: Equal to pressure drop of coil or exchanger.
2. Maximum pressure drop: 5.5 psi.
3. Relief and bypass valves: Sized according to pressure available.
4. 2-position valves: Line size.
5. Manual by-pass operator.

F. Electronic Actuator:
1. Direct coupled installation
2. Visual and electronic stroke indicator
3. Die-cast aluminum housing
4. Manual override
5. Self-lubricating bearing and gear train
6. Automatic calibration
7. Automatic duty cycle protection

8. Overload and stall protection
9. Non-spring return
10. Floating /0-10 VAC / 4-20mA operation
11. UL approved
12. Provide smooth modulating action and tight close off against the system pressure.
13. Torque to exceed the maximum required operating torque by not less than 150%.
14. Actuator input signal shall be compatible with output DDC controller.
15. Provide weatherproof enclosure (exterior use).
16. Damper actuators not acceptable for valves.

2.16 FLOW DETECTION SWITCHES

A. Remote Flow Solid-State Flow Detection:
1. Extended length flow probe
2. Cabinet-mounted control monitor
3. Wetted parts, 316 stainless steel probe
4. Optional temperature and wire-break outputs
5. Flow and temperature switch points
6. LED bar graph display for status indication

B. Approved Manufacturer:
1. IFM Effector

2.17 DIFFERENTIAL PRESSURE SWITCHES

A. Wet/wet differential pressure switch
1. Integral Mounting Frame
2. Watertight, dust-tight, and corrosion resistant enclosure.
3. Wetted materials of brass and flouroelastomer.
4. Externally adjustable set point

B. Approved manufacturer:
1. Square D #9012GGW4
2. Dwyer #DXW-11-153-1
3. Carrier #HK06ZC033

2.18 TEMPERATURE LOW LIMIT SWITCH

A. Responsive to the coldest 1' section of its length.
1. Double pole single throw switch
2. 20' capillary
3. Line voltage with bellows actuated switch
4. Auto reset for outdoor installation
5. Manual reset for indoor installation

2.19 TEMPERATURE AND HUMIDITY SENSORS

A. Space Temperature Sensors
1. Thermister with resistance of 10,000 ohms at 77°F.
2. Accuracy shall be +/-1/2°F.
3. Range of 55° to 95° F.
4. Flush mounted
a. Stainless steel flush mount sensor, submit sample for review.
6. Location and height to be approved by Architect/Engineer prior to installation.

B. Space / Duct Humidity Sensor
   1. Capacitance element in the space or duct as required and output a 4 to 20 MA signal proportional to 0 to 100% RH to the DDC.
   2. Capacitance element shall be field replaceable and not require calibration.
   3. Accuracy shall be +/-2% in the range from 20 to 95% RH.
   4. Relative humidity sensors shall have the sensing element of inorganic resistance media.
   5. Provide impact resistant Polycarbonate equal to BAPI-Guard covers suitable for institutional use. Submit sample for review.
   6. Provide manufacturers calibration certificate.
   7. Provide impact resistant Polycarbonate equal to BAPI-Guard guards in the following locations:
      a. Corridors
      b. Cafeteria
      c. Kitchen.
      d. Gymnasium.
      e. Dressing Rooms.
      f. Industrial Labs.

C. Duct Temperature Sensors
   1. Range of 20° to 120°F.
   2. Single point sensing of temperature.
   3. Averaging elements of sufficient length to sense temperature across 2/3 duct width.
   4. Averaging elements of sufficient length to provide accurate, representative indication and control.
   5. Averaging elements of sufficient length to prevent variances in temperature or stratification.

D. Liquid Immersion Temperature Sensors
   1. Platinum type resistance temperature detector (RTD).
   2. Match sensor range to medium being monitored.
      a. Hot water range 30° to 250°F.
      b. Chilled Water 20° to 70°F.
   3. Furnish stainless steel wells for installation by Mechanical Contractor.
   4. Locate all sensors in field with Owner/Engineer present.
   5. System accuracy for liquid temperature sensing shall be +/-1/2°.
   6. Sensors must be removable from wells.

E. Outside Air / Freezer / Cooler Sensors
   1. Range of –58° to 122°F.
   2. Weatherproof sun shield.
   3. External trim material corrosion resistant with all parts assembled into water tight, vibration-proof, heat resistant assembly.
   4. Minimum of 8' long leads.
   5. Encapsulated into Type 304 stainless steel tubes with low conductivity moisture proofing material and lag extension for thickness of insulation.

2.20 CURRENT SENSITIVE RELAYS

A. Ensure compatibility with VFD applications for variable speed motor status.
   1. Provide with adjustable set point.
   2. Relays must be mounted and not hung by power wires thru CT.
   3. Provide split-core type current sensors.
   4. Loop powered.
   5. LED Status.

6. Acceptable Manufacturer: Veris Industries / Hawkeye
7. Relays shall close status contacts in response to current flow in power leads to the equipment being monitored.

2.21 DIFFERENTIAL PRESSURE TRANSDUCER

A. Transducers to convert differential pressures to 4-20 MA analog outputs.
1. Solid state pressure sensor with accuracy of +/- 1% of calibration range.
2. Factory calibrated and have zero and span trimmers for field calibration.
3. Range shall be selected to match the medium being monitored.
4. Pressure snubbers to protect from pressure pulses and a 3-way bypass / valve assembly to protect the transducer from overpressure damage during start-up.
5. LCD Display
6. Acceptable Manufacturer: Rosemount 1151 or 3051 Pressure Transmitter

2.22 FLOW DIFFERENTIAL PRESSURE SWITCH

A. The pressure sensing element shall be of the convoluted diaphragm type for sensitivity to system differential pressure.
1. Select the pressure range based on the sensed differential pressure.
2. The unit shall be protected against overpressure to the full static pressure rating.
3. Accuracy: +/- 2% of full scale.

B. Switch assembly.
1. Reed switch.
2. NEMA-4 enclosure.
3. Threaded boss conduit entrance.
4. SPST action.
5. Voltage and rating as required for the control circuit.

C. Wetted parts shall be made of type 303 stainless steel.

D. Install an isolation valve in each sensing pipe leg to permit servicing without shutting the system down.

2.23 ELECTRIC REMOTE BULB THERMOSTAT

A. Two position remote bulb thermostat:
1. Bimetal controlled.
2. Sealed mercury switches.
3. Provide specified control action.
4. Adjustment can be made by removing unit cover.
5. Element with capillary length as required for the location.

2.24 ELECTRIC SPACE THERMOSTAT

A. Two position space thermostat.
1. Single Pole switch actuated by bi-metal sensing element.
2. Range shall be 60°F to 90°F.
3. Removable external knob adjustment means.

2.25 HIGH STATIC PRESSURE SWITCH

A. With manual reset switch
1. Approved manufacturer: Cleveland AFS-460.

2.26 INSERTION FLOW SENSORS

A. Turbine Flow Meter
1. Retractable hot tap flow sensor
2. Accuracy: +/- 1% of full scale
3. Dual Turbine
4. Custom thread-o-let 400 psi / 250°F rated
5. Line size from 2-1/2 to 72 inch
6. Metering range from 0.3 to 15 f/sec.
7. Remote NEMA 4 wall mounted LCD display
8. Field Pro Software & Communicator
9. Warranty two years
10. Approved Manufacturer: Onicon Flow Meter F1200 Series

B. Electromagnetic Flow Meter
1. Retractable hot tap flow sensor
2. Accuracy: +/- 1% of full scale
3. Electromagnetic
4. Custom thread-o-let 400 psi / 250 degree F rated.
5. Line size from 1-1/4 to 72 inch
6. Metering range from 0.3 to 15 f/sec.
7. Remote NEMA 4 wall mounted LCD display
8. Field Pro Software & Communicator
9. Warranty two years
10. Approved Manufacturer Onicon Flow Meter F3500

2.27 CONTROL DAMPERS

A. Opposed blade dampers.
1. Frames of 13-gauge galvanized sheet metal.
2. Provisions for duct mounting.
3. Damper blades not exceeding 8" in width.
4. Blades of two sheets of 16-gauge galvanized sheet metal.
5. Blades suitable for high velocity performance.
6. Bearings of nylon or oil-impregnated, sinthered bronze.
7. Shafts of 1/2" zinc-plated steel
8. Leakage does not exceed 1/2% based on 2000 fpm and 4" static pressure.
9. Replaceable resilient seals along top, bottom and sides of frame and blade edge.
10. Submit leakage and flow characteristics data with shop drawings.
11. Linkage shall be concealed out of the air stream within damper frame.
12. Acceptable Model is Ruskin Model CD60.

2.28 PHOTO CELL CONTROL

A. Light Sensitive Resistor.
1. 4-20 output or switch.
2. On = 3.0 / fc. Off 10.0 / fc.
3. UL Approved.

2.29 DRAIN PAN FLOAT SWITCH

A. Rated at 10 Amps.
1. Shuts off equipment if water level becomes too high.
2. DPDT Contacts.

2.30 BY-PASS AUTOMATIC SHUT-OFF TIMERS

A. Rated at 10 Amps, 125 VAC
   1. Shuts off equipment with timed switch
   2. White decorated timer
   3. Without hold feature
   4. Time Cycle 60 minutes

PART 3 - EXECUTION

3.1 REPLACEMENT OF EXISTING BMCS SYSTEMS

A. Provide a complete replacement of the existing Building Management and Control Systems at this campus only within the area of work and shall include the following:
   1. Remove all existing control devices and replace with new.
   2. Remove all existing wiring and replace with new.
   3. Replace all of the existing control valves at each coil.
   4. Replace all of the existing damper actuators on exhaust fans, terminal units, outside air intake and relief hoods or etc.
   5. Remove all existing BMCS control cabinets and provide new.
   6. Existing control conduits may be reused. All existing control conduit being abandoned shall be removed.
   7. New wiring shall not be routed in the same conduit or pathway as any high voltage wiring.
   8. The owner shall be given first right of refusal on all existing control devices. This contractor shall be responsible for removing all control devices and returning them to the owner.
   9. All exhaust fans, outside air intakes, and relief vents shall be equipped with motorized dampers upon completion of project. If a device is found not to have an existing damper or the damper is not functioning, notify the engineer/owner immediately

B. The new BMCS system shall maintain control of all equipment and devices currently on the BMCS system. The existing building control system points list is available upon request and contains all point to be control upon completion of this project.

C. It is the responsibility of the contractor to ensure all equipment is under control of a BMCS system prior to the building system being started and building becoming occupied. This includes intermediate systems startups due to phased construction.

D. Verify operation of all existing equipment prior to adding existing equipment to new control system. Notify engineer/owner of inoperable equipment.

E. Contractor is to maintain safety interlocks during all phases of the BMCS installation. This includes providing temporary rough-ins of high static limits to VFD shut downs, freeze stat interlocks to starters/VFDs, etc. The wiring for these rough-ins may be run in a temporary fashion overhead, exposed and unsupported as long as the wiring is not in the path of the normal construction movement in the space. Wires laying on the floor and/or in the path of other workers in not acceptable at any time. These safeties are to be maintained until the AHUs controls are downloaded, commissioned, and operating in automatic mode per sequence of operations.

3.2 INSTALLATION

A. The control system shall be installed and final adjustments made by full-time employees of the factory-approved BMCS Building Management Control Subcontractor.

B. The contractor shall collaborate through Architect / Engineer and Owner to determine the Owner's preference for naming conventions, etc. before entering the data in to the system.

C. Due to actual operational or space conditions, it may be necessary for the Contractor to make sequence of operation modifications and/or controller adjustments, change the location or type of sensor to obtain proper operation and coverage of the system in each room or space. These change, if requested by the Owner or Engineer, shall be performed at no additional cost to the Owner. Therefore labor allowances should be made for such changes and adjustments if requested.

D. Points listed within this section are to be connected to the BMCS system as hard-wired points to cards and not connected through BacNet integration. The BacNet interface is for read only points not included within sequences of this specification.

3.3 INTERLOCK AND SAFETY CIRCUITS

A. Close the outdoor air dampers when the related HVAC unit supply or exhaust fan is de-energized:
   1. The damper and actuators are specified in this section.
   2. Outdoor air damper shall be fully opened before related air handling unit fan is energized for 100% outside air use.
   3. Provide motorized outside air dampers for the following:
      a. Supply fans
      b. AHUs
      c. Exhaust fans (except kitchen exhaust)

B. Close the chilled and hot water valves to the coil when the related unit is de-energized.

C. Interlock each chiller to start its dedicated chilled and condenser water pumps.
   1. On shutdown provide a circuit to permit the chilled water pumps and condenser water pumps to run while the chillers pump down as required by the manufacturer.
   2. As per manufacturer’s recommendations

D. Primary chilled water control:
   1. Operating and safety controls are furnished as an integral part of the water-chilling unit and not specified in this section.
   2. Provide a high limit temperature sensor in each primary chilled water pump loop.

E. Exhaust/Supply Fans:
   1. Interlock the related exhaust and supply fans and the related outside air damper.
   2. Interlock the exhaust fans with the related air-handling unit through software.
   3. Interlock related exhaust fan for dishwasher with time delay off relay.
   4. Interlock related exhaust fan for kiln with time delay off relay
   5. Interlock kitchen hood related supply and exhaust fans.
   6. Provide additional interlocks as indicated on fan schedule and on drawings.
   7. Interlock electrical and mechanical room exhaust fans with thermostat.
   8. Interlock refrigerant monitor with mechanical room purge system.
   9. Interlock science room related supply and exhaust fans.
   10. Interlock outside air supply fans for VAV air-handling unit with air-handling unit status point.

F. Freeze Protection:
   1. Provide a freeze protection sequence to ensure proper operation of equipment during a freeze condition not limited to the following:

a. Outside Air Handling Units & Supply Fans with heating and cooling coils: If unit is in occupied or unoccupied mode, upon the triggering of software point indicating a freeze condition or the low temperature sensor (freeze stat) indicates a freeze condition, the system will be disabled, close the outside air damper, open both heating and cooling valves to enable full flow condition. If heating coil discharge air sensor indicates a failure to control and is below setpoint then enable software point indicating a freeze condition, disable unit, close outside air damper, and open both heating and cooling valves to enable full flow condition. Ensure HW & CHW pumps are operational.
b. Boilers - Enable during a freeze condition.
c. Chillers – Open isolation valves then command by-pass valve to dump water into basin or by-pass tower. Enable condenser water pumps during a freeze condition.
d. Air Cooled Chillers – Open isolation valves, then enable pumps, run cycle for 15 minutes per hour, open all chilled water valves.
e. Protect coils downstream of DX cooling coil with freeze protection. If unit is in occupied or unoccupied mode, upon the triggering of software point indicating a freeze condition or the low temperature sensor (freeze stat) indicates a freeze condition, the system will be disabled, close the outside air damper, disable the DX cooling coil. If coil discharge air sensor indicates a failure to control and is below setpoint then enable software point indicating a freeze condition.

2. Temperature low limit switch wired with double pole single throw switch with one switch leg hard-wired to de-energize fan and one switch leg to signal BMCS.

G. Drain Pan Float Protection:
1. Interlock to shut down unit and close valves.
2. Cooling Coils mounted above ceiling and in roof mounted units.
3. Provide for each cooling coil location.
4. Signal BMCS alarm point

H. Copper Tube Boiler:
1. Interlock each boiler to start its dedicated primary circulating pump. Interlock flow switch and pump to boiler safety terminal strip.
2. On startup enable boiler and primary pump prior to starting secondary system pump until primary loop temperature reaches 105 degrees as per manufacturer’s recommendations.
3. Disable secondary pump if boiler goes into alarm or fails to produce heating water within 30 minutes.

3.4 GRAPHICS

A. Furnish as-built drawings indicating finally corrected "as installed" diagram(s) of the complete Building Management Control System.
1. Modification of existing control systems shall be included.
2. These must be as-built and any changes during the warranty period drawings must be revised and updated.
3. Provide final sequence of operation in written format.

B. Provide a set of the "as installed" diagram(s) of the complete control system laminated in plastic and hung in the main mechanical room or as directed by Owner.

C. Provide a color-coded floor plan of the building showing the location of each system, and the area served by each AHU or related zone. These must be of professional quality. Floor plan is to hang in main mechanical room near central control panel.

D. Provide computer graphics for each system.

E. Provide final graphic room numbers as selected by Owner / Architect.. Obtain a graphic submittal package for review. Construction Drawing room numbers are not to be used unless approved in writing.

3.5 IDENTIFICATION

A. Provide a laminated engraved nameplate on all control panels and devices shown on the "as installed" control diagrams. Coordinate engraving with nomenclature used on the diagrams.

B. A black-white-black laminated plastic engraved identifying nameplate shall be secured to each terminal cabinet, and control panels. Identifying nameplates shall have ½ inch high, engraved letters.

3.6 WIRING FOR BUILDING MANAGEMENT AND CONTROL SYSTEMS

A. Furnish and install all wire, conduit, raceways and cable systems required for the complete operation of the Building Management and Control System.

B. All wiring for the Building Management and Control System is specified in this section and includes, but is not limited to:
1. Wiring of interlock system.
2. Wiring of control instruments.
3. Wiring of control panels.
4. Wiring of related power supplies, i.e. transformers.
5. Wiring of 120 VAC power circuits for control panels and devices.

C. All materials and methods specified in this section shall comply with the requirements specified in Division 26 of this specification.

D. All power supply requirements shall be connected to the building electrical distribution system in an approved manner. Do not connect control equipment of circuits common with other building loads or devices.

E. Temperature control wiring shall be jacketed cables installed with or without conduit as specified below or single conductors installed in conduit. Control wiring shall have minimum 300V insulation for low voltage wiring and 600V insulation for line voltage wiring.

F. All line voltage control wiring, all low voltage control wiring which is exposed in the central plant, penthouse, and other similar spaces; all low voltage control wiring which is routed through concealed inaccessible locations shall be installed in conduit.

G. All low voltage control wiring which is routed through concealed accessible locations may be run without conduit provided that the wiring run without conduit is properly supported from the building structure on maximum 5' centers and does not depend upon the ceiling grid or the ceiling support system for support. Wiring run in plenum spaces shall be plenum rated. Support all plenum wiring in accessible locations in bridle rings, J-hooks, D rings. Plenum wiring is not to be supported within building structure or attached to conduit raceways. All low voltage wiring must be installed through supports. Wires shall be supported on 5’ centers and identified at each termination point and at 50’ centers minimum. Install wire parallel or perpendicular to the structural features of the building.

H. Line and low voltage control wiring shall not be installed in the same conduit with control wiring and shall not be installed in the same conduit with power wiring.

I. All wiring associated with building management and control system cover shall be as follows:
1. Sensor jacket color, Green
2. LAN communications, Yellow
3. All THHN wiring shall comply with Division 26 insulation color identification

3.7 EXHAUST AND SUPPLY FANS

A. Provide interlocks as scheduled on the plans unless shown on the electrical drawings.

B. Provide BMCS override to disable operation of all exhaust and supply fans interlocked and/or specified throughout project.

C. Provide by-pass timers for fans indicated in Fan Schedule and in the following locations:
1. Fume Hoods
2. Science Room exhaust fans

POINT DESCRIPTION	TYPE	DEVICE
Start/stop	DO	Control Relay
Outside Air Damper	DO	Electronic Operator
Fan Status	DI	Current Sensitive Relay

3.8 MISCELLANEOUS

A. Lighting Control:
1. The BMCS shall provide individual astronomical time/photo sensor and scheduled time-based control of each exterior lighting low voltage controller specified in Division 26. This includes but not limited to parking lot lighting, building mounted lighting and marquee lighting.
a. Provide separate control of each Exterior Lighting contactor.
2. The exterior lights shall be controlled by the BMCS using both a combination of photosensor, time schedules and astronomical sunrise/sunset. The exterior lights shall automatically come on when the sun sets based on the longitude and latitude coordinates of the facility (adjustable +/- 30 minutes). At 11 p.m. (adjustable) the time schedule shall turn off the exterior lights. At 4:00 a.m. (adjustable) the exterior lights shall automatically turn on based on time schedule. Upon sunrise, which shall be based on longitude / latitude of the facility the exterior lights shall turn off.
3. Photo-sensor shall override scheduling and turn lights off if ambient light levels are adequate to provide sufficient lighting. (adjustable).
4. New BMCS controller shall be provided with spare DO for future parking lot lighting controls.

POINT DESCRIPTION	TYPE	DEVICE
Lighting Contactor	DO	Control Relay

B. Photocell: Provide a photocell mounted on the north side of the building. Location is to be

approved by Owner / Architect / Engineer.

POINT DESCRIPTION	TYPE	DEVICE
Photocell	AI	Contact

C. Outside Air: Provide a temperature sensor and a humidity sensor to monitor outside air conditions.

POINT DESCRIPTION	TYPE	DEVICE
Outside Temperature	AI	Thermistor
Outside Humidity	AI	Humidity Sensor

3.9 EXISTING AUTOMATION SYSTEM

A. The new system shall be fully integrated with the existing Building Automation System Host computer located at the School District maintenance facility.

A. The integrating shall include, but not be limited to, database additions, creation of graphics and implementing communications. Integration shall be consistent with District standards and practices.

3.10 TERMINAL UNIT COORDINATION

A. Equipment furnished in this section and installed by Section 23 36 16:
1. Automatic temperature control card (DDC).
2. Damper Actuator

B. Equipment furnished and installed by Section 23 36 16:
1. Damper.
2. Multi-point flow sensor.
3. Power transformer.
4 Controller enclosure.

3.11 VARIABLE FREQUENCY DRIVE INTERFACE

A. Interface to the VFD directly

B. Interface may be hardwired or via RS-485

C. The following points shall be available at a minimum:

Point Name	Type
Start-stop	DO
Drive alarm	DI
Last fault	AI
Reset drive	DO
Percent output	AI
Frequency output	AI
Speed	AI
Current	AI

Power	AI
Drive temperature	AI
KWH	AI
Run time	AI

3.12 VARIABLE VOLUME AIR HANDLING UNITS

A. Units consist of a chilled water coil, a fan, a variable speed drive, and outside air fan.

B. The unit shall be started and stopped from the BMCS system.

C. Discharge air temperature control:
   1. A sensor far enough from the fan discharge to be truly representative of the average temperature shall modulate the valve on the cooling coil to maintain setpoint. Reference drawing schedule for discharge temperature.

D. Variable air volume control:
   1. Duct static pressure sensor shall be located in the duct at a position approximately 2/3 the distance from the fan in the longest duct run. Location is to be approved by Engineer and coordinated with Section 23 05 93.
   2. The static pressure sensors shall, through the DDC panel, accept the signal from the operating control sensor to:
      a. Transmit a signal to the supply fan motor speed controller.
      b. Modulate the fan speed to maintain the desired static pressure.
      c. Coordinate signal with the fan motor speed controller.
   3. Install a static pressure high limit safety device to de-energize the system.
      a. Manual reset.

E. Outside air Fan control:
   1. Each unit will be provided with an outside air supply fan. The supply fan will be activated with the air-handling unit.
   2. A hot water coil or electric heating coil shall be supplied in the outside air ductwork. A duct mounted temperature sensor shall modulate a hot water valve or stages of heat to maintain a leaving air temperature of 55°F (adjustable).
   3. Provide a temperature low limit switch located on the discharge side of the preheating unit to de-energize the air handling unit, close the outside air damper, open the hot water valve 100%, start the boiler and hot water pump, signal an alarm to the BMCS when the temperature drops below 37°F. Device shall be manual reset.
   4. During warm-up and cool-down periods (optimum start/stop), the outside air fans shall not be activated. During occupied times, the fans shall be activated.

POINT DESCRIPTION	TYPES	DEVICE
Start/Stop	DO	Control Relay
AHU Status	DI	Current Sensitive Relay
Discharge Air Temperature	AI	Space Thermistor
CHW Valve	AO	Electronic Operator
Outside Air Fan	DO	Control Relay
Outside Air Preheat Valve or Electric Heating Unit	AO DO	Electronic Operator or Relay for each stage

POINT DESCRIPTION	TYPES	DEVICE
Outside Air Temperature	AI	Duct Thermistor
Duct Static Pressure	AI	Static Pressure Sensor
Variable Speed Fan	AO	Motor Controller
Freeze Status	DI	Temperature Low Limit Switch

3.13 VARIABLE VOLUME TERMINAL UNITS

A. Each unit shall consist of a pressure independent variable volume damper, and a hot water heating coil. The fans shall be interlocked with the AHU fan. Constant volume terminal shall start before AHU fan starts. Controls shall be as follows:
   1. A space temperature sensor shall, through the direct digital control system, modulate the variable volume damper from full open to a minimum airflow rate to maintain room setpoint. If heating is required, the temperature sensor shall modulate the hot water control valve to maintain room setpoint with the variable volume damper in the minimum airflow position.
   2. Control valve, and control valve operator are specified in this section.
   3. The Controls Contractor shall furnish the terminal box manufacturer with a controller to be factory mounted. The controller shall display cfm, temperature, damper position, and hot water valve position.

POINT DESCRIPTION	TYPES	DEVICE
Space Temperature	AI	Space Thermistor
Primary Air	AO	Variable Volume Damper Operator
HW Valve	AO	Electronic Operator
Start/Stop	DO	Control Relay
Discharge Air Temperature	AI	Duct Thermistor

3.14 SINGLE ZONE VARIABLE AIR VOLUME AIR HANDLING UNIT

A. This unit is furnished with a hot water preheat coil, chilled water cooling coil, a hot water reheat coil, outside air measurement station and a variable frequency drive. Control shall be as follows:
   1. A room Thermistor sensing space temperature through the Direct Digital Control Panel shall vary the speed of the fan to maintain room setpoint. The air volume of the fan can range from 100% to 30% (adjustable) of the air quantity specified or to the outside air percentage whichever value is larger. A chilled water coil leaving air temperature sensor through the Direct Digital Control Panel shall modulate the cooling coil control valve to maintain the leaving air temperature as scheduled. When the fan is at minimum speed of its specified air quantity and the room temperature is below the room setpoint, the room Thermistor shall modulate the valve on the cooling coil and the valve on the hot water coil in sequence to maintain the desired space temperature. A room humidity sensor shall override the operation of the cooling coil control valve to maintain the relative humidity setpoint in the space. The room temperature sensor shall

modulate the hot water reheat coil control valve to maintain the space temperature. The dehumidification sequence only applies after the fan has reached the minimum fan speed.

B. Outside Air Control

1. Units is being provided through unit outside air measurement system which consists of a outside air damper, return air damper and airflow measurement system. The outside air volume shall be maintained at a constant value as required to maintain space CO2 levels. Desired CO2 level is less than 1000 PPM (adjustable). The outside air and return air damper shall modulate as required to ensure volume is maintained as main unit fan speed is modulated.
2. Provide a temperature low limit switch located on the discharge side of the preheating unit to de-energize the air handling unit, close the outside air damper, open the hot water valve 100%, start the boiler and hot water pump, signal an alarm to the BMCS when the temperature drops below 37°F. Device shall be manual reset.
3. During warm-up and cool-down periods (optimum start/stop), the outside air fans shall not be activated. During occupied times, the fans shall be activated.

POINT DESCRIPTION	TYPES	DEVICE
Start/Stop	DO	Control Relay
AHU Status	DI	Air Flow Sensing Switch
Fan Speed	AO	Variable Frequency Drive
Space Temperature	AI	Space Thermistor
Space Humidity	AI	Humidity Sensor
Space CO2	AI	CO2 Sensor
CHW Valve	AO (1)	Electronic Operator
Preheat HW Valve	AO (1)	Electronic Operator
Reheat HW Valve	AO (1)	Electronic Operator
Cooling Coil Leaving Air Temp.	AI	Averaging Sensor
Discharge Air Temperature	AI	Duct Thermistor
Freeze Status	DI	Temperature Low Limit Switch

3.15 CHILLED WATER COOLING SYSTEM

A. This system consists of a single packaged air-cooled chiller with dedicated chilled water pump.

B. Whenever there is a call for cooling in the system energize the system.

A. Reference interlock and safety circuits for interlocks and shut down.

B. Pump VFD shall only be used for balancing and soft start.

POINT DESCRIPTION	TYPE	DEVICE
Chiller Start/Stop	DO	Control Relay
Status (Chiller)	DI	Safety Alarm Relay
Pump Status	DI	Current Sensitive Relay
Pump Start/Stop	D0	Control Relay
Pump VFD	AO	Motor Controller
Building Supply/Return	AI	Temperature Sensors

3.16 HYDRONIC HEATING SYSTEM

A. The system consists of one heating water boiler, and dedicated pump.

B. Energize the pump whenever there is a call for heating in the building.

C. Heating water temperature reset
1. A temperature sensor located in the building heating water supply piping shall:
   a. Signal the DDC panel.
   b. Modulate the three-way valve in the boiler water piping to maintain the desired building heating water temperature.
2. A temperature sensor sensing outdoor air shall reset the control point of the DDC inversely with the outside air temperature.
   a. Maintain 180°F when the outside air temperature is 20°F.
   b. Maintain 140°F when the outside air temperature is 70°F and above.

D. Enable the boiler throughout the year with an override option to disable the boiler, as Owner requires.

E. Interlock the boiler circulating pump with the related boiler. Provide a time delay relay off to disperse the heat in the boiler as required by manufacturer. Disable the related pump if boiler fails to produce heating water or boiler goes into alarm.

F. Pump VFD shall only be used for balancing and soft start.

POINT DESCRIPTION	TYPES	DEVICE
Boiler Enable/Disable	DO	Control Relay
Boiler Alarm Status	DI	Safety Relay
Pump Start/Stop	DO	Control Relay
Pump Status	DI	Current Sensitive Relay
Pump VFD	AO	Motor Controller

POINT DESCRIPTION	TYPES	DEVICE
Building Supply/Return Temperature	AI	Pipe RTD
Hot Water Mixing Valve	AO	Electronic Operator
Boiler discharge water Temperature	AI	Pipe RTD
Ambient Temperature	AI	Thermistor

3.17 START-UP AND POINT VERIFICATION

A. Final startup and point verification shall include the following information.
   1. Field panel checkout:
      a. Verify enclosure is not mounted on vibrating surface.
      b. Verify class I and class II wiring is separated within enclosure.
      c. Check for shorts/grounds/induced voltages/proper voltages.
      d. Verify proper point terminations in accordance with as-builts.
      e. Verify that all modules are in proper place and addressed.
      f. Verify proper power voltage.
      g. Load database and programming.
      h. Startup the panel.
      i. Point and device checkout.
   2. Analog input point checkout:
      a. Verify the correct wiring terminations per the design documentation package, at the field panel. Verify that all wiring and terminations are neat and dressed.
      b. Verify the point address by checking that the analog input instrument is wired to the correct piece of field equipment. Do this by altering the environment at the sensing element or by disconnecting one of the wires at the sensor, and verifying that the reading at the field panel has reacted to this change.
      c. Verify the point database to be correct, (i.e., alarmability, alarm limits, slope/intercept, engineering units, etc.). Verify that the correct change of value (COV) limit has been defined.
      d. Verify the sensor has the correct range and input signal. (i.e., 20-120°F, 4 - 20 ma). Verify that the device is mounted in the correct location and is wired and installed correctly per the design documentation package.
      e. Set-up and/or calibrate any associated equipment (i.e., panel LCD meters, loop isolators, etc.). Verify that these auxiliary devices are mounted in the correct location and are wired and installed correctly per the design documentation package.
      f. Verify the correct reading at the field panel using appropriate MMI devices. Verify that any associated LCD panel meters indicate the correct measured value.
   3. Digital input point checkout:
      a. Verify the device is correctly wired and terminated as shown in the design documentation package. Verify that all wiring and terminations are neat and properly secured.
      b. Verify the point address by verifying that the digital input is correctly terminated at the controlled piece of equipment.
      c. Verify the point database is correct (i.e., point name, address, alarmability, etc.).
      d. Set-up and/or calibrate the associated equipment, i.e. smoke detector,

high/low temp detector, high/low static switch, end switch, current relay, pressure switch, etc. is mounted in the correct location, and is wired and installed correctly per the control system installation drawings.

e. With the controlled equipment running or energized as described in the digital output checkout procedures, verify the correct operation of the digital input point and associated equipment by putting the digital input monitored equipment into its two states. Verify that the proof or status point indicates the correct value at the operator's terminal and that the status led is giving the proper indication in each mode of operation (on/off).

4. Digital output point checkout:
   a. Verify that device is correctly wired and terminated as shown in the design documentation package.
   b. Verify that the correct voltage is utilized in the circuit.
   c. Verify the point database to be correct (i.e. point name, address, etc.).
   d. Check and verify that the end device responds appropriately to the digital output(s).
   e. After verifying the set-up and operation of any associated digital input/proof points, check and verify correct operation of the logical point and associated equipment by commanding the point to all possible states (i.e. off, on, fast, slow, auto, etc.). Verify that the defined proof delay is adequate for all modes of operation.
   f. If any interlocked equipment exists that has independent hand-off-auto or auxiliary control wiring, verify correct operation of same. Also check that any interlocked equipment such as EP switches for damper operation or exhaust and return fans are wired correctly and operate correctly.
   g. Verify that the controlled piece or pieces of equipment cannot be caused to change state via the digital output if an associated hand-off-auto switch is in the hand/on or hand/off mode of operation, unless specified as a fireman's override point etc.
5. Analog output point checkout:
   a. Verify the correct wiring or piping terminations per the design documentation package, at the field panel. Verify that all wiring and piping terminations are neat and dressed.
   b. Insure that the correct output device(s) are installed per the Control System Installation Drawings. (i.e., I/P or P/I transducers, transformers, power supply, etc.). Verify that these devices are installed, wired and piped correctly. Verify that any configuration jumpers are in the proper settings for the required application. Verify related transformers are fused in accordance with installation drawings.
   c. Verify the point database to be correct. Verify that the correct COV limit has been defined.
   d. Verify the point address by checking that the analog output is wired and/or piped to the correct output transducer and/or equipment.
   e. Verify that the controlled device is calibrated (i.e., 3-8PSI valve, 8-13 PSI damper motor, 4-20 ma variable frequency drive, etc.) and is in the correct location, and is wired or piped and installed correctly per the design documentation package. If the controlled device is not calibrated, then a three-point (high, low and mid-point) calibration procedure must take place. Verify proper operation of the end device. When calibration has been verified, ensure that installation drawings, point database, and PPCL have been updated.
   f. Set-up and or calibrate any associated equipment, (i.e., panel LCD meters, loop isolators, pneumatic gauges, etc.). Also verify that these

auxiliary devices are mounted in the correct location, and are wired or piped and installed correctly per the design documentation package.

g. After verifying the set-up and operation of any associated equipment check for the correct operation of the logical point and associated equipment by commanding the analog output to the top and bottom of its range. Verify that the control device(s) responded appropriately as indicated by the design documentation package. Check to insure that all network terminals, host console devices, etc. can also command these outputs.

h. Check that all pneumatic gauges, pilot positioners and LCD panel meters indicate the correct values.

6. Terminal equipment controller checkout:
   a. Load program database
   b. Enable programs
   c. Verify sequence of operations
7. Programming checkout:
   a. Provide checkout for each system and sequence of operation.
   b. The following are sample sequence of operations tests. The intent of these procedures is to provide a plan of action to verify system operations via block checks of the project specific sequence of operations. The procedures may be used in this format, or one procedure to a page should more detail be required. The procedures outlined below should be verified for accuracy, and may be modified to meet your specific requirements.
   c. Description of Test: AHU Alarm Checkout. Verify AHU-1 discharge air temperature alarming is operational and is received at the designated terminal.
   d. Input to Trigger Test: Change discharge temperature high alarm limit through software to a value below the current discharge temperature (discharge temperature - 10°F).
   e. Expected Outcome: A high temperature alarm will be received per the Alarm Definition Report at its designated terminal.
   f. Provide signoff sheet with indication for test Pass, Fail, Date of test and Initials for signoff.
8. Workstation checkout:
   a. Verify the operation of all trunk interface equipment.
   b. Verify all workstation software, including options, based upon the installation instructions for the PC.
   c. Perform software backup (site, options, etc.)
   d. Complete workstation configuration report for owner signoff.
   e. Provide verification that all graphics have been created, as required by project bid documents.

3.18 TESTING AND ACCEPTANCE

A. General:
   1. After completion of installation and start-up procedures, commence the specified 3-phase verification and testing sequence leading to final acceptance.
      a. Follow in the order specified.
      b. Each testing phase shall be satisfactorily completed before entering the next phase.
   2. Prior to entering each phase of the sequence, submit for approval, a written agenda describing in detail the procedure to be followed to meet the requirements for each specified verification, test or demonstration.

3. Submit for approval, a sample of the form on which the test will be reported.
    a. Identify project.
    b. Provide a list of all points, arrange in numerical order of point addresses.
        1) Show point descriptor and location of each.
        2) Indicate DDC panel that processes each point.
        3) Use the list as a basis for the specified report form.
    c. Signatures of participants and observers.
    d. Results.
    e. Description of adjustment or corrections of points in error.
    f. Date.
4. Provide schedule of tests. Estimate dates of significant events.
5. Test, calibrate and adjust each point in the system as specified.
6. Provide documentation of all tests and verifications as specified.
7. Provide trend reports indicating proper control of all points for an extended period of time.

B. Phase 1 - Testing, Calibrating, and Adjusting:
1. Operate each analog point in the entire system.
    a. At a point in the upper quarter of its range.
    b. At a point in the lower quarter of its range.
    c. At its operating point.
2. Provide personnel and diagnostic instruments at both the central and remote locations.
3. Provide testing stimulants for alarms.
4. Use digital meters of double the accuracy of the instruments being calibrated.
5. Provide an approved test device for simulating high and low temperatures.
6. When the function is performed, read values at the central control and observe the actual function at the field instrument.
7. Exercise each binary point and observe indication at console and simultaneously observe operation in the field.
8. Submit an operation report for each point in the system, in approved format, and describe any corrective or adjusting action taken.
9. Test all power transducers with a Dranetz Power Analyzer.

C. Phase 2 - Equipment and Point Verification:
1. Verify calibration or function of each point.
    a. Verify analog points at operating value.
    b. Record on specified form.
    c. Make approved adjustments to out of tolerance points.
        1) Identify these points for ready reference.
2. After verification procedure in completed:
    a. Verify corrected points.
    b. Record on specified form.
    c. Points requiring correction.
        1) Replace sensor or actuator if electrical measurements indicated components are out of specified tolerance.

D. Phase 3 - Software Verification:
1. Submit agenda and report format for software demonstrations.
2. Demonstrate to the Owner and the Engineer that all software programs and automatic control sequences function as specified.
3. Demonstrate compliance with response time specifications.
    a. Simulate normal heavy load conditions.
    b. Initiate at least ten successive occurrences on normal heavy load conditions as specified, and measure response time of typical alarms and status changes.

04. Provide written documentation of demonstration, signed by representatives of the Contractor and Engineer.

E. Provide the following reports to Engineer at final completion of all Testing:
1. List of all points.
2. List of all points currently in alarm.
3. List of all disabled points.
4. List of all points in over-ride status.
5. List of all points currently locked out.
6. List of user accounts and access levels.
7. List all weekly schedules.
8. List of holiday programming schedules.
9. List of limits and deadbands.
10. System diagnostics reports including, list of DDC panels on line and communicating, status of all DDC terminal units device points.
11. List of programs.
12. Provide trend data reports to ensure proper operation and sequence control of BMCS.

F. Substantial Completion of the BMCS will not occur until completion and acceptance of all testing and acceptance procedures.

3.19 TRAINING

A. The contractor shall provide factory-trained instructor to give full instruction to designated personnel in the operation of the system installed. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. The contractor shall provide all students with a student binder containing product specific training modules for the system installed. All training shall be held during normal working hours of 8:00 am to 4:30 PM weekdays.

B. Provide 40 hours of training for Owner's designated operating personnel. Training shall include:

Explanation of drawings, operations and maintenance manuals
Walk-through of the job to locate control components
Operator workstation and peripherals
DDC controller and ASC operation/function
Operator control functions including graphic generation and field panel programming
Operation of portable operator's terminal
Explanation of adjustment, calibration and replacement procedures
Student binder with training modules

C. Since the Owner may require personnel to have more comprehensive understanding of the hardware and software, additional training must be available from the Contractor.

3.20 PROJECT MANAGEMENT

A. Provide a designated project manager who will be responsible for the following:
1. Construct and maintain project schedule.
2. Authorized to accept and execute orders or instructions from General Contractor, Owner / Architect & Engineer.
3. Attend project meetings as necessary to avoid conflict and delays.
4. Make necessary field decisions relating to this section.
5. Coordination / Single point contact.

6. Have Internet access for project management.

END OF SECTION

SECTION 23 20 00 - HVAC PIPE AND PIPE FITTINGS - GENERAL

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install pipe and pipe fittings for piping systems specified in Division 23 - Mechanical.

1.2 RELATED WORK

A. Division 23 Mechanical:
   1. Earthwork.
   2. Valves, Strainers and Vents.
   3. Vibration Isolation.
   4. Insulation.
   5. Other Piping Sections

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. The particular type of pipe and fittings for each system is specified in the individual sections.

2.2 JOINTS

A. Make screwed joints using machine cut USASI taper pipe threads. Apply a suitable joint compound to the male threads only. Ream the pipe to full inside diameter after cutting. All-thread nipples are not permitted.

B. Dissimilar Metals. Make joints between copper and steel pipe and equipment using insulating unions or couplings such as Crane Company #1259; EPCO as manufactured by EPCO Sales, Inc.; or an approved equal.

C. Solder joints.
   1. Prior to making joints, cut pipe square and ream to full inside diameter. Clean exterior of pipe and socket. Apply a thin coat of suitable fluxing compound to both pipe and socket, and fit parts together immediately.
   2. Heat assembled joint only as required to cause the solder to flow. Run the joint full, slightly beaded on the outside, and wipe to remove excess solder.
   3. Use silver brazing alloy or Sil-Fos on refrigerant piping and on underground piping. Use lead free solder on all other copper piping.

D. Make welded joints as recommended by the standards of the American Welding Society. Ensure complete penetration of deposited metal with base metal. Provide filler metal suitable for use with base metal. Keep inside of fittings free from globules of weld metal. The use of mitered joints is not approved.

E. Flanged.
   1. Prior to installation of bolts, center and align flanged joints to prevent mechanical pre-stressing of flanges, pipe or equipment. Align bolt holes to straddle the vertical, horizontal or north-south centerline. Do not exceed 3/64" per foot inclination of the flange face from true alignment.
   2. Use flat-face companion flanges only with flat-faced fittings, valves or equipment. Otherwise, use raised-face flanges.

3. Install gaskets suitable for the intended service and factory cut to proper dimensions. Secure with manufacturers recommended gasket cement.
4. Use ANSI nuts and bolts, galvanized or black to match flange material. Use ANSI 316 stainless steel nuts and bolts underground. Tighten bolts progressively to prevent unbalanced stress. Draw bolts tight to ensure proper seating of gaskets.
5. Use carbon steel flanges conforming to ANSI B16.5 with pipe materials conforming to ASTM A 105 Grade II or ASTM A 108, Grade II, ASTM A 53, Grade B. Use slip-on type flanges on pipe only. Use welding neck type flanges on all fittings. Weld slip-on flanges inside and outside.
6. Keep flange covers on equipment while fabricating piping. Remove when ready to install in system.

F. Mechanical Joints: Provide a stuffing box type mechanical joint adapted to use gasket, cast iron gland and bolts. Coat bolts with bitumastic enamel. Use joint parts similar in design to one of the following:
1. Doublex Simplex Joint manufactured by the American Cast Iron Pipe Company, Birmingham, Alabama.
2. U.S. joints manufactured by the United States Pipe and Foundry Company, Burlington, New Jersey.
3. Boltite Joint manufactured by the McWane Cast Iron Pipe Company, Birmingham, Alabama.
4. Flexlamp manufactured by the National Cast Iron Pipe Company, Birmingham, Alabama.

2.3 UNIONS

A. Use 150 lb. standard (300 lb. WOG) malleable iron, ground joint unions with bronze seat. Provide flanged joints on piping 2-1/2" and larger.
1. Where pipe material of different types join, use a dielectric union. Union shall be threaded, solder or as required for its intended use.

2.4 BRANCH CONNECTIONS

A. Pipe 2" and Smaller: For threaded piping, use straight size reducing tee. When branch is smaller than header, a nipple and reducing coupling or swagged nipple may be used.

B. 2-1/2" through 36": For welding piping, when branch size is the same as header size, use welding tee. For threaded branch connections, use 3000 lb. full coupling or Thread-o-let welded to header.

2.5 GASKETS

A. High Temperature Piping: Provide 1/16" thick ring gaskets of aramid reinforced SBR such as Garlock #3200 or 3400 or equal by Advanced Products and Systems.

B. Other Piping: Provide ring rubber gaskets, Garlock #7992 or equal by Advanced Products and Systems. Use 1/8" thick cloth reinforced neoprene gaskets. For smaller than 6", use 1/16" thick gasket.

2.6 FLOORS AND CEILING PLATES

A. Provide chrome-plated floor and ceiling plates around pipes exposed to view when passing through walls, floors, partitions, or ceilings in finished areas; size plates to fit pipe or insulation and lock in place.

2.7 DOMESTIC MANUFACTURE

A. All piping material, pipe and pipe fittings shall be manufactured in the United States of America.

PART 3 - EXECUTION

3.1 PIPE FABRICATION AND INSTALLATION

A. Make piping layout and installation in the most advantageous manner possible with respect to headroom, valve access, opening and equipment clearance, and clearance for other work. Give particular attention to piping in the vicinity of equipment. Preserve the required minimum access clearances to various equipment parts, as recommended by the equipment manufactured, for maintenance.

B. Cut all pipes to measurement determined at the site. After cutting pipe, remove burrs by reaming. Bevel plain ends of ferrous pipe.

C. Install piping neatly, free from unnecessary traps and pockets. Work into place without springing or forcing. Use fittings to make changes in direction. Field bending and mitering is prohibited. Make connections to equipment using flanged joints, unions or couplings. Make reducing connections with reducing fittings only.

D. Install piping without tapping out of the bottom of pipe.

3.2 WELD

A. Weld and fabricate piping in accordance with ANSI Standard B31.1, latest edition, Code for Pressure Piping.

B. Align piping and equipment so that no part is offset more than 1/16". Set fittings and joints square and true, and preserve alignment during welding operation. Use of alignment rods inside pipe is prohibited.

C. Do not permit any weld to project within the pipe so as to restrict flows. Tack welds, if used, must be of the same material and made by the same procedure as the completed weld. Otherwise, remove tack welds during welding operation.

D. Do not split, bend, flatten or otherwise damage piping before, during or after installation.

E. Remove dirt, scale and other foreign matter from inside piping before tying into existing piping sections, fittings, valves or equipment.

F. Bevel ends of ferrous pipe.

3.3 OFFSETS AND FITTINGS

A. Due to the small scale of drawings, the indication of offsets and fittings is not possible. Investigate the structural and finish conditions affecting the work and take steps required to meet these conditions.

B. Install pipe close to walls, ceilings and columns so pipe will occupy minimum space. Provide proper spacing for insulation coverings, removal of pipe, special clearances, and offsets and fittings.

3.4 SECURING AND SUPPORTING

A. Support piping to maintain line and grade, with provision for expansion and contraction. Use approved clevis-type or trapeze-type hangers connected to structural members of the building. Single pipe runs to be supported by approved clevis type hangers. Multiple pipe runs to be supported by approved trapeze type hangers. Do not support piping from other piping or structural joist bridging. Review structural drawings for additional information.

B. Provide supports both sides and within 12” of each horizontal elbow for pipe 6" and larger.

C. Support vertical risers with steel strap pipe clamps of approved design and size, supported at each floor. Support piping assemblies in chases so they are rigid and self-supported before the chase is closed. Provide structural support for piping penetrating chase walls to fixtures. On chilled water pipe supports shall be outside the insulation.

D. Where insulation occurs, design hangers to protect insulation from damage. Pipe saddles and insulation shields, where required, are specified in the appropriate insulation section and are sized in accordance with the schedule on the drawings.

E. Install trapeze hangers, properly sized, to support the intended load without distortion. Use hangers with 1-1/2” minimum vertical adjustment.

F. Use electro-galvanized or zinc plated beam clamps if acceptable to the structural engineer, threaded rods, nuts, washers and hangers. All hanger rods shall be trimmed neatly so that no more than 1 inch of excess hanger rod protrudes beyond the hanger nut. Use only on beams as directed by the Structural Engineer.

G. At outdoor locations, all supports, brackets and structural members shall be hot-dipped galvanized.

H. Provide hangers within 3' of pipe length from all coil connections.

I. Support spacing: As recommended by the project structural engineer and support manufacturer, but not more than listed below. Not to exceed spacing requirements of smallest pipe.

Pipe Size	Copper & Steel Max. Support Spacing, Ft.	Cast Iron Max. Support Spacing, Ft.	Minimum Rod Diameter, Inches
1" & smaller	6		3/8
1-1/4" & 1-1/2"	8	5	3/8
2"	10	5	3/8
3"	10	5	1/2
4" & 5"	10	5	5/8
6" and above	10	5	3/4

3.5 PIPE SUPPORTS

A. Provide P1001 or P 5000 Unistrut metal framing members and appurtenances for pipe support. Hot-dip galvanized members and appurtenances when located outside. Sagging of pipes or supports is not acceptable.

B. Adjustable clevis hangers shall be used for single pipe supports; Anvil Fig. 260. When oversized clevis is used, a nipple shall be placed over the clevis bolt as a spacer to assure that the lower U-strap will not move in on the bolt. Provide adjustable clevis with a nut / washer above and below the hanger on the support rod. Ring type clevis hangers

are not acceptable.

C. Provide Anvil Figure 45 galvanized or primed and painted channel assembly for trapeze hangers.

3.6 PIPE SUPPORTS ON ROOF

A. Support condensate drain pipe on roof with Portable Pipe Hanger Model PP-10 with roller and fully adjustable height throughout pipe run. Base material shall be high density / high impact polypropylene with UV inhibitors and anti-oxidants. Provide with hot dip galvanized rod finish and framing. Nuts and washers shall be hot dip galvanized.

3.7 ANCHORS

A. Provide anchors as required. Use pipe anchors consisting of heavy steel collars with lugs and bolts for clamping to pipe and attaching anchor braces. Install anchor braces in the most effective manner to secure desired results. Do not install supports, anchors or similar devices where they will damage construction during installation or because of the weight or the expansion of the pipe. When possible, install sleeves in structural concrete prior to pouring of concrete.

3.8 FLOOR PENETRATIONS

A. At locations where pipe passes through floors, provide watertight concrete curb around penetration.

3.9 PIPE SLEEVES

A. Sleeves through masonry and concrete construction:
   1. Fabricate sleeves of Schedule 40 galvanized steel pipe.
   2. Size sleeve large enough to allow for movement due to expansion and to provide continuous insulation.

B. Sleeves through gypsum wall construction.
   1. Fabricate sleeves of 16 gauge galvanized sheet metal.

C. Sleeves through elevated slab construction.
   1. Fabricate sleeves of Schedule 40 galvanized steel pipe with welded center flange in floor.

D. Extend each sleeve through the floor or wall. Cut the sleeve flush with each wall surface. Sleeves through floors shall extend 2” above floor lines for waterproofing purposes. Slab on grade floors shall not be sleeved except where penetrating waterproofing membrane or insect control is required.

E. Caulk sleeves water and air tight. Seal annular space between pipes and sleeves with mastic compound to make the space water and air tight.

F. For sleeves below grades in outside walls, provide Thunderline Link-Seal or Advance Product and System Interlynx, with 316 stainless steel nuts and bolts, with cast iron pressure plate.

G. Provide chrome plated escutcheon plates on pipes passing through walls, floors or ceilings exposed to view. At exterior walls, stainless steel sheet metal is to be used.

H. For sleeves through fire and smoke rated walls, seal with a UL through-penetration

firestop, rated to maintain the integrity of the time rated construction. Install in accordance with the manufacturer's installation instructions. Comply with UL and NFPA standards for the installation of firestops. Refer to Architectural drawings for all fire and smoke rated partitions, walls, floors, etc.

3.10 ISOLATION VALVES

A. Provide piping systems with line size shutoff valves located at the risers, at main branch connections to mains for equipment, to isolate central plant, and at other locations.

3.11 DRAIN VALVES

A. Install drain valves at low points of water piping systems so that these systems can be entirely drained. Install a line size drain valve for pipes smaller than 2" unless indicated otherwise. For pipes 2-1/2" and larger, provide 2" drain valves unless indicated otherwise. Drain valves shall be plugged when not in use and at completion.

3.12 CLEANING OF PIPING SYSTEMS

A. General cleaning of piping systems. Purge pipe of construction debris and contamination before placing the systems in service. Provide and install temporary connections as required to clean, purge and circulate. Flush the chilled and hot water systems utilizing the filter feeders.

B. Install temporary strainers at the inlet of pumps and other equipment as necessary where permanent strainers are not indicated. Keep strainers in service until the equipment has been tested, then remove either entire strainer or straining element only. Fit strainers with a line size blow down ball valve and pipe to nearest drain. Blow down strainers, remove and clean as frequently as necessary.

C. Phase One: Initial flushing of system. Remove loose dirt, mill scale, weld beads, rust and other deleterious substances without damage to system components. Open valves, drains, vents and strainers at all system levels during flushing procedures. Flush until “potable water clear” and particles larger than 5 microns are removed.

D. Connect dead-end supply and return headers, even if not shown on the drawings, and provide terminal drains in bottom of pipe end caps or blind flanges.

E. Dispose of water in approved manner.

F. Phase Two: Cleaning of Piping Systems. Remove, without chemical or mechanical damage to any system component, adherent dirt (organic soil), oil, grease, (hydrocarbons), welding and soldering flux, mill varnish, piping compounds, rust (iron oxide) and other deleterious substances not removed by initial flushing. Chemical shall be equal to Nalco 2578 prepping compound. Insert anti-foam compound as necessary. Circulate for 48 hours or as recommended by the manufacture. Dispose of water in approved manner. Flush system and replace with clean water. Verify compatibility of chemicals used with existing chemical treatment program on remodel projects.

G. Phase Three: Final flushing and rinsing: Flush and rinse until “potable water clear” and particles larger than 5 microns are removed. Operate valves to dislodge any debris in valve body. Dispose of water in approved manner.

H. Submit status reports upon completion of each phase of work on each system.

I. Special requirements, if any, are specified in the sections on each type of piping or in the

section on Water Treatment Systems.

3.13 TESTING

A. Test piping after installation with water hydrostatic pressure of 1-1/2 times operating pressure (150 psig minimum) and carefully check for leaks. Repair leaks and retest system until proven watertight.

B. Do not insulate or conceal piping systems until tests are satisfactorily complete.

C. If any leaks or other defects are observed, suspend the test and correct the condition at once. Repeat testing until leaks are eliminated and the full test period is achieved.

D. The satisfactory completion of testing does not relieve the Contractor of responsibility for ultimate proper and satisfactory operation of piping systems and their accessories.

3.14 PIPE MARKERS

A. Identify interior exposed piping and piping in accessible chases or plenums with Opti-Code Brady Pressure Sensitive Adhesive Pipe Markers, consisting of pipe marker and direction of flow arrow tape. Clean pipe prior to installation. Background colors of markers, arrows and tape for each type of system shall be the same. Meet ANSI/OSHA standards and clearly identify each system. Provide minimum 2-1/4-inch letters through 4-inch pipe and 4-inch letters for 5-inch pipe and larger.

B. Identify exterior and mechanical room piping with Snap Around pipe markers through 4-inch pipe and Strap Around markers 5-inch pipe and larger. Pipe markers consisting of pipe marker and direction of flow arrow tape; background colors of markers, arrows and type for each type of system shall be the same. Meet ANSI / OSHA standards and clearly identify each system. Provide minimum 2-1/4-inch letters through 4-inch pipe and 4-inch letters for 5-inch pipe and larger.

C. Install identification in the following locations:
   1. both sides of penetrations through walls, floors and ceilings.
   2. Close to valves or flanges.
   3. Intervals on straight pipe runs not to exceed 50 feet
   4. Apply marker where view is obstructed.

D. Pipe markers shall meet or exceed the specifications of the ASME A13.1 “Scheme for Identification of Piping Systems”.

END OF SECTION

SECTION 23 21 13 - HOT WATER AND CHILLED WATER PIPING, VALVES AND APPURTENANCES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install heating water and chilled water piping, valves and appurtenances, including fittings and strainers. Domestic hot water piping is specified in the Domestic Water Piping and Appurtenances section.

1.2 RELATED WORK

A. Division 23 Mechanical:
   1. Pipe and Pipe Fittings - General
   2. Valves, Strainers and Vents
   3. Vibration Isolation
   4. Insulation

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. For pipe 2" and less in diameter, provide pipe conforming to ASTM A 53, Grade A or B, or ASTM A106 standard weight seamless, or electric-resistance welded black steel pipe. Furnish 150 lb. screwed malleable iron fittings conforming to ANSI B 16.3 for chilled water. Provide fittings conforming to ANSI B 16.4 for hot water.

B. For pipe 2-1/2" in diameter and larger, provide pipe meeting the requirements of ASTM A 53, Grade A or B, or ASTM A 106 standard weight seamless, or electric-resistance welded black steel pipe with standard weight seamless steel welded fittings, satisfying ASTM A 234, Grade WPA or WPB, ANSI B16.9.

2.2 VALVES

A. Refer to Section 23 05 23.

B. Refer to Building Management and Control System.

2.3 WATER SPECIALTIES

A. Pressurized Expansion Tanks shall be precharged steel tank with a replaceable heavy duty Butyl rubber bladder. The tank shall have a 1-1/2" system connection, drain, and a standard tire valve to facilitate on-site charging of the tank. The tank shall be fitted with lifting rings and a floor mounting skirt for vertical installation. The tank must be constructed in accordance with Section VIII of ASME Boiler and Pressure Vessel Code and stamped 125 PSI working pressure.
   1. Acceptable manufacturers: Bell & Gossett, Taco, Wessels, John Wood Company, and Wheatley.

B. Air Separators shall be centrifugal type. The inlet and outlet connections shall be the same as adjoining pipe. Vessel shell diameter is to be three times the nominal inlet/outlet pipe diameter. The unit shall have an internal stainless steel air collector tube with perforations and 63% open area designed to direct accumulated air to the compression tank via a vent connection at top of unit. The air separator must be designed, constructed and stamped for 125 psig @ 350°F in accordance with Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code, and registered with the National Board of Boiler and Pressure Vessel Inspectors. The air separator(s) shall be painted with one shop coat of light gray air dry enamel. A Manufacturer's Data Report for Pressure Vessels, Form U-1 as required by the provisions of the ASME Boiler and Pressure Vessel Code shall be

furnished for each air separator upon request.

1. Acceptable manufacturers: Bell & Gossett, Armstrong, Taco, John Wood Company, and Wheatley.

C. Automatic Air vents shall be float actuated high capacity air vent designed to purge free air from the system and provide shutoff at pressures up to 150 psig at a maximum temperature of 250 degrees F. The design of the high capacity air vent shall prevent air from entering the system if system pressure should drop below atmospheric pressure. The high capacity air vent shall purge free air at pressures up to 150 psig during normal system operation. The high capacity air vent shall be constructed of cast iron and fitted with components of stainless steel, brass, and EPDM.

1. Acceptable Manufacturers: Bell & Gossett, Armstrong, Taco, and Wheatley.

D. Pressure Reducing Valves shall be diaphragm operated with brass body, low inlet pressure check valve and inlet strainer. The strainer shall be easily removed without system shutdown. The valve seat, strainer, and stem must be removable and of non-corrosive material.

1. Acceptable Manufacturers: Bell & Gossett, Armstrong, Taco, and Wheatley.

PART 3 - EXECUTION

3.1 TESTING

A. Test all piping systems to assure they are absolutely leak free.

B. Apply a hydraulic pressure 1-1/2 times the operating pressure, 150 psig minimum, and check for leaks. Maintain test for a minimum of 24 hours. The piping system must remain absolutely tight during this period. The satisfactory completion of any test or series of tests will not relieve the contractor of responsibility for ultimate proper and satisfactory operation of piping systems and their accessories. The test should be observed by the Architect / Engineer before pressure is removed and water drained.

3.2 AIR HANDLING UNIT PIPING

A. Provide a minimum of 12" of straight pipe at all coil piping connections.

3.3 AIR SEPARATOR

A. Install full size drain to nearest floor drain.

END OF SECTION

SECTION 23 21 23 - HVAC PUMPS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. General characteristics for pumps specified in Division 23 - Mechanical.

1.2 RELATED WORK

Requirements for pumps are specified in other sections of Division 23 - Mechanical, including the following:

A. Division 23 Mechanical - Electrical Provisions of Mechanical Work.

1.3 PUMP SELECTION

A. Select pumps conservatively for scheduled conditions. Furnish pumps that have reasonably high efficiencies, with peak efficiency at or near rated conditions. Select pumps that will operate stably at 15' suction lift despite substantial reduction in head or substantial increase in delivery.

B. If the pumps proposed are not considered suitable, submit manufacturer's data on other pumps, for review.

C. Scheduled design flow, design head, pump efficiency, and motor horsepower are the minimum acceptable.

D. The pump curve shall rise continuously from maximum flow to cut-off.

E. Shut-off head approximately 10 percent greater than design head, unless otherwise indicated in pump schedules.

F. Pump brake horsepower shall not exceed the motor horsepower rating over the entire operating range from shut-off to run-out.

G. Select the pump for operation at or near peak efficiency.

H. Cavitation-free at all points on the curve.

I. Impeller diameter shall not exceed 90 percent of the maximum published diameter.

J. Pumps shall be suitable for parallel operation. Where pumps are operated in parallel, individual pumps shall be capable of stable operation with only one pump operating in the system. Submit pump curves with single and multiple pumps operating on system curve for approval.

1.4 PUMP SIZE AND TYPE

A. Provide motor-driven pumps of the type and speed scheduled. Select pumps that are not overloaded throughout the entire range of pump operation. Provide pump connection sizes as indicated.

B. The head capacities indicated in the schedules are listed for bidding purposes only. Calculate the operating head at each pump; take into consideration the actual routing of the various lines, pressure drops in heat exchangers and coils, exact lengths of pipe,

fittings, etc. Submit these calculations, together with copies of manufacturer's performance curves, as shop drawings on each pump. Clearly mark the curves for each pump to indicate the diameter of the impeller and the selection point.

1.5 CERTIFIED DATA

A. Submit factory certified pump curves showing pump performance characteristics with pump and system operating points plotted. Curves shall include as a minimum, flow (gallons per minute), head (feet of water), all available impeller diameters (inches), efficiency (percent), net positive suction head required (feet of water), brake horsepower, pump size and pump model. When multiple pumps are operating in parallel, show pump curves for one pump running, two pumps running, and so on. Show pump curves with system curve plotted.

PART 2 - PRODUCTS

2.1 VERTICAL IN-LINE (VIL) PUMPS

A. Pump Construction:
1. Pump casing, cast iron with 125 psig ANSI/PN16 flanges for working pressure below 175 psig at 150°F and ductile iron with 250 psig ANSI / PN25 flanges for working pressure to 375 psig at 150°F.
2. Suction and discharge connections shall be flanged and the same size and shall be drilled and tapped for seal flush and gauge connections.
3. Impeller: Bronze, fully enclosed type; dynamically balanced, two-plan balancing is required where installed impeller diameter is less than 6 times the impeller width.
4. Shaft: Provide stainless steel pump shaft.
5. Coupling: Rigid spacer type of high tensile aluminum alloy. Coupling is to be designed to be easily removed on site to reveal a space between the pump and motor shafts sufficient to remove all mechanical seal components for servicing and to be replaced without disturbing the pump or motor.
6. Mechanical seals shall be stainless steel multi-spring inside or outside balanced type with Viton secondary seal, carbon rotating face and silicon carbide stationary seat. Provide 316 stainless steel glad plate. Provide factory installed flush line with manual vent.
7. Split coupled pumps shall be provided with a lower seal chamber throttle bushing to ensure seals maintain positive cooling and lubrication.
8. Provide seal flush supply line to the mechanical seal with a 50 micron cartridge filter and sight flow indicator to suit the working pressure encountered. Filters shall be changed by the installing contractor after system is flushed and on a regular basis until turned over to the Owner.
9. Supply in the flush line to the mechanical seal a maintenance free sediment separator with sight flow indicator.

B. Single stage, single or double suction type, with pump characteristics which provide rising heads to shut off. Refer to pump schedule for pump flows and heads and motor speed, enclosure, efficiency and power requirements and other system conditions.

C. Pump Motor:
1. Premium efficiency
2. Totally enclosed fan cooled
3. Cast iron frame and end plate
4. Forge steel lifting eye
5. Over sized conduit box with ground lug
6. So sized with relation to the pump impeller that the brake horsepower

requirements will not overload the motor at any point on the pump curve

7. Designed for Variable Frequency Drive Application
8. Minimum Efficiency

3 hp	1800 rpm	89.5%
5 hp	1800 rpm	90.2%
7.5 hp	1800 rpm	91.7%
10 hp	1800 rpm	91.7%
15 hp	1800 rpm	92.4%
20 hp	1800 rpm	93%
25 hp	1800 rpm	93.6%
30 hp	1800 rpm	94.1%
40 hp	1800 rpm	94.5%
50 hp	1800 rpm	94.5%
60 hp	1800 rpm	95%
75 hp+	1800 rpm	95.4%

D. Data plates:
   1. Provide the pump with a nameplate constructed of 300 series stainless steel securely fastened to pump casing with stainless steel pins.
   2. Locate the nameplate for easy visibility.
   3. Clearly stamp the rating conditions and other data below, as a minimum, on the nameplate.
      a. Manufacturer, address, telephone number
      b. Pump model number
      c. Pump serial number
      d. Size (including impeller diameter scheduled in inches)
      e. Type
      f. Equipment designation as listed on the pump schedule.
      g. Flow scheduled (gallons per minute)
      h. Dynamic head scheduled (feet of water)
      i. Efficiency (percent)
      j. Shut-off head (feet of water)
      k. Speed (rpm)
      l. Brake horsepower
      m. Maximum brake horsepower with rated impeller
      n. Rotation
      o. Maximum allowable pressure (psig)

E. The schedule on the drawing sets forth the type of pump and GPM required.
   1. The head capacities and horsepower are for bidding purposes only.
   2. Make pump selection based on actual system calculations.

F. Acceptable manufacturers:
   1. Bell & Gossett
   2. TACO

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install the pumps in accordance with Manufacturer's "Installation, Start-up and Service Instructions".
   1. Provide access space around pumps for service.
   2. Install pumps on concrete housekeeping base, with anchor bolts, set and level, and grout in place. Install stainless steel drain pan with trough under chilled water

pumps only.

3. Provide air cock and drain connection piped to floor drain.
4. Lubricate pumps prior to start-up.
5. Install condenser water pumps to ensure a full flooded suction.
6. Paint entire unit with two coats of machinery enamel after completion of installation.
7. Provide a spool piece between the suction diffuser and the suction side of the pump minimum length 8" face to face.
8. Provide pressure taps with valves on each side of the pump.
9. Install hot water circulator horizontally, properly supported to wall, in an accessible location for testing and maintenance at a height not to exceed 60” above finished floor. Install line size Ernst bronze rotating wheel, flow indicator with double window, downstream of circulator.

B. Provide a line size isolation valve and strainer on the pump suction and a line size silent check valve and balancing valve on the pump discharge. Provide an automatic air vent off the pump casing. For base mounted pumps, provide a drain line the full size of the base connection and extend it to and terminate it over the nearest floor drain.

C. Support piping adjacent to the pump such that no weight is carried on the pump casing. Decrease from pipe size with eccentric reducer on suction side and concentric increaser on discharge side.

D. Ensure pumps:
1. Operate at specified system fluid temperatures without vapor binding and cavitation.
2. Are non-overloading in parallel and individual operation.
3. Operate within 25 percent of midpoint of published maximum efficiency curve.

E. Refer to pump detail on the Contract Drawings for piping accessories to be provided.

3.2 ALIGNMENT FOR BASE MOUNTED PUMPS

A. Set the pump on a concrete inertia base or concrete housekeeping pad as specified; anchor, level and grout.

B. Align the pump and driver in accordance with Hydraulic Institute Standards for centrifugal, rotary and reciprocating pumps.

C. Realign the pump and driver after initial leveling of pump base before placing the grout and again after the grout has set and the foundation bolts are tightened. Recheck the alignment after the piping has been connected.

3.3 MANUFACTURER START-UP SERVICE ALIGNMENT

A. After installation, the pumps and motors are to be aligned by the manufacturer or their representative utilizing a dial indicator. After completion, a formal report must be submitted by the Manufacturer to the Engineer prior to final acceptance. This report must include pump serial number, location, beginning and final alignment at a minimum.
1. Technicians, as required, shall be trained and experienced in the work they perform (contractor start-up / alignment is unacceptable).

B. Before starting pumps, but after connecting piping:
1. Align shafts and coupling with a precision dial indicator alignment instrument to the minimum tolerances .004 (TIR) per inch of coupling radius or as recommended by the manufacturer, whichever is the greater.

2. Tabulate the actual pump alignment reading with manufacturer's minimum tolerances.
3. Submit readings for approval.
4. Include the approved readings in the Owner's Maintenance Manual.

3.4 FINAL PUMP FLOW CALIBRATION

A. Based on the results of the final phases of the test and balance sequences, if the flow of the unthrottled pump is more than 10% above the scheduled values:
   1. Request detailed instructions from the pump manufacturer for the correct impeller diameter.
   2. Trim the impeller to the diameter recommended by the manufacturer, employing precision machinery.

B. Enter the information on the final configuration of the pump in the Owner's Manual.
   1. Modify the pump nameplate to reflect the correct head and flow data and the impeller diameter.

3.5 SPARE PARTS

A. Provide the following spare parts and material to the Owner for his use after the warranty period.
   1. A mechanical seal for each pump
   2. A set of bearings for each pump

END OF SECTION

SECTION 23 25 12 - FLUSHING AND CLEANING OF STEEL PIPING SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01, apply to this Section.

B. Addenda issued during the bidding period that affect this section of the specifications.

1.2 WORK INCLUDED

A. Flushing and cleaning of the complete closed loop condenser water system including the hot water portion of system. This work shall be performed prior to replacing the air separator with new air dirt separator.

1.3 SERVICE AND SUPPLIES

A. All work shall be performed by a qualified, full-time, Flushing Contractor.
1. Specialist in the field of industrial system flushing and cleaning.

B. After the mechanical contractor has tested the piping, it shall be flushed and cleaned for service. Provide a complete water flushing and cleaning of the closed loop chilled and hot water systems as specified herein. Systems must be commissioned as clean and meet water treatment specifications.

C. All closed loop condenser water, and hot water piping and related equipment shall be thoroughly flushed out with precleaning chemicals designed to remove deposits such as pipe dope, oils, loose rust, mill scale and other extraneous materials. Recommended dosages of pre-cleaner chemical products shall be furnished by water treatment supplier, added and circulated throughout the water systems. The water system shall then be diluted and final flushed thoroughly until no foreign matter is observed and total alkalinity of the water is equal to or better that that of the make-up water.

D. All temporary connections required for flushing, cleaning, purging, and circulating shall be provided by mechanical contractor. Provide suitable pipe bypasses at each coil and heat exchanger during the flushing and cleaning operation.

E. Self-contained flush unit requirements shall contain a pump or pumps connected that will meet or exceed the volume required to flush and purge the system at the required velocity rate through the largest pipe. Pump curve shall be submitted along with other important documentation for the related equipment on the unit. This will include, at minimum, filtration, flow meter(s), pressure gauges, and unit description or picture. All operators shall comply with all safety regulations of the project site. The flushing operation shall be manned continuously during the flushing process**.**

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. PurgeRite

B. Owner or Engineer approved equivalent. Substitution request must be received as outlined elsewhere in specifications.

PART 3 - EXECUTION

3.1 FLUSHING PROCEDURE

A. PRE-FLUSH

1. Bypass loops should be installed in front of any strainers and control valves at all equipment components. Coordinate with flushing and cleaning contractor for proper sizing and placement of bypasses and flush ports.
2. Install temporary strainer elements in front of pumps, tanks, solenoid valves, control valves, and other equipment where permanent strainers are not indicated that are not bypassed. Keep these strainers in service until the equipment has been tested, then remove either entire strainer or straining element only. Fit strainers with a line size blow-off valve. Strainers should be removed when a self-contained flush unit is used in conjunction with on board filtration.
3. Flush ports should be identified along with the type of high pressure hose or piping that will be used to connect to the system.
4. The water source shall be provided and identified to the flushing and cleaning contractor by the mechanical contractor and must be adequate to fill and make up water in a timely manner to the system during the flush process.
5. A water dump location source shall be provided and identified to the flushing and cleaning contractor by the mechanical contractor which is usually the sanitary.

B. CLEAR WATER FLUSH

1. Fill the piping system with clean potable water. The first flush is a clear- water flush intended to circulate water through the system and force loose debris to low point drains and flush cart filtration system. This flush should be at minimum velocity throughout the system of 5 -7 ft./sec throughout. Filtration should be at minimum, 50 microns. This flush shall continue until the system water is comparable to the make-up water. Iron content should be under 2.0 ppm.

C. CLEANING AND PASSIVATION

1. The second flush cycle is a combined flushing cycle where cleaning and passivation chemicals are introduced into the system to clean the oils and treat the inside wall of the piping system. This process will be monitored by the chemical treatment company to meet the chemical specifications of the water. The cleaning velocity should be between 3 to 5 ft./sec throughout, and the circulation time will be based on the chemical testing, but will be at minimum, 24 hours.

D. FINAL CLEAR WATER FLUSH

1. The system will be continuously flushed while discharging chemicals into the sanitary system as approved locally. As the existing treated water is being discharged, a fresh water make-up source will be utilized to ensure air is not introduced into the system. Continue to drain the system while adding domestic water to dilute the treated water. The chemical treatment company will monitor the outgoing water composition and compare the composition with the incoming water. Flush with fresh water until the conductivity is reduced to that of the make-up water and iron meets specifications. The final system water should be approved by the chemical treatment company. Filtration should be 5 microns.

E. FINAL CHEMICAL FILL

1. Once the chemical treatment company has determined the system has been brought back to the correct composition, the chemical treatment company will inject the final chemicals into the system. Once the system is filled with the final chemicals it is important the water not be left stagnant.
2. Verify satisfactory completion of clean piping and a final flushing and chemical treatment report should be submitted by field personnel. The report should

include at minimum, project name, date, location, parties involved, type of pipes treated, scope summary, flows, durations, and other relevant information.

3. Cleaning chemicals, procedure, water testing, reporting, and consultation must be provided by a qualified water treatment company specializing in this type of work.

END OF SECTION

SECTION 23 25 13 - CIRCULATING WATER SYSTEM CHEMICAL TREATMENT

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide equipment, chemicals and treatment materials for the complete water treatment system.

B. Determine which chemicals to use from the results of a water sample analysis taken from the building domestic water supply.

C. Provide water treatment products, holding reservoirs, equipment and labor for testing, cleaning, flushing and dispensing products to achieve the required water quality for each system specified.
   1. Closed chilled and hot water systems
   2. The cooling tower condenser water system
   3. Closed condenser water system

1.2 SERVICE AND SUPPLIES

A. All work shall be performed by a qualified, full-time, Water Program Manager.
   1. Specialist in the field of industrial water treatment.
   2. Facilities include water analysis laboratory, development facilities and service department.

B. Provide a water treatment test set for each system (pH, alkalinity, hardness, chloride) for field use including test equipment and reagents as required for specific use with the treatment products employed.

C. Where specialized supplementary testing or control equipment is required, provide appropriate items.

D. Provide a water management and service program for a period of one year beginning at substantial completion. Make routine visits bi-weekly during first two months of operation and monthly during the remainder of the specified period.

E. Routing Services
   1. Check and adjust water treatment system operation.
   2. Instruct, train and advise operating personnel.
   3. Check efficiency of chemicals and chemical applications.
   4. Replenish chemicals and replace expendables.
   5. Clean or replace filter in feeder.

F. Chemically clean the piping system.

G. Provide a complete laboratory analysis of water samples. Insert in the Owner's manuals.

H. Provide review of report figures in the field water testing.

1.3 QUALITY ASSURANCE

A. Acceptable program manager shall have:
   1. Research and development facilities.
   2. Regional laboratories capable of making water analysis.
   3. A service department and qualified technical service representatives located

within a reasonable distance of the project site.

4. Service representatives who are registered Engineers or factory-certified technicians with not less than 5 years of water treatment experience with the water treatment system manufacturer.

B. Ensure that all products, packaging, blow-down or other effluents do not violate local, state, or federal laws or regulations. Use only chemicals that are registered, when required, with the U.S. Department of Agriculture or the U.S. Environmental Protection Agency and that are labeled as required by law.

C. Provide electrical products that have been tested, listed and labeled by Underwriters Laboratories and comply with the National Electrical Manufacturers Association Standards.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Chem-Aqua

2.2 CLOSED HOT WATER SYSTEM

A. By-pass filter feeders in the hot water and chilled water systems:
   1. Rated at 40-gpm capacity.
   2. Operating conditions: 150 psig and 250°F.
   3. Quick opening cap with a Buna N-O ring seal; or 1-1/2" valve and funnel.
   4. 5 micron polypropylene filter bag mounted in a perforated stainless steel holder. Filter bag shall be supported from top of feeder.
      a. Filter bag and holder shall extend full length of feeder tank.
      b. Bottom feed tanks are not acceptable.
   5. Fabricated hot dipped galvanized steel support legs and frame. Refer to detail drawing for requirements.
   6. Provide sufficient quantity of filter bags for warranty period. Minimum of six additional bags provided to owner.

B. Acceptable Manufacturers
   1. Neptune Model FTS-5
   2. Efficiency Dynamics FF-100.
   3. J.L. Wingert Model FHC-5HD.
   4. Hydro-systems HS-800
   5. Vector Industries, Inc. FA-900

C. Treatment chemicals:
   1. Furnished as a concentrated liquid in 5 gallon pails
   2. A corrosion inhibitor of the nitrite-borate type.
   3. Maintained at a nitrite residual of 600 – 800 ppm in chilled loops and 1000-1500 in hot loops.
   4. With effective copper, black iron, stainless steel and aluminum corrosion inhibitors.
   5. Form a protective film to prevent corrosion and scale formation.
   6. Have colored dye to indicate presence.

D. Multiple chemicals used in a common system shall be compatible.

E. Flow Indicator:

1. Bronze Construction
2. Rotating Wheel
3. Line Size
4. Double Window
5. Ernst Flow Industries Model EFIE-57-3

PART 3 - EXECUTION

3.1 INSTALLATION/START-UP

A. In accordance with manufacturer's recommendations.

B. Anchor the chemical filter feeder to a concrete housekeeping pad using wedge type expansion anchors.

D. Clean and flush closed loops systems.
1. Clear water flush systems before introducing chemical cleaners.
2. Chemical cleaner shall be introduced into the systems to remove construction related oils, greases, threading compounds, and silt.
3. Chemical Cleaner shall passivate and pre-film pipe system.

3.2 WATER ANALYSIS

A. The chemical treatment agency shall provide the services of a testing laboratory to perform a site water analysis. As a minimum, conduct the following tests in accordance with ASTM standards and to the satisfaction of the Owner/Architect/Engineer.
1. Silica in water and wastewater.
2. Acidity or alkalinity of water.
3. Iron in water.
4. Hardness of water.
5. Ph of water.
6. Particulate and Dissolved Matter, Solids or Residue in Water.
7. Turbidity in water.
8. Corrosivity of water in absence of heat transfer.
9. Standard practices for sampling water.

B. Take water samples in accordance with ASTM.

C. Prepare a test report in accordance with ASTM for each of the tests conducted.

D. Submit the test reports to the Architect/Engineer.

3.3 CHEMICAL TREATMENT

A. The chemical treatment agency shall provide complete services necessary for chemically cleaning and treatment the following systems:
1. Chilled water.
2. Hot water.
3. Condenser water.

B. The chemical treatment agency shall provide, but not be limited to the following:
1. Equipment and installation.
2. Chemicals.
3. Analytical and testing work.
4. Inspection.
5. Calculations.

6. Assistance to the trade installing the piping.
7. Instruction to Owner.

C. Determine which chemicals to use from the results of site water analysis. Provide the chemical necessary to achieve the desired water condition.

D. Examine and supervise flushing and pipe cleaning operations and verify that the systems are clean, free of debris and rust and other construction materials before starting water treatment.

E. After the piping has been flushed, cleaned, rinsed and charged with chemicals, then start-up and operate the chemical treatment equipment to provide steady, stable characteristics for the systems treated.

F. During construction, instruct the Contractor in the field piping and wiring of chemical feeding equipment. If such piping and wiring details are not shown on the Contract Drawings, then provide all equipment, piping, wiring, instrumentation and chemicals to provide a complete and operating system without additional cost.

G. After the chemical treatment is functioning as intended, the chemical treatment agency shall demonstrate to the Architect/Engineer the chemical treatment operation.

3.4 OWNER TRAINING

A. A chemical treatment agency, in conjunction with the chemical treatment equipment manufacturer's factory representative, shall train the Owner to operate and maintain the chemical treatment system as a whole and in part for each piece of equipment.

B. Furnish to the Owner a chemical treatment administration manual covering the chemical treatment program for each of the systems treated. The manual shall include, but not be limited to:
1. Name, address and telephone number of the chemical treatment agency and each of the equipment manufacturers.
2. Operation and maintenance manuals.
3. Test reports.
4. Chemical data sheets.
5. A narrative describing the chemical treatment program for each of the systems being treated.

3.5 TESTING AND INSPECTION

A. After the systems have been accepted, the chemical treatment agency shall visit the site every month during the warranty period.

B. During each visit:
1. Check and adjust the chemical treatment equipment.
2. Check the chemistry of the treated system to confirm the chemicals are maintaining the system as intended.
3. Advise and instruct the Owner on operational changes made to the chemical treatment program.
4. Take a water sample of each system being chemically treated and have the samples tested by a testing laboratory. Prepare a report for each water sample and submit it to the Owner. Include in the test report the changes that need to be made to the chemical treatment program.
5. Maintain complete records of the treatment program for each system at the project site. Keep the records in a hardbound manual with the building manager.

A second copy shall be maintained by the agency for the agency's records.

C. Routine visits must be coordinated with the Owner.

D. Send copy of monthly report to Engineer for Verification.

END OF SECTION

SECTION 23 31 13 - DUCTWORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Duct construction, support and accessories. Dimensions shown on the drawings are free area dimensions.

1.2 RELATED WORK

A. Division 23 Mechanical
   1. Air Devices
   2. Air Handling Units
   3. Insulation
   4. Terminal Units
   5 Fan Coil Units
   6. Fans
   7. Packaged Rooftop Air Conditioners
   8. Testing, Balancing and Adjusting (TAB) of Environmental Systems

B. Division 9 – Finishes, Painting and Color Coding

1.3 QUALITY ASSURANCE

A. The intent of ductwork specifications is to obtain superior quality workmanship resulting in an installation that is absolutely satisfactory in both function and appearance. Provide ductwork in accordance with the specifications for each type of service.

B. An approved contractor for this work under this division shall be:
   1. A specialist in this field and have the personnel, experience, training, skill, and the organization to provide a practical working system.
   2. Able to furnish evidence of having contracted for and installed not less than 5 systems of comparable size and type that have served their owners satisfactorily for not less than 5 years.

1.4 GUARANTEE

A. Guarantee ductwork for 1 year from the date of substantial completion. The guarantee covers workmanship, noise, chatter, whistling, or vibration. Ductwork shall be free from pulsation under conditions of operation.

1.5 CONTRACTOR COORDINATION

A. Erect ducts in the general locations shown, but conform to structural and finish conditions of the building. Before fabricating any ductwork, check the physical conditions at the job site and make necessary changes in cross sections, offsets, and similar items, whether they are specifically indicated or not.

B. Coordinate location of ductwork with structural members and Architectural drawings and requirements.

1.6 SHOP DRAWINGS AND SAMPLES

A. Submit shop drawings of all ductwork layouts, including enlarged plans and elevations of all air handling equipment, and summit details of duct fittings, including particulars such as gauge sizes, welds, and configurations prior to starting work.

B. Submit product data and sealing materials to be used.

C. Submit sound attenuation data.

D. Submit shop drawings in plan, elevation and sections, and three-dimensional view showing equipment in mechanical equipment areas.

PART 2 - PRODUCTS

2.1 STANDARDS AND CODES

A. Except as otherwise indicated, sheet metal ductwork material and installation shall comply with the latest edition of SMACNA HVAC Duct Construction Standards. Air distribution devices (such as dampers) included in this specification shall comply with the latest applicable SMACNA Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems and NFPA 90A.

2.2 DUCT MATERIAL AND CONSTRUCTION

A. Except for the special ducts specified below use lock forming quality prime galvanized steel sheets or coils up to 60" wide. Stencil each sheet with gauge and manufacturer's name. Stencil coils of sheet steel throughout on 10' centers with gauge and manufacturer's name. Provide certification of duct gauge and manufacturer for each size duct.

B. Rectangular low and medium pressure duct constructed of sheet metal in accordance with the latest edition of SMACNA HVAC Duct Construction Standards.

C. Medium pressure oval and round ductwork shall be spiral seam. Spiral lock-seam SMACNA Type RL-1. Fittings shall be welded construction.
   1. Galvanized

D. Low pressure round ducts shall be shop fabricated with snap lock longitudinal seams. Ducts shall be constructed for a minimum of 2" w.g. static pressure.

E. Dishwasher Hood Exhaust System: Welded 304 Stainless steel.

F. Shower Area Exhaust Systems: Welded 304 Stainless steel.

G. Kitchen exhaust duct: Welded Black steel, minimum 16 gauge

H. Natatorium Ductwork: 304 Stainless Steel

2.3 ACOUSTICAL DUCT

A. Duct and fittings:
   1. Double wall acoustically treated.
   2. Annular space packed with fiberglass insulation.
   3. Perforated metal liner to provide specific acoustic impedance
   4. Insulation 1.0 pcf. 1 inch thick
   5. United McGill Acousti-K27 spiral lockseam or approved equal
   6. Material as indicated below:
      a. Paintable Galvanized Steel

B. Pressure rating and tests as specified for single wall ductwork.

2.4 DUCT SEALING OF SEAMS AND JOINTS

A. Follow seal classification as indicated in Table 1-2 of SMACNA "HVAC AIR DUCT LEAKAGE TEST MANUAL". Use seal class A for 4" w.g. static. All longitudinal and transverse joints and seams shall be sealed by use of a fireproof, non-hardening, and non-migrating elastomeric sealant. With the exception of continuously welded joints and machine made spiral lock seams, joints and seams made air tight with duct sealer.
   1. Indoor applications – Foster 32-14
   2. Outdoor applications – Foster 32-17

2.5 FLEXIBLE DUCT LOW PRESSURE

A. Construction:
   1. Continuous galvanized spring steel wire helix, with reinforced metalized cover
      a. The fabric shall be mechanically fastened to the steel helix without the use of adhesives.
   2. UL 181 Class I air duct label
   3. Reinforced vapor barrier jacket
   4. Rated for use at system pressure (6" wc minimum)
   5. Flexible duct connections from lateral taps to variable volume boxes or terminal boxes shall be rated at twice the maximum pressure rating of the medium pressure system.

B. Fire hazard classification:
   1. Flame spread rating 25 maximum.
   2. Smoke developed rating 50 maximum.

C. Thermal characteristics:
   1. R-6 BTU/hr/sq. ft./°F (when located in a conditioned plenum)
   2. R-8 BTU/HR/Sq.Ft./°F (when located in an unconditioned plenum)
   3. 2" minimum wall thickness insulation with 1" overlap

D. Acceptable manufacturers:
   1. Flexmaster
   2. Hart & Cooley
   3. Omniair
   4. Peppertree Air Solutions

2.6 FLEXIBLE DUCT MEDIUM/HIGH PRESSURE

A. The duct shall be constructed of a heavy coated fiberglass cloth fabric supported by helical wound galvanized steel. The fabric shall be mechanically fastened to the steel helix without the use of adhesives.

B. The internal working pressure rating shall be at least as follows with a bursting pressure of at least two times the working pressure:
Positive: 12" w.g.
Negative: 5" w.g.

C. The duct shall be rated for a velocity of at least 5500 fpm.

D. Suitable for operating temperature range of -20°F to +250°F.

E. Factory insulate the flexible duct with fiberglass insulation.
   1. R-6 BTU/hr/sq. ft./°F (when located in a conditioned plenum)
   2. R-8 BTU/HR/Sq.Ft./°F (when located in an unconditioned plenum)

3. 2" minimum wall thickness insulation with 1" overlap

F. Cover the insulation with a fire retarding polyethylene vapor barrier jacket having a permeance of not greater than 0.10 perms when tested in accordance with ASTM E96, Procedure A.

G. Acceptable manufacturers:
1. Flexmaster
2. Omniair
3. Peppertree Air Solutions

2.7 FIRE DAMPERS

A. Fire dampers for required wall ratings that are 95% minimum free area. Provide Type B or Type C UL dampers for low, medium and high-pressure rectangular, square or round ducts. Dampers shall be activated by a fusible link designed to react at 165°F. Install per manufactures recommendations to provide a UL assembly. Provide sealed sleeve to meet desired leakage performance.

B. Acceptable Manufacturers:
1. Ruskin
2. Prefco Products
3. Air Balance
4. Greenheck, Inc.
5. Nailor Industries
6. Pottoroff

2.8 CEILING RADIATION DAMPERS

A. Ceiling Radiation Dampers at location shown on plans constructed and tested in accordance with the current edition of UL555C of a minimum 22 gauge (0.8) blades, hinged in the center and held open with a 165° fusible link. Maximum blade height in the open position shall be 10" overall regardless of damper area. Maximum distance between blades held in the open position shall be 1-1/4" for units not requiring blade insulation and 1/4" for units with sheetrock blade insulation. Blades requiring radiation protection insulation shall utilize sheetrock. Refractory Ceramic or Mineral Wool Fiber is not allowed in the air stream. Radiation insulation outside of the air stream shall be Mineral Wool Fiber only. Ceramic Fiber Material is not approved for use. Units shall be constructed of a minimum 20-gauge (0.9) frame welded at all seams.

B. Acceptable Manufactures
1. Ruskin
2. Prefco
3. Air Balance
4. Phillips
5. Safe-Air
6. Nailor Industries

2.9 WALL LOUVERS

A. Refer to schedule on drawings. Coordinate with Architectural Drawings.

B. All louver frames shall be a minimum of 0.08" extruded aluminum. All blades shall be a minimum of 0.081" extruded aluminum. Beginning point of water penetration at 0.01 oz/sq.ft. Shall be a minimum of 800 ft/min.

C. Provide all louvers with removable aluminum bird screen with 1/4" mesh.

D. Louvers shall be AMCA-550 tested and approved.

E. Acceptable manufacturers:
1. American Warming and Ventilation
2. Arrow
3. Greenheck
4. NCA
5. Pottorff
6. Ruskin

2.10 FLUES FOR POWER EXHAUST AND HIGH EFFICIENCY BOILERS AND WATER HEATERS

A. Double wall air insulated positive pressure chimney equal to Metalbestos, Van-Packer, Schebler or Metal-Fab. Chimney shall be rated for 550°F maximum flue gas temperature and with a UL tested pressure rating of 40 inches w.c. The interior pipe shall be constructed of AL 29-4C stainless steel and the exterior pipe shall be constructed of 304 stainless steel. Stack system shall be complete with a one inch air gap between inner liner and outer cover. Chimney shall be constructed and installed per UL-1738 and NFPA-211. All accessories shall be made by the same manufacturer and designed to be a part of a positive pressure chimney system.

2.11 DUCT LINING

A. Duct lining shall be 1" thick, 1-1/2 lb. density, flexible lining coated on the air stream side to reduce attrition. Liner shall be Schuler Lina-Coustic, Certain-Teed Ultralite, or equal meeting requirements of NFPA 90-A. Provide I.A.Q. rated liner.

2.12 VOLUME DAMPERS

A. Manual balancing dampers that meet or exceed the following minimum construction standards:
1. Frame 16-gauge
2. Blades 16-gauge
3. Bearings corrosion resistant
4. Concealed linkage
5. Opposed blade dampers

B. Acceptable manufacturer:
1. Ruskin Model MD-35 or approved equal, by
2. Arrow
3. American Warming and Ventilating
4. Nailor Industries
5. Pottoroff

2.13 ACCESS DOORS

A. Round spin-in door of galvanized steel.
1. Fire proof sealing gaskets and quick fastening locking devices
2. Insulated door
3. Conform to the requirements of the NFPA
4. Identification and use of each access door
5. UL label to match the construction in which it is installed
6. Cable attached to door and outer frame
7. Low leakage Access Door

B. Acceptable Manufacturer

1. Flex master, Inspector Series
2. Approved Equal

2.14 COMBINATION FIRE/SMOKE DAMPERS

A. Combination fire/smoke dampers meeting the following requirements:
1. Each combination fire/smoke damper shall be 1-1/2 hour fire rated under UL Standard 555, 4th Edition, and shall be further classified by Underwriters Laboratories as a leakage Rated Damper for use in smoke control systems under the latest version of UL555S, and bear a UL label attesting to same. The damper manufacturer shall have tested, and qualified with UL, a complete range of damper sizes covering all dampers required by this specification. Testing and qualifying a single damper size is not acceptable. The leakage rating under UL555S shall be Leakage Class II.
2. The damper frame shall be a minimum of 16 gauge, galvanized steel, formed into a structural hat channel shape with tabbed corners for reinforcement, as approved in testing by Underwriters Laboratories. Bearings shall be integral high surface area non-electrolytic materials construction to incorporate a friction free frame blade lap seal, or molybdenum disulfide impregnated stainless steel or bronze oilite sleeve type turning in the damper frame. The dampers shall be opposed blade type. The blades shall be constructed with a minimum of 16-gauge galvanized steel. The blade edge seal material shall be able to withstand 450°F. The jamb seals shall be flexible stainless steel compression type.
3. As part of the UL qualification, dampers shall have demonstrated a capacity to operate (open and close) under HVAC system operation conditions, with pressures of at least 4" water gauge in the closed position, and 2,000 fpm air velocity in the open position.
4. Each combination fire/smoke damper shall be equipped with a controlled 7 to 15 second heat-actuated release device. The electric EFL shall close and lock the fire/smoke damper during test, smoke detection, power failure or fire conditions through actuator closure springs. To prevent duct and HVAC component damage, the damper shall at all times be connected to the actuator for controlled closure in not less than 7 seconds and no more than 15 seconds. Instantaneous damper closure is unacceptable. After exposure to high temperature of fire, the damper must be inspected prior to reset to ensure proper operation. Release temperature is 165°F.
5. Provide UL555S qualified electric actuator at 120 VAC.
6. Provide air-foil type blades.

B. Provide integral sleeves

C. Acceptable Manufacturers:
1. Ruskin
2. Air Balance, Inc.
3. Greenheck, Inc.
4. Nailor Industries
5. Pottoroff

2.15 SMOKE DAMPERS

A. Smoke dampers meeting the following requirements.
1. Each smoke damper shall be classified by Underwriters Laboratories as a leakage Rated Damper for use in smoke control systems under the latest version of UL555S, and bear a UL label attesting to same. The damper manufacturer shall have tested, and qualified with UL, a complete range of damper sizes covering all dampers required by this specification. Testing and qualifying a single damper size is not acceptable. The leakage rating under UL555S shall be

Leakage Class II.

2. The damper frame shall be a minimum of 16 gauge, galvanized steel, formed into a structural hat channel shape with tabbed corners for reinforcement, as approved in testing by Underwriters Laboratories. Bearings shall be integral high surface area non-electrolytic materials construction to incorporate a friction free frame blade lap seal, or molybdenum disulfide impregnated stainless steel or bronze oilite sleeve type turning in the damper frame. The dampers shall be opposed blade type. The blades shall be constructed with a minimum of 16 gauge, galvanized steel. The blade edge seal material shall be able to withstand 450°F. The jamb seals shall be flexible stainless steel compression type.
3. As part of the UL qualification, dampers shall have demonstrated a capacity to operate (open and close) under HVAC system operation conditions, with pressures of at least 4" water gauge in the closed position, and 2,000 fpm air velocity in the open position.
4. Provide UL555S qualified electric actuator at 120 VAC.
5. Provide air-foil type blades.

B. Provide integral sleeves.

C. Acceptable Manufacturers:
1. Ruskin
2. Air Balance, Inc.
3. Greenheck, Inc.
4. Nailor Industries
5. Pottoroff

2.16 DIFFUSER FITTINGS LOW PRESSURE TAPS

A. Fitting shall meet or exceed the following minimum construction standards:
1. Conical with a base diameter two inches larger than the tap diameter.
2. Construct fitting and damper of galvanized steel in accordance with ASTM A 527, G90 finish.
   a. Fitting with a 3/16-inch high stop bead approximately 2-1/2-inches from the discharge end of the fitting
   b. Provide the fitting with a butterfly damper, damper rod, end bearings and heavy duty locking quadrant.
   c. Size the length of the straight section of the fitting to match the damper blade diameter. Center the damper blade in the straight section.
3. Match the fitting body gauge to the SMACNA duct gauge, but not less than:
   a. Through 8 inches: 26 gauge; Damper blade 22 gauge
   b. 10 inches and 12 inches: 24 gauge; Damper blade 22 gauge
   c. 14 inches and 16 inches: 22 gauge; Damper blade 22 gauge
   d. 18 inches and 20 inches: 20 gauge; Damper blade 20 gauge
4. Fasten damper blade to a 3/8 X 3/8 continuous square rod with minimum (2) galvanized U-bolts.
5. Support the damper rod to the fitting with airtight nylon end bushings / bearings.
6. Provide the damper with a self-locking regulator and handle.
7. Provide a 2” sheet metal stand-off to extend the regulator.
8. Flex duct grip area – 2 inches behind retaining bead
9. Flex duct retaining bead – 1 inch from end
10. Conical length of at least 3 inches
11. Barrel length of at least 9 inches

2.17 AUXILIARY DRAIN PANS

A. Galvanized steel, same gauge and same bracing or cross breaks as a duct with same dimensions. Sides of pan turned up to 1-1/2”, all joints soldered watertight. Pan is to be

large enough to complete cover drip lines of unit.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Use construction methods and requirements as outlined in SMACNA HVAC Duct Construction Standards as well as SMACNA Balancing and Adjusting publications, unless indicated otherwise in the specifications. Refer to details on the drawings for additional information.

B. Reinforce ducts in accordance with recommended construction practice of SMACNA. Provide additional reinforcement of large plenums as required to prevent excessive flexing and or vibration.

C. Cross break or bead sheet metal for rigidity, except ducts that are 12" or less in the longest dimension.

D. Where ducts pass through walls in exposed areas, install suitable escutcheons made of sheet metal angles as closers.

E. At locations where ductwork passes through floors, provide watertight concrete curb around penetration.

F. Support ducts where passing through floors with galvanized steel structural angles of adequate bearing surface.

G. Metal or lined ductwork exposed to view through grilles, registers, and other openings shall be painted flat black. Do not install grilles, registers, or similar items until painting is complete.

H. Fire Dampers shall be installed per manufacturer’s recommendations to create a UL rated assembly.

I. Install end bearing at all location where damper shaft penetrates duct wall.

J. Clean duct to remove accumulated dust. Ducts shall be closed on ends between phases of fabrication to assure that no foreign material enters the ducts.

3.2 DUCTWORK

A. Construct rectangular ducts and round ducts in accordance with the latest SMACNA HVAC Duct Construction Standards. Use the static pressure specified on the air handling unit schedule or fan schedules as a minimum for duct construction. All ductwork between the variable volume air handling units and the terminal units shall be constructed to the medium pressure ductwork specification.

B. Provide adjustable, galvanized splitter-dampers, pivoted at the downstream end with appropriate control device at each supply duct split.

C. For branch ducts wider than 18", and when shown on drawings provide extractors with an appropriate control device at each rectangular zone or branch supply duct connection. Provide controllers for extractors. Branch ducts shall have a 45° angle in the direction of flow. Do not provide extractor at branch ducts to sidewall registers where the registers are within 10 feet of the main duct.

D. Shop manufactured curved blade scoops may be used for branch duct takeoffs up to 18"

wide. Taper scoop blade to the end, to prevent any sagging that may cut into, or damage duct liner if specified during operation.

1. Construct shop manufactured scoops and splitter blades of galvanized sheet metal 2 full gauges heavier than equivalent sheet metal gauge of branch duct (up to 16 gauge).
2. Check extractors, scoops and splitter blades thoroughly for freedom of operation. Oil bearing points before installing.

E. Use pushrod operator with locking nut and butt hinges assembly.

F. Provide opposed-blade volume dampers with an appropriate control device in each of the following locations:

1. Return air ductwork
2. Outside air branch duct
3. Exhaust branch duct
4. Exhaust connections to hoods except kitchen grease hoods or equipment
5. In each zone at multi-zone unit discharge installed downstream of duct mounted re-heat coils
6. At each outside air and return air duct connection to plenum of constant volume units
7. At discharge side of constant volume boxes
8. Where otherwise indicated or required for balancing coordinate location of additional dampers required by TAB Contractor.
9. Provide multi-blade dampers when blade width exceeds 12". Provide end bearing where damper shaft penetrates duct wall.

G. Elbows:

1. Rectangular: Where square elbows are shown, or are required for good airflow, provide and install single-wall or airfoil turning vanes. Job-fabricated turning vanes, if used, shall be single-thickness vanes of galvanized steel sheets of the same gauge metal as the duct in which they are installed. Furnish vanes fabricated for the same angle as the duct offset. The use of radius elbows with a centerline radius of not less than 1-1/2 times the duct width may be provided in lieu of vaned elbows where space and air flow requirements permit.
2. Round Oval Duct. Provide elbows with a centerline radius of 1-1/2 times the duct diameter or duct width. For round ducts, furnish smooth elbows or 5 piece, 90° elbows and 3 piece, 45° elbows.

H. For control devices concealed by ceilings, furring, or in other inaccessible locations, furnish extension rods and appropriate recessed-type Young regulators, mounted on the surface of the ceiling or the furring, unless specified, or shown otherwise. Provide with chrome plated cover plates. Use only one mitered gear set for each control device.

I. Install streamline deflectors at any point where dividing a sheet metal duct around piping or where other such obstruction is permitted. Where such obstructions occur in insulated ducts, fill space inside streamliner and around obstructions with glass fiber insulation.

J. Insulated Flexible Duct:

1. Install in accordance with manufacturer's instructions, and the terms of its UL listing. Duct shall not exceed 6' in length. Make connections by use of sheet metal collars and stainless steel circular screw clamps. Clamps shall encircle the duct completely and be tightened with a worm gear operator to the point that will provide an airtight connection without unnecessary deformation of the duct. Provide one clamp on flexible duct and one clamp on external insulation. Vapor barrier jacket shall be tucked inside to conceal insulation material.
2. Construct bends over 45° with sheet metal elbows.

K. Duct Supports:
   1. Horizontal ducts up to 40". Support horizontal ducts up to and including 40" in their greater dimension by means of #18 U.S. gauge galvanized iron strap hangers attached to the ducts by a minimum of two locations per side by means of screws, rivets or clamps, and fastened to inserts with toggle bolts, beam clamps or other approved means. Place supports on at least 8' centers. Use clamps to fasten hangers to reinforcing on sealed ducts.
   2. Horizontal ducts larger than 40". Support horizontal ducts larger than 40" in their greatest dimension by means of hanger rods bolted to angle iron trapeze hangers. Place supports on at least 8' centers in accordance with SMACNA Standards.
   3. Support vertical ducts where they pass through the floor lines with 1-1/2" x 1-1/2" x 1/4" angles for ducts up to 60". Above 60", the angles shall be increased in strength and sized on an individual basis considering space requirements.
   4. Supports shall be suspended from structural or by independent support. Do not support from structural bridging. Upper attachments should be selected with a safety factor of 4 or 5 times actual load conditions and subject to Engineers approval. Double wrap straps over open web of joist.

L. Branch connections for medium pressure ductwork shall be made with a conical lateral. Field installed conical branch ducts shall be minimum 20-gauge galvanized sheet metal, “Everdur” welded and coated with “Galvabar”.

3.3 PLENUMS

A. Return air plenums shall be rectangular galvanized sheet metal ductwork.

B. Fabricate plenums upstream of fan of 16-gauge material.

C. Fabricate plenums upstream of filters minimum 18-gauge material.

3.4 FLEXIBLE CONNECTIONS

A. Where ducts connect to fans or air handling units that are not internally isolated, make flexible airtight connections using "Ventglas" fabric. The fabric shall be fire-resistant, waterproof and mildew resistant with a weight of approximately 30 ounces per square yard. Provide a minimum of 1/2" slack in the connections, and a minimum of 2-1/2" distance between the edges of the ducts. Also, provide a minimum of 1" slack for each inch of static pressure on the fan system. Fasten fabric to apparatus and to adjacent ductwork by means of galvanized flats or draw bands. Where connections are made in outdoor locations, seal fabric to metal with mastic.

3.5 ACCESS DOORS

A. Install ductwork access doors as noted below, arranged for convenient access. Stencil each door for specific use. Install access doors in each of the following locations:
   1. Fire Dampers
   2. Smoke Dampers
   3. Smoke/fire Dampers
   4. Outside Air Dampers
   5. Duct Mounted Coils (up-stream)
   6. Control Dampers

B. Size access door 1" smaller than ductwork.
   1. Available Sizes: 8”, 10”, 12”, 18”, 24”

C. Construct access door air tight, and conform to recommendations of NFPA and SMACNA.

D. Demonstrate suitability of access for the intended purpose. Install multiple access doors as required.

3.6 DUCT LINING

A. Install glass fiber acoustical lining where shown on drawings. Secure to duct surfaces with Foster 85-62 / 85-60 or Childers CP-125-1 / CP-127 adhesive and sheet metal fasteners on 12" centers. Coat exposed edges and leading edges of cross-joints with adhesive.

B. Provide metal nosing that is either channeled or "Z" profiled or are integrally-formed from the duct wall securely installed over transversely oriented liner edges facing the air stream at fan discharge and at any interval of lined duct preceded by unlined duct.

C. Refer to Insulation & Liner Detail on drawings for locations requiring liner to be installed.

D. Do not install liner in multi-zone unit ductwork.

3.7 SEALING OF SEAMS AND JOINTS

A. Seal supply, return, exhaust and outside air duct systems.

3.8 FLUES

A. Provide and install flues for all gas fired equipment.

B. Refer to plans for all related locations.

C. Contractor is responsible for coordinating stack sizing, stack drains, stack test ports, stack termination fittings and all other required fittings with the selected equipment manufacturers.

D. All fittings and accessories shall be manufactured by the flue manufacturer. The flue shall be installed per manufacturer's instruction.

E. Terminate flues at height above roof to prevent flue gas from entering the building.

3.9 SHOWER AREA EXHAUST SYSTEM

A. All material and fittings shall be 304 Stainless steel, welded joints, watertight construction. Grade horizontal duct 1/4" per lineal foot slope down to grille connection. Install in accordance with Fig. 2-21 of SMACNA HVAC Duct Construction Standards.

3.10 ACOUSTICAL DUCT

A. Install in the following locations:
   1. Where indicated on the drawings

3.11 SCREENS

A. Furnish and install screens on all duct, fan, etc., openings furnished by the Contractor that lead to, or are, outdoors; screens shall be No. 16 gauge, one-half inch (1/2”) mesh in removable galvanized steel frame. Provide safety screens meeting OSHA requirements for protection of maintenance personnel on all fan inlets and fan outlets to which no

ductwork is connected.

3.12 CONNECTIONS TO LOUVERS

A. Make watertight connections to all louvers. Ductwork behind louver shall have watertight soldered joints for a minimum of three feet and be sloped to bottom of louver. Lap duct to be over bottom louver blade where possible.

B. Where plenums are installed on inside of louver, construct such that bottom of plenum will lap over bottom blade of louver to drain any water that may enter.

3.13 PLENUMS

A. Construct plenums with galvanized steel framing members and galvanized sheet steel, cross broken and rigidly braced with galvanized angles. Gauges and bracing shall conform to SMACNA recommendations for ductwork of like sizes. Openings for fans, access doors, etc., shall be framed with galvanized steel angles.

B. Provide access doors.

3.14 AUXILIARY DRAIN PANS

A. Where coils that have a condensate drain are located above ceiling.

3.15 TESTING OF LOW PRESSURE DUCTWORK

A. Test ductwork for leaks before concealing. Maximum allowable leakage is 5% of total airflow.

B. Provide equipment necessary for performing tests, including rotary blower large enough to provide required static pressure at allowed CFM quantity, certified orifice section with proper papers, traceable serial numbers and pressure vs CFM leakage rate scale, U-tube gauge board complete with cocks, tubing, and inclined manometer for leakage rates.

C. Mains: Test mains after risers and branches are tied in and all equipment set. Close runout connections and place fan in operation. Provide pressure in mains at 1-1/2 times design pressure. Visually inspect joints. Repair leaks detected by sound or touch. Release mains for completion after joints are tight.

D. Ductwork down stream of terminal boxes, return, exhaust, and outside air ducts are to be visually inspected.

3.16 TESTING OF MEDIUM AND HIGH PRESSURE DUCT

A. As the project progresses, test the ductwork in sections.

B. Provide equipment necessary for performing tests, including rotary blower large enough to provide required static pressure at allowed CFM quantity, certified orifice section with proper papers, traceable serial numbers, and pressure vs. CFM leakage rate scale, U-tube gauge board complete with cocks, tubing, and inclined manometer for leakage rates.

C. Finally as a complete system, test ductwork at a minimum of 2.5” with a maximum allowable leakage of 1% of the total design supply airflow.

D. Test method as set forth in SMACNA "HVAC Duct Construction Standards".

END OF SECTION

SECTION 23 31 14 - FABRIC AIR DISPERSION SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Extent of non-metal ductwork is indicated on drawings and by requirements of this section.

1.2 QUALITY ASSURANCE

A. Building Codes and Standards:
   1. Product must be Classified by Underwriter's Laboratories in accordance with the 25/50 flame spread/smoke developed requirements of MFPA 90-A and are also classified in accordance with ICC Evaluation Service AC 167.
   2. All product sections must be labeled with the logo and classification marking of Underwriter's Laboratories.
   3. Product must be treated with an EPA registered antimicrobial agent.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's specifications on materials and manufactured products used for work of this section.

B. Building Code Data: Submit UL file number under which product is Classified by Underwriter's Laboratories for both NFPA 90-A and ICC AC167.

C. Submit manufacturer's documented design support information including duct sizing, vent and orifice location, vent and orifice sizing, length, and suspension. Submit parameters for design, including maximum air temperature, velocity, pressure and fabric permeability.

D. Color selections

E. Manufacturer's recommended suspension system

1.4 WARRANTY

A. Manufacturer must provide a 10 Year Product Warranty for products supplied for the fabric portion of this system as well as a Design and Performance Warranty.

1.5 DELIVERY, STORAGE AND HANDLING

A. Protect fabric air dispersion systems from damage during shipping, storage and handling.

B. Where possible, store products inside and protect from weather. Where necessary to store outside, store above grade and enclose with a vented waterproof wrapping.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

Subject to compliance with requirements, choose one of the following:

A. DuctSox Corporation

B. Fabric-Air

C. KE Fibertec

D. Prihoda

2.2 FABRIC AIR DISPERSION SYSTEM

A. Air diffusers shall be constructed of a woven fire retardant fabric complying with the following physical characteristics:
   1. Fabric Construction: 100% Flame Retardant and treated with a machine wash-able anti-microbial agent from the manufacturer.
   2. Weight: 6.75 oz./yd^2 per ASTM D3776
   3. Fabric Porosity: 1.5 (+2/-1) cfm/ft^2 per ASTM D737, Frazier
   4. Temperature Range: 0 degrees F to 180 degrees F
   5. Fire Retardancy: Classified by Underwriters Laboratories in accordance with the flame spread/smoke developed requirements of NFPA 90-A and ICC AC 167.
   6. Antimicrobial agent shall be proven 99% effective after 10 laundry cycles per AATCC Test Method 100.

B. Systems Fabrication Requirements:
   1. Air dispersion and extended throws accomplished by reinforced orifices and permeable fabric. Reinforced orifices are to be installed to deep the integrity of opening and withstand laundry processes.
   2. Diameter, quantity, and location of reinforced orifices to be specified and approved by manufacturer.
   3. Inlet connection to metal duct via fabric draw band with anchor patches as supplied by manufacturer. Anchor patches to be secured to metal duct via zip screw fastener – supplied by contractor.
   4. Inlet connection includes zipper for easy removal/maintenance.
   5. Lengths to include required zippers as specified by manufacturer.
   6. System to include adjustable flow devices to balance turbulence, airflow and distribution as needed. Flow restriction device shall include ability to adjust the airflow resistance from 0.06 – 0.60 in w.g. static pressure.
   7. End cap includes zipper for easy maintenance.
   8. Fabric system shall include connectors to accommodate suspension system listed below.
   9. Any deviation from a straight run shall be made using a gored elbow or an efficiency tee. Normal 90 degree elbows to be 5 gores with the radius of the elbow 1.5 times the diameter.

C. Systems Design Parameters:
   1. Use fabric diffusers only for positive pressure air distribution components of the mechanical ventilation system.
   2. Do not use fabric diffusers in concealed locations.
   3. Fabric diffusers shall be designed from 0.25” water gauge minimum to 3.0” maximum, with 0.5” as the standard.
   4. Fabric air diffusers shall be limited to design temperatures between 0 degrees F and 180 degrees F (-17.8 degrees C and 82 degrees C).
   5. Design CFM, static pressure and diffuser length shall be designed or approved by the manufacturer.

D. Suspension Hardware:
   1. Internal Hoop Suspension (for duct diameters 10” to 48”): As a minimum, the system shall include a 3 row connection to fabric system at 10, 12, and 2 o’clock locations. The powder-coated aluminum hangers are secured and connected to a single (1 row) tension cable every 3’-0” and connect to the fabric system at the

10 and 2 o'clock locations with detachable D-Clasps. The fabric system will also have intermediate cable clips located at 12 o'clock and between the hangers to attach directly to the single tension cable system located 3" above top-dead-center location of the fabric system. Tension cable hardware to include cable, eye bolts, thimbles, cable clamps, and turnbuckles as required.

2. Component options include:
   a. Stainless steel cable
   b. Adjustable Gripple Mid-Supports – incremental lengths of 5', 10', 15', 20' and 30'.

PART 3 - INSTALLATION

3.1 INSTALLATION OF FABRIC AIR DISPERSION SYSTEM

A. Install approved suspension system in accordance with the requirements of the manufacturer. Instructions for installation shall be provided by the manufacturer with product.

3.2 CLEANING AND PROTECTION

A. Clean air handling unit and ductwork prior to installation of the fabric duct system. Clean external surfaces of foreign substance which may cause corrosive deterioration of facing.

B. Temporary closure: At ends of ducts which are not connected to equipment or distribution devices at time of ductwork installation, cover with polyethylene film or other covering which will keep the system clean until installation is completed.

C. If fabric duct systems become soiled during installation, they should be removed and cleaned following the manufacturers standard terms of laundry.

END OF SECTION

SECTION 23 34 16 - FANS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install fans, including centrifugal, axial and propeller types, with supplemental equipment.

1.2 RELATED WORK

A. Division 23 Mechanical:
   1. Ductwork
   2. Vibration Isolation
   3. Air Balance
   4. Electrical Provisions of Mechanical Work

1.3 PERFORMANCE

A. Provide fan type, arrangement, rotation, capacity, size, motor horsepower, and motor voltage as shown. Fan capacities and characteristics are scheduled on the drawings. Provide fans capable of accommodating static pressure variations of +10% of scheduled design at the design air flow.

B. Rate fans according to appropriate Air Moving and Conditioning Association, Inc. (AMCA), approved test codes and procedures. Supply fans with sound ratings below the maximums permitted by AMCA Standards. All fans provided must be licensed to bear the Certified Ratings Seal.

C. Statically and dynamically balance all fans.

D. Motors shall be sized so that they do not operate within the motor service factor.

E. Fans shall be capable of 120% of the scheduled air capacities.

F. All static pressures shown on schedules are external to fans. Manufacturer shall add damper and accessory losses to scheduled value before selecting fan.

1.4 SUBMITTALS

A. Submit fan performance curves with system operating point plotted on curves.

B. Submit manufacturer’s printed installation instructions.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. ACME

B. Cook

C. Greenheck

D. Penn Barry Ventilator

E. Twin City Fans

2.2 PROTECTIVE COATINGS

A. Manufacturer's Standard. Apply to fans, motors and accessories, the manufacturer's standard prime coat and finish, except on aluminum surfaces or where special coatings are required.

B. Galvanizing. After fabrication of the parts, hot-dip coat surfaces that require galvanizing. Where galvanizing is specified, a zinc coating may be used. After fabrication, apply the zinc coating and air-dry the coating to 95% pure zinc. Acceptable zinc coatings include Zincilate, Sealube, Amercoat, Diametcoat, or an approved equal.

2.3 SUPPLEMENTAL EQUIPMENT

A. Motor Covers. Provide weatherproof motor covers for installations out of doors. Apply the same finish as used on the fan.

B. Belt Drives:
1. Unless otherwise specified for belt-driven fans, equip the fan motors with variable pitch sheaves. Select the sheave size for the approximate midpoint of adjustment and to provide not less than 20% speed variation from full open to full closed. Size drives for 150% of rated horsepower. Key the fan sheave to the fan shaft.
2. Nonadjustable motor sheaves may be used for motor sizes over 15 horsepower, at the Contractor's option. However, if changing a nonadjustable sheave becomes necessary to produce the specified capacity, the change must be made at no additional cost.
3. Provide belt guards and apply the same finish as used on the fan.
4. Oil and heat resistant, nonstatic type belts.
5. Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy duty, regreasable, ball type, in a pillow block, cast iron housing, selected for a minimum L50 life in excess of 200,000 hours at maximum catalog operating speed.

C. Safety Disconnect Switch: Provide a factory-wired to motor, safety disconnect switch on each unit.

D. Relief Vents and Air Inlets: Provide vents and inlets with aluminum frames and 1/2" mesh, galvanized bird screens. Include dampers where shown.

E. Prefabricated Roof Curbs: Furnish prefabricated roof curbs as detailed. The minimum height is 14". Include a resilient pad on each roof curb so the equipment can be mounted on the top flange for proper seal. Coordinate roof slope and curb to ensure equipment is installed in level position. Provide double shell to protect insulation from damage.

F. Where motorized damper is scheduled:
1. The motor and damper are specified in the Building Management and Control System Specification.

G. All fans are to be provided with a durable, deep etched, .025" thick, factory installed aluminum identification plate with the following information. Plates are to be furnished with four mounting holes.
1. Fan mark as indicated on the Contract Drawings.
2. Serial number
3. Model number
4. Capacity (CFM) and static pressure.

5. Motor HP
6. Motor Amps
7. Manufacturer
8. Motor phase
9. Number of Belts/Make/Size
10. Motor volts

H. Utility Vent Set Fans, provide minimum ¾ inch threaded coupling drain connection at lowest point of housing.

2.4 VENTILATION AND EXHAUST FANS

A. Provide the ventilation and exhaust fans shown on the drawings.

B. Provide each motor with internal overload protection.

C. Provide each belt driven fan with approved, totally enclosed belt guard.

D. Provide approved safety screen where inlet or outlet is exposed.

E. Provide duct flanges where required for connections.

F. Furnish kitchen hood exhaust fans with vented curb extension that meets NFPA 96, cleanout port, grease tap, curb seal, drain connection and hinge kit.

G. Furnish supply fans with 1" aluminum, washable filter section.

2.5 ROOFTOP VENTILATION AND EXHAUST SYSTEMS

A. Provide the rooftop ventilation and exhaust systems shown on the drawings.

B. Provide each motor with internal overload protection.

C. Components:
1. Aluminum, stainless steel or plastic coated bird guard.
2. Screws and fasteners of stainless steel or nonferrous material.
3. All aluminum construction unless indicated otherwise on fan schedule.

D. Welded construction, corrosion resistant fasteners, minimum 16 gauge marine allow aluminum.

E. Aluminum base shall be continuously welded curb cap corners.

2.6 GRAVITY ROOF-TOP INTAKE AND RELIEF VENTS

A. Provide the rooftop intake and relief vent systems shown on the drawings.

B. Provide with aluminum, stainless steel or plastic coated bird guard.
1. Screws and fasteners of stainless steel or nonferrous material
2. All aluminum construction

C. Welded construction, corrosion resistant fasteners, minimum 16-gauge marine alloy aluminum.

D. Aluminum base shall be continuously welded curb cap corners.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install fans according to the manufacturer's instructions and in the locations shown on the drawings. Ensure fan location is installed at minimum distance from roof edge to meet code requirements.

B. Do not operate fans or fan powered devices for any purpose until ductwork is clean, filters in place, bearings lubricated and the fan has been run under observation.

C. Roof mounted fans and gravity roof-top intake and relief vents shall be secured to the curb with stainless steel lag screws at a minimum of 6-inches on center. Follow manufacturer’s installation instructions if they are more stringent. Install roof mounted equipment in a level position. Units shall be seated on properly sized curb. Gap between base of the fan and top of the curb shall be sealed with neoprene 1” x ¼” gasket. Gasket shall be glued or attached with pressure sensitive adhesive.

D. Install curbs and equipment in level position.

E. Ceiling mounted in-line centrifugal blowers
   1. Shall be suspended from structure with 1/2-inch zinc plated all-thread rods secured to structure.
   2. Provide sub-structure where required.
   3. Mount bottom of fan no more than 18-inches above the finished ceiling height.

3.2 EXTRA MATERIALS

A. Provide two sets of belts for each fan, not including the set installed on the fans. Tag set to identify fan.

END OF SECTION

SECTION 23 36 16 - VARIABLE VOLUME TERMINAL UNITS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install variable volume terminal units, including hangers, controls and other required elements.
   1. Provide variable volume terminal units where indicated on the drawings.

1.2 RELATED WORK

A. Division 23 Mechanical.
   1. Ductwork.
   2. Air Balance.
   3. Electrical Requirements for Mechanical Work.
   4. Building Management and Control System.
   5. Vibration Isolation,

1.3 COOPERATION WITH OTHER TRADES

A. Coordinate this work with work under Division 26 Electrical, to ensure that intended functions of lighting and air systems are achieved.

B. Coordinate the primary (input) voltage with the electrical power source. Refer to the Electrical Drawings for specific requirements.

1.4 SUBMITTALS

A. Submit product data for control devices, terminal boxes, and similar equipment for review prior to placement of purchase order. Submit internal wiring diagrams, installation and operation manual as a complete submittal package.

B. Submit certified sound power levels for both discharge sound and casing radiated sound in accordance with ARI 880-98 Certification Program. All NC levels shall be calculated using ARI 885-98, Appendix E attenuation factors for mineral ceiling.

C. Submit for each box the following information:
   1. Box size
   2. Inlet size
   3. Box number
   4. Box designation
   5. Minimum / Maximum Fan CFM
   6. L / R Coil connection
   7. GPM
   8. Motor HP
   9. NC Level
   10. External Static Pressure
   11. Scheduled MBH
   12. Actual MBH
   13. Heating Coil Pressure Drop (ft.)
   14. Entering and Leaving Water Temperature
   15. Entering and Leaving Air Temperature

1.5 QUALITY ASSURANCE.

A. Make air flow tests and sound level measurements in accordance with applicable ASHRAE Standards 130-96 and ARI 880-98.

B. Manufacturer shall certify cataloged performance and ensure correct application of terminal units.

C. Sound power levels to occupied space shall not exceed NC-30 as calculated using ARI 885-98 Appendix E attenuation factors for mineral tile ceiling.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Titus.

B. Krueger

C. Price

D. Nailor

E. Metalaire

2.2 BOX CONSTRUCTION

A. Galvanized 22-gauge steel casing with suspension lugs.

B. Lined with minimum 1.5 PCF / 1" thick fiber free
1. Flame spread not higher than 25.
2. Smoke developed rating not higher than 50.
3. Condensation on the exterior of the box is not approved.
4. Coat all cut edges of liner with NFPA approved sealant.
5. Lining shall pass UL 181, NFPA 90A and ASTM C 665.

C. Provide access to controls, fan compartment, and unit servicing, without disturbing duct connections. Limit the size of access doors to 24 inches. Where required, provide multiple access doors. Gasket each door in the unit casing.

D. Components shall be constructed of corrosion resistant materials.

E. Bearings shall not require lubrication.

F. Casing leakage shall not exceed 2.0% of scheduled design air flow at 3.0” WG interior casing pressure.

G. Seal casing joints with approved adhesive if required to meet the maximum casing leakage rate.

H. The maximum overall height of the variable air volume unit shall not exceed available ceiling space.

I. Maximum static pressure drop of air through terminal box shall be 0.2” w.g.

J. Maximum velocity through duct inlet shall be 2,000 fpm.

2.3 COMPONENTS

A. The entire terminal unit, including the heating coil, shall be designed and built as a single unit.

B. Provide each unit with a primary variable air volume damper that controls the air quantity in response to a space sensor.

C. Each unit shall contain:
   1. Fan and motor assembly. For Fan Powered Units Only
   2. Heating coil.

D. Locate the heating coil in the discharge of the blower section.

E. Provide single point electrical connections for the entire unit. Entire assembly shall be UL or ETL Certified, electrical components shall be UL listed and installed in accordance with the National Electrical Code.

F. The variable air volume units provided by the manufacturer shall be the quietest design available from the manufacturer for the type specified.

G. Sufficient power for the VAV unit DDC controller, electric actuator and other components necessary to satisfy the sequence of operation. Size each transformer for the total connected load plus an additional 25% of the connected load. Primary and secondary fuses housed in a fuse block.

2.4 PRIMARY AIR DAMPER AND ACTUATOR

A. The control actuator shall vary the primary air damper in response to the control signal.
   1. Damper leakage at shutoff shall not exceed 2.0% at 1" WG pressure.
   2. Locate the damper inside the unit.
   3. Damper connection to the operating shaft shall be a positive mechanical connection.
   4. Damper shall have bearings at all penetrations of inlet tube and terminal housing. Penetration of damper shaft in terminal lining shall have seal at surface of lining to prevent fiber entrainment through rotation of damper shaft.
   5. Two damper stop pins shall be provided. One pin shall ensure damper cannot rotate beyond full closed position. One pin shall ensure damper cannot rotate beyond full open position.
   6. Inlet tube shall have rolled bead (outward position) prior to penetration point of flow sensor tubing to provide stop point for hard duct and anchor point for flex duct.
   7. Flow sensor tubing shall have gaskets at penetration point of inlet tube.
   8. Flow sensor shall be center averaging type. Non-center averaging flow sensors are not acceptable.

2.6 AIR FLOW CONTROL

A. Provide a flow control device that will limit the maximum CFM of the unit to that scheduled on the drawings.
   1. Air quantity shall be factory set.
   2. Thermostat signal shall reset the flow control device to reduce primary air quantity to match load requirements.
   3. Control shall be pressure independent.
   4. Each terminal shall incorporate a flow cross sensor with pick-up points connected to a center averaging chamber to ensure the following performance:
      a. Controller fidelity shall be +/-5% of set volume with a flex inlet

configuration and inlet static variation of 0.5" WG to 6.0" WG.

5. Provide flow measuring taps and a flow chart with each unit for field balancing air flow.

B. HOT WATER HEATING COILS

1. Provide hot water heating coils sized as scheduled.
   a. The hot water heating coil is specified to be provided and mounted under the work of this Section.
   b. Coil access door upstream of coil.
   c. Install coil with supply inlet at bottom and on leaving airside of coil.
   d. Maximum static pressure drop of water through heating coil shall not exceed 10’ w.g.
   e. Maximum static pressure drop of air through heating coil shall not exceed 0.25” esp

PART 3 - EXECUTION

3.1 INSTALLATION

A. Deliver and store products in a clean and dry place. Protect products from the weather, dirt, dust, construction debris and physical damage.

B. Install each unit in accordance with the manufacturer's printed installation instructions.

C. Suspend each unit from 1/4" electroplated zinc thread rods secured from structure.
1. Provide sub-structure where required.
2. Mount bottom of terminal unit no more than 18" above the finish ceiling height.
3. Install units so that they are level and plumb.

D. Install a straight length of rigid ductwork upstream of all boxes. Provide at least 3 primary air inlet diameters of straight ductwork upstream of the primary air inlet connections. Flexible duct connections at boxes are allowed but are not a substitute for the straight run of rigid duct. A maximum of 4' of flexible duct is allowed at each box. All changes in direction shall be made with rigid duct. Seal connection at box, as required to comply with system maximum allowable leakage.

E. Coordinate the location of each variable air volume unit to ensure proper clearance so that all components are accessible and not blocked by other trades. Provide no less than the code required clearances to electrical components.

F. Cover and seal the openings of the VAV inlets during construction to prevent the inside from getting dirty. Where VAV units are considered dirty, as determined by the Architect / Engineer / Owner, clean the VAV units with a vacuum machine, and then wipe all surfaces with a cleaning agent, using clean rags.

G. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

H. All installation shall be in accordance with manufacturer’s published recommendations.

I. Provide clearance for inspection, repair, replacement and service. Ensure accessibility to all terminal unit electrical control panel doors, controllers and operators are located a minimum of 30 inches from all obstructions (walls, pipe, etc.).

J. Provide ceiling access doors or locate units above easily removable ceiling components.

K. Support units individually from structure. Do not support for adjacent ductwork. Terminal units shall be supported using unit's hanger brackets and threaded rods.

3.2 MISCELLANEOUS CONTROLS

A. The following equipment items are to be furnished by Building Management and Control System and installed by Fan Powered Terminal Unit manufacturer:
   1. Automatic temperature control card (DDC).
   2. Damper actuator.

B. The following equipment items are to be furnished and installed by the Fan Powered Terminal Unit manufacturer:
   1. Damper.
   2. Multi-point flow sensor.
   3. Controller enclosure.
   4. Power transformer.

C. Coordinate the output voltage required by the Building Management and Control System.

D. Coordinate location of controller enclosure.

3.3 ACOUSTICAL PERFORMANCE TEST

A. Test each size for each type of variable air volume unit furnished on the project.

B. Test for radiated noise and discharge noise in all operational modes from minimum to maximum primary air settings; at inlet air pressures of 1 and 2 inches water column, and at primary air settings of 20, 40, 60 and 100 percent.

C. Testing shall be done by an independent testing laboratory. Sound values submitted shall be certified by the laboratory doing the testing. Testing laboratory must be approved by Engineer. Final testing and approval must be witnessed by Engineer.

D. Testing procedures shall be in accordance with ASHRAE Standard 130-96 and rated in accordance with ARI 880.

E. Test the unit complete with damper, coils and controls. The unit shall be operational and represent a final version of the units to be installed on the project.

F. If the units do not meet sound criteria, modify the units and retest at no additional cost to the Owner until the sound criteria is in accordance with Contract Documents. The variable air volume unit manufacturer shall be held liable for the costs associated with construction delays resulting from failed test, not to exceed the purchase order cost.

G. Sound Levels: Maximum sound power levels resulting from any box shall not exceed the following:

OCTAVE BAND CENTER FREQUENCY, Hz.						
	125	250	500	1000	2000	4000
Radiated SPL db	52	45	40	36	34	33
Discharge SPL db	44	37	31	27	24	22

   1. Sound power levels are referenced to 10-12 watts.
   2. Box inlet static pressure = 1-1/2"
   3. No discounting for roof effect, ceiling attenuation, lined duct, division of flow and

other similar effects.

H. All terminal boxes shall be equipped with a sheetmetal elbow with liner connected to plenum air inlet.

END OF SECTION

SECTION 23 37 13 - AIR DEVICES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install air distribution devices, including grilles, diffusers, registers, dampers, and extractors.

1.2 RELATED WORK

A. Division 23 Mechanical.
   1. Ductwork.
   2. Air Balance.
   3. Electrical Requirements for Mechanical Work.

1.3 COOPERATION WITH OTHER TRADES

A. Coordinate this work with work under Division 26 Electrical, to ensure that intended functions of lighting and air systems are achieved.

1.4 SUBMITTALS

A. Submit product data for outlets, grilles, registers, control devices, and similar equipment for review prior to placement of purchase order.

B. Submittal shall include performance sheet for each air device type. Performance sheet shall include NC levels, throw, and total pressure loss at various air flows.

1.5 FINISHES

A. Paint exposed devices with factory standard prime coat, or factory finish coat, as specified.

PART 2 - PRODUCTS

2.1 DIFFUSERS, GRILLES AND REGISTERS - Refer to Drawing Schedule.

2.2 ACCEPTABLE MANUFACTURERS

A. Titus.

B. Krueger.

C. Nailor Industries.

D. Price

E. Metal-Aire

2.3 ACCESSORIES

A. Supply Grille Extractors. Provide supply grilles with an air control device capable of positively regulating the volume of air extracted from the supply duct.

Select extractors similar to Titus Model AG25, tight-closing in the minimum position.

Include a key-operated or worm-gear adjusting mechanism to facilitate positioning from the grille opening. Where adjustment is not accessible at the grille opening, provide a square control rod equipped with a locking quadrant.

B. Mounting Frames. Provide each grille or register not equipped with a removable core with a companion, all-purpose mounting frame constructed like grille frame to facilitate installation and removal of the grille or register without marring adjacent mounting surfaces.
   1. Furnish frames with 1/2" thick sponge rubber gasket to prevent air leakage.
   2. Provide a frame that neatly fits the grille. Mounting frames will not be required for grilles or registers mounted directly on exposed ductwork.

PART 3 - EXECUTION

3.1 INSPECTION

A. Do not install ceilings adjacent to fixtures until installation of fixtures, air supply assemblies, return-air blank-off strips and flexible duct have been approved. Remove and reinstall any part of the installation found incorrect.

3.2 INSTALLATION

A. Louvered diffuser outlets mount tight against the ceiling. Fasten outlets to ductwork with sheet metal screws. For perforated diffusers, attach the frame assembly by a concealed hinge assembly to an outer frame compatible with the type of ceiling on which the diffuser is installed.

END OF SECTION

SECTION 23 41 00 - AIR FILTRATION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install air filters and air filter gauges.

1.2 RELATED WORK

A. Division 23 Mechanical.

1.3 SUBMITTALS

A. Submit manufacturer's product data sheets and capacity information as specified.

B. Submit recommended Dirty Filter pressure drop.

PART 2 - PRODUCTS

2.1 MEDIUM EFFICIENCY AIR FILTERS

A. The filter cells:
   1. Pleated media.
   2. Disposable type.
   3. Contain not less than 4.6 sq. ft. of filtering media per square foot of face area.
   4. 16 pleats per linear foot of filter.
   5. 2" thick.
   6. Minimum MERV 13

B. Media of reinforced nonwoven cotton fabric treated with adhesive and continuously laminated to a supporting steel wire grid conforming to the configuration of the pleats.
   1. Seal the media pack in a chipboard frame.

C. Rated average dust spot efficiency of not less than 36%.
   1. Average synthetic arrestance in excess of 93% when tested in accordance with the ASHRAE 52-68 test standard.

D. Filter capable of operating with variable face velocities up to 500 fpm without impairing efficiency.

E. Initial resistance to air flow:
   1. 300 fpm - 0.12" WG.
   2. 500 fpm - 0.28" WG.

F. UL listed with Class II rating.

G. Provide one spare set for a complete change, in original cartons, for Owner's use during the warranty period.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install the filters and filter gauges in accordance with the manufacturer's instructions.

END OF SECTION

SECTION 23 52 33 - COPPER TUBE BOILER

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install a copper tube hot water boiler complete with all controls and trim.

1.2 RELATED WORK

A. Division 23 - Mechanical
   1. Hot water piping.
   2. Gas piping.

1.3 PERFORMANCE

A. Provide performance as scheduled on drawings; rate boiler in accordance with test standards of American Gas Association.

1.4 WARRANTIES

A. The boiler manufacturer shall warrant each boiler, including boiler, trim, boiler control system, and all related components, accessories, and appurtenances against defects in workmanship and material for a period of twelve (12) months from date of substantial completion. Heat exchanger and fuel burner shall be warranted for a period of ten (10) years from date of substantial completion. Boiler shall be provided with a twenty (20) year thermal shock warranty from date of substantial completion.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Lochinvar Powerfin

B. Laars Pennant

2.2 PERFORMANCE CRITERIA

A. Each boiler shall be capable of operating continuously at rated capacity while maintaining a CSA certified efficiency of not less than 84 %.

B. The boiler(s) shall be ASME inspected and stamped and National Board registered for 160 PSIG working pressure, complete with a Manufacturer's Data Report.

C. Fuel shall be natural gas with an assumed higher heating value of 1,030 Btu/Cu Ft and an assumed specific gravity of 0.60 (relative to air). Natural gas shall be supplied at a pressure of no less than 3.5 inch WC to the inlet gas valve. Maximum inlet gas pressure shall not exceed 14 inch WC.

D. Boilers shall be certified for low NOx by the TCEQ. NOx emissions shall not exceed 30 PPM when referenced at 3% O2 at all firing rates.

2.3 HEAT EXCHANGER

A. Heat exchanger shall be of a single-bank, horizontal bank, horizontal-grid with integral cupro nickel copper finned tubes, each of which is rolled into an ASME boiler quality steel tube

sheet.

B. The heat exchanger shall be sealed to 160 PSIG rated Cast Iron headers with silicone "O" rings, having a temperature rating over 500°F.

C. The low water volume heat exchanger shall be explosion-proof on the water side and shall carry a twenty-year warranty against thermal shock.

D. The headers shall be secured to the tube sheet by stud bolts with flange nuts to permit inspection and maintenance without removal of external piping connections.

E. The boiler(s) shall be capable of operating at inlet water temperatures as low as 105°F without condensation.

F. The boiler(s) shall be designed to accommodate field changes of either left or right hand plumbing and electrical while leaving the tube bundle in place.

2.4 BURNERS

A. The tubular burners shall have multiport radial gas orifices, punched ports and slots, be capable of quiet ignition and extinction without flashback at the orifice, and be manufactured from corrosion resistant titanium-stabilized stainless steel with low expansion coefficient.

B. The burners will be supplied with a fan-assisted, clean burning, and highly efficient fuel-air mixture.

2.5 PILOT CONTROL SYSTEM

A. The boiler(s) shall be equipped with a 100 percent safety shutdown system.

B. The ignition shall be Hot Surface Ignition type with full flame rectification by remote sensing separate from the ignition source, with a three-try-for-ignition sequence, to ensure consistent operation.

C. The igniter will be located away from the water inlet to protect the device from condensation during startup.

D. The ignition control module shall include an LED that indicates six (6) individual diagnostic flash codes.

E. Two external viewing ports shall be provided, permitting visual observation of burner operation.

2.6 GAS TRAIN

A. The boiler(s) shall have a firing/leak test valve and pressure test valve as required by CSD-1.

B. The boiler(s) shall have dual-seated main gas valve(s).

C. Gas control trains shall have a redundant safety shut-off feature, main gas regulator, shut-off cock and plugged pressure tapping to meet the requirements of ANSI Z21.13/CSA 4.9.

2.7 BOILER CONTROL

A. The following safety controls shall be provided:
   1. High limit control

2. Flow switch, mounted and wired
3. 60 PSIG ASME pressure relief valve, piped by the installer to an approved drain
4. Temperature and pressure gauge

B. The boiler(s) shall be equipped with a fixed five-minute energy-saving pump control relay, mounted and wired, which automatically shuts off the boiler pump at a set period after boiler shut-down to avoid standby losses associated with constant pump operation.

2.8 FIRING MODE

A. Provide two-stage firing control of the gas input to the boiler.

2.9 BOILER DIAGNOSTICS

A. Provide external LED panel displaying the following boiler status/faults:
1 Power on - Green
2. Call for heat – Amber
3. Burner on – Blue
4. Safety fault – Red

B. A Central Point Wiring board with diagnostic LED's indicating the status of each relay.

C. Provide ignition module indicating the following flash codes by LED signal:
1. 1 flash – low air pressure
2. 2 flashes – flame in the combustion chamber w/o CFH
3. 3 flashes – ignition lock-out (flame failure)
4. 4 flashes – low hot surface igniter current
5. 5 flashes – low 24VAC
6. 6 flashes – internal fault

2.10 COMBUSTION CHAMBER

A. The lightweight, high temperature, multi-piece, interlocking ceramic fiber combustion chamber liner shall be sealed to reduce standby radiation losses, reducing jacket losses and increasing unit efficiency.

2.11 VENTING

A. When routed vertically, the boiler's flue material and size shall be in accordance with the National Fuel Gas Code, ANSI Z223.1/NFPA54 latest edition (Category I).
B. When routed horizontally, the boiler(s) flue material and size shall meet or exceed the requirements as specified for Category III in the National Fuel Gas Code, ANSI Z223.1/NFPA 54 latest edition.
C. The boiler(s) shall be ducted combustion air ready.

2.12 CABINET

A. The corrosion-resistant galvanized steel jackets shall be finished with a baked-on epoxy powder coat which is suitable for outdoor installation, applied prior to assembly for complete coverage, and shall incorporate louvers in the outer panels to divert air past heated surfaces.

B. The boiler shall have the option of venting the flue products either through the top or the back of the unit.

C. Combustion air intake shall be on the left side of the cabinet.

D. Boiler controls shall be installed in an enclosed weatherproof enclosure.

E. Boiler will be installed outdoors and shall be provided with all options for an exterior boiler installation. At minimum this shall include combustion air intake weather shield, boiler controls cabinet rated for exterior environment, pump cover, and combustion air cover.

2.13 OPERATING CONTROLS

A. The boiler(s) shall feature an optional multi-stage digital controller with adjustable outdoor reset, mounted and wired.

B. Water and air temperature sensors shall be shipped loose for field installation by installing contractor.

2.14 CIRCULATION PUMP

A. Boiler shall be equipped with a circulation system piped across the boiler vessel. System shall include a pump, two isolation valves, check valve, piping, starter and disconnect, all factory piped, mounted and wired. Pump shall be wired to boiler's control panel such that only one power source is required for blower motor, boiler controls and pump. Pump GPM and Head shall be designed to provide at least the minimum flow required by the boiler manufacturer. Pump GPM shall not exceed the maximum flow required by the boiler manufacturer.

2.15 SOURCE QUALITY CONTROL

A. The boiler(s) shall be completely assembled, wired, and fire-tested prior to shipment from the factory.

B. The boiler(s) shall be furnished with the sales order, ASME Manufacturer's Data Report, inspection sheet, wiring diagram, rating plate and Installation and Operating Manual.

2.16 CARBON MONOXIDE MONITORING SYSTEM

A. Provide and install a manual reset Carbon Monoxide Detector located within the the adjacent mechanical room. The Carbon Monoxide Detector and the boiler shall be interlocked so that the burners will not operate when the level of CO in the room rises above 100ppm. The Carbon Monoxide detector shall disable the boiler's burner upon loss of power to the detector.

B. Carbon Monoxide Sensor with two year warranty by U.S. Draft Co. Model CGM-505 with model XB expansion module.
   1. Provided with pre-programmed dry contacts to shut down equipment during unsafe operation.
   2. NEMA 1 Enclosure
   3. Complies with Texas State Boiler Code 65.603-2015
   4. Additional features shall include 0-10 VDC control signal out, visual alarm and audible alarm.
   5. Provide expansion board for additional equipment interlocks.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation as per manufacturer's recommendations.

B. Install isolation valves and unions on supply and return water lines to boiler.

C. Install strainer, drain lines with ball valve, pressure and temperature gauges on return and supply line to boiler.

D. Install main gas valve and cock, drip leg and union close to boiler.

E. Vent gas pressure regulator, N.O. vent valve, high and low gas pressure switches to above adjacent roof line. Support piping to exterior wall.

F. Install on 4" concrete pad and place into operation in accordance with manufacturer's instructions. Pipe as detailed on drawings.

C. Install per State Boiler Code.

D. Boiler flue shall be extended up to above adjacent roof line. Flue pipe shall be secured to exterior wall using stainless steel brackets that provide proper separation from wall surface.

3.2 BOILER MANUFACTURER START-UP SERVICE

A. Startup shall be performed by factory trained personnel to assure proper operation.

C. Test the following items at a minimum and adjust as necessary for proper boiler operation:
1. Boiler Safeties
2. Operating Controls
3. Static and full load gas supply pressure
4. Gas manifold and blower air pressure.

C. Perform a flue gas analysis at the boiler outlet. Record the following results of the analysis:
1. Carbon dioxide percent volume.
2. Oxygen percent volume.
3. Stack temperature.
4. Calculated combustion efficiency.

D. Do not operate the boiler for any reason until the factory start-up service has been completed.

E. Submit a copy of start-up report to Engineer.

3.3 TRAINING

A. Provide factory-authorized service representative to train maintenance personnel on procedures and schedules related to start-up, shut-down, trouble shooting, servicing, and preventive maintenance.

B. Schedule training at least seven days in advance.

END OF SECTION

SECTION 23 65 27 - AIR COOLED ROTARY SCROLL CHILLER

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install a packaged, electric-driven, air-cooled, water chilling unit with multiple scroll compressors complete with controls.

1.2 RELATED WORK

A. Division 23 - Mechanical
   1. Chilled Water Piping
   2. Insulation
   3. Building Management Control System
   4. Vibration Isolation
   5. Electrical Provisions of Mechanical Work

1.3 REFERENCES

A. ANSI/ARI 550/590 - Water Chilling Packages using the Vapor Compression Cycle.
B. ANSI/ASHRAE 15 - Safety Code for Mechanical Refrigeration.
C. ANSI/ASHRAE 90A - Energy Conservation in New Building Design.
D. ANSI/ASME SEC 8 - Boiler and Pressure Vessel Code
E. ANSI/NEMA MG 1 - Motors and Generators.
F. ANSI/UL 465 - Central Cooling Air Conditioners.
G. ANSI/AFBMA 9-1978 - Load Ratings and Fatigue Life for Ball Bearings. Bearings must have life of not less than 200,000 hours.
H. ANSI/NFPA Standard 70 - National Electrical Code (NEC)
I. ASTM B117 - Standard Method of Salt Spray (Fog) Testing
J. ASTM A123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
K. ASTM A525 - Zinc (Hot-Dip Galvanized) Coatings on Sheet Steel Products
L. ASTM D1654 - Evaluation of Painted or Coated Specimens, Subjected to Corrosive Environments.

1.4 PERFORMANCE

A. Provide performance as scheduled on drawings. Provide factory run test to ensure proper chiller operation. Provide certified documentation to Owner in Closeout Documents.

1.5 WARRANTY

A. The Chiller manufacturer shall provide a full machine parts, labor, and refrigerant warranty for a period of five (5) years from substantial completion.
   1. The warranty shall include, but not be limited to the compressor assemblies including motor, condensers, fans, variable frequency drives, controls, evaporator, condenser, refrigeration system and all other auxiliary components and accessories as well as refrigerant and oils in systems.
   2. In the event of failure, provide new or factory authorized rebuilt parts. Shop or job site rebuilt parts are not acceptable.
   3. On all manufacturers warranties the chiller manufacturer shall provide a factory certificate listing as a minimum chiller model, serial, and warranty information as specified above. Each chiller tag shall be provided with an individual and unique warranty certificate. Manufacturer's representative warranty letters are not acceptable as an alternative to the original manufacturer's certificates.

4. The chiller manufacturer authorized service agency is required to perform any and all warranty service. Contractor warranty service is not authorized. Warranty work shall be performed with District Representative present.

1.6 SUBMITTALS

A. Submit manufacturer's certified computer generated performance and capacity data in accordance with specification requirements.

B. Submit the following information:
1. Manufacturer's installation instructions.
2. Minimum Circuit Ampacity.
3. Maximum Overcurrent Protection size.
4. Maximum conductor / Terminal Lug size.
5. Minimum flow thru evaporator.
6. Electrical interlocks.

C. Submit recommended clearance dimensions for air flow and service.

D. Submit coordination drawings as specified.
1. Give consideration to adjacent structures as they affect air flow patterns.

E. Submit internal wiring diagram of Control Center.

F. Submit sequence of operation in narrative form.

G. Submit a letter stating chiller being proposed meets the efficiency requirements of Centerpoint Energy's Score Program listed in Centerpoint Energy's Design Guide: HVAC Recommendations document.

H. Mark-up a copy of the specifications, indicating in the margin of each paragraph, the following: COMPLY, DO NOT COMPLY, NOT APPLICABLE.

1.7 STORAGE/HANDLING/SHIPPING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

B. Protect units from physical damage. Factory coil shipping covers shall be kept in place until installation.

C. Unit controls shall be capable of withstanding 203°F (95°C) storage temperatures in the control compartment for an indefinite period of time.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Carrier

B. Daikin

C. Trane

2.2 COMPRESSORS

A. Provide a minimum of two independently circuited hermetic rotary scroll type compressors with the following:
   1. Direct drive, 3600 rpm, suction gas-cooled hermetic motor.
   2. Rubber isolation pads.
   3. Crankcase heaters.
   4. Oil sight glass.
   5. Load and unload solenoid valves.
   6. Discharge oil separator.
   7. Hot gas bypass for compressor unloading.
   8. Centrifugal oil pump.
   9. Oil charging valve.

B. Provide capacity modulation from 100% to 25% via compressor cycling.
   1. Control to be based upon leaving chilled water.
   2. To avoid excessive compressor cycling while maintaining leaving chilled water temperature at desired temperature +/- differential, compressor cycling set points to be separated by a minimum 20% capacity dead band.

2.3 CONDENSER COILS

A. Coil shall be microchannel design and shall have a series of flat tubes containing multiple, parallel flow microchannel layered between the refrigerant manifolds. Tubes shall be 9153 aluminum alloy. Tubes made of 3102 alloy or other alloys of lower corrosion resistance shall not be accepted. Long Life Alloy Microchannel shall pass 4500hr salt spray rating uncoated.

B. Protect all vertical or angled coil sections from hail or physical damage with corrosion resistant louvered hail guard including chiller ends, factory installed to cover compressor and condenser sections.

C. Field adjustable head pressure based fan cycling controls for each circuit capable of maintaining minimum head pressure down to 20°F unless noted otherwise.

D. Protect condenser coils during shipping.

E. Provide condenser coils coated with corrosion resistant epoxy utilizing a dip and bake. Coating shall be flexible and uniformly bonded to all condenser coil surfaces.

2.4 FANS AND MOTORS

A. Direct drive propeller type fans.

B. Vertical discharge.

C. Protect fan blades with a heavy-gauge wire guard.

D. Motors with built in thermal overload protection

E. Permanently lubricated ball bearings.

F. Weatherproof motors.

G. Statically and dynamically balanced.

2.5 COOLER/EVAPORATOR

A. Provide tube-in-shell direct expansion cooler or brazed plate and frame direct expansion

cooled with:

1. Tube-in-shell
    a. Copper tube and steel shell construction
    b. 300 psig water side working pressure
    c. ASME coded 225 psig refrigerant side working pressure
    d. Fully independent refrigerant circuit for each group of compressors.
    e. Serviceable construction including removable heads and field replaceable tubes.
    f. Drain and vent connection.
2. Brazed plate
    a. Copper and stainless steel construction
    b. 150 psig water side working pressure
    c. ASME coded 430 psig refrigerant side working pressure
    d. Fully independent refrigerant circuit for each compressor.
    e. Serviceable construction including removable heads and field replaceable tubes.
    f. Drain and vent connection.

C. Protect cooler with ambient controlled heater cable and minimum 1-1/4" thick flexible elastomeric rubber closed cell insulation. Heater cable to protect evaporator to -20°F (-29°C). Heater cable shall be wrapped helically around the shell under the insulation.

D. Protect insulation and equipment from abrasion by unit enclosure.

E. After completion of successful start-up, installing contractor shall seal all openings.

F. Provide water drain connection, vent and fittings for factory installed leaving water temperature control and low temperature cutout sensors.

G. Water connections shall be grooved or flanged.

H. Proof of flow shall be provided by the equipment manufacturer factory installed.

I. Provide field installed evaporator inlet strainer.

2.6 CASING/ENCLOSURES

A. House components in minimum 14 gauge galvanized steel frame and mounted on welded structural steel base. Hot-dip galvanized steel frame coating shall be Underwriters Laboratories Inc. (UL) recognized as G90-U, UL guide number DTHW2.

B. Unit panels, and control panels shall be 14 gauge, finished with a baked on powder paint. Control panel doors shall have door stays. Paint system shall meet the requirements for outdoor equipment of Federal Government Agencies.

C. Mount starters and disconnects in weatherproof panel provided with full opening access doors. Provide lockable disconnect operating handle external to panel and clearly visible from outside of unit indicating if power is on or off.

D. Casings fabricated from steel that do not have a Zinc coating conforming to ASTM A 123 or ASTM A525 shall be treated for the prevention of corrosion with a factory coating or paint system. The coating or paint system shall withstand 672 hours in a salt-spray fog test in accordance with ASTM B 117. Each specimen shall have a standard scribe mark as defined in ASTM D 1654. Upon completion of exposure, the coating or paint system shall be evaluated and rated in accordance with procedures A and B of ASTM D 1654. The rating of failure at the scribe mark shall be not less than six (average creepage not greater than 1/8").

The rating of the unscribed area shall not be less than ten (no failure). Thickness of coating or paint system on the actual equipment shall be identical to that on the test specimens with respect to materials, conditions of application, and dry-film thickness.

E. Coated wire mesh to limit access beneath the condenser coils, cooler, and compressor section area.

F. Convenience outlet (GFIC) at control panel connected to 120-vac circuit provided for heat tracing on cooler.

G. A control power transformer shall be factory installed within the chiller control panel to provide unit control power.

2.7 REFRIGERANT CIRCUIT

A. All units shall have a separate independent refrigerant circuit for each compressor. Twenty & 30 Ton single circuit; 40, 50 & 60 Tons, dual individual refrigerant circuits.

B. Provide for each refrigerant circuit:
1. Liquid line isolation valve.
2. Filter dryer (replaceable core type).
3. Liquid line sight glass and moisture indicator.
4. Electronic or thermal expansion valve sized for maximum operating pressure. Expansion valves with less than five years of proven field operation are not acceptable.
5. Charging valve.
6. Discharge and oil line check valves.
7. Compressor suction and discharge service valves.
8. Relief valve.
9. Full operating charge of refrigerant and oil.
10. Unit factory leak tested at 200 psig.
11. Provide refrigerant not schedule for phase out.

2.8 CONTROL PANEL

A. The Control Center.
1. NEMA 3R weatherproof cabinet with hinged lockable outer door.
2. Control system.
3. Solid-state compressor three phase motor protection.
4. Single point field power connection points.
5. Control interlock terminals.
6. Fan motor and control circuit fuses.
7. Individual contactors for each fan motor.
8. Unit power terminal blocks for connection to remove disconnect switch.
9. Power supply terminals for evaporator heater circuit.
10. Dead front panels over line voltage.
11. Control power / circuit transformer.
12. Provide incoming power terminals, sized to accept the feeder conductors.
13. Chiller run and alarm status relay cards.

B. Microprocessor control system.
1. Stage unit based on leaving water temperature control.
2. Oil differential pressure setpoints.
3. Motor protection.
4. High pressure alarm.
5. Loss of refrigerant alarm.

6. Loss of water flow alarm.
7. Freeze protection alarm.
8. Low refrigerant pressure alarm.
9. Auto start/stop switch.
10. Chilled water setpoint adjustment.
11. Anti-recycle timer.
12. Compressor run status.
13. Password protection.
14. Low water temperature safety (freeze protection).
15. Automatic pump down cycle.
16. Limit supply water temperature pull down on start up to 1° per minute.
17. Automatic lead-lag sequence change of compressors.
18. Unload the compressors if the return water is too high.
19. Compressor starts with the controlled cylinders unloaded.
20. Reset of the chilled water temperature.
21. Indicate status of safeties.
22. Non-volatile memory (EPROM) with setpoints retained with battery backup.
23. Automatic high pressure unloader to unload compressor at pressures above 375 psig.
24. Auto restart after power failure.
25. BacNET interface
26. Alarm Relay
27. Percent of Running Load Amperage

C. Display the following information with 16 key keypad with two line x 40 character clear English Display for outdoor viewing.
1. Supply and Return water temperature.
2. Low water temperature cutout setting.
3. Low ambient temperature cutout setting.
4. Outdoor air temperature.
5. English and Metric data.
6. Suction pressure cutout setting.
7. Each system suction pressure.
8. Each system discharge pressure.
9. Each system oil pressure.
10. Percent of full load motor current.
11. Liquid control range. (2.0 - 20°F above setpoint).
12. Liquid pulldown rate sensitivity adjustment.
13. Anti-recycle timer status for each compressor.
12. Compressor starts & operating run hours.
13. Safety shutdown shall be date and time stamped.
14. Compressor run status.
15. History and alarm diagnostic memory display.

D. All control functions and information shall be available at the unit control panel or via RS 232 cable and phone modem to personal computer.

E. Chiller shall include a relay board with dry contacts for alarms to notify a Building Automation System of certain events or statues of the chiller.

F. Chiller shall include input for leaving chilled water temperature setpoint based upon a 2-10VDS or 4-20mA signal from a Building Automation System.

G. Chiller shall include input for chiller current limit setpoint based upon a 2-10VDC or 4-20mA signal from a Building Automation System.

PART 3 - EXECUTION

3.1 CHILLER MANUFACTURER START-UP/ FIELD SERVICES

A. Provide the services of a factory trained service technician employed full time by the chiller manufacturer to start-up the system. Technicians, as required, shall be factory trained and experienced in the work they perform. (Contractor startup is unacceptable.)

B. The technicians shall utilize comprehensive report forms to document results. Sample forms shall be submitted for review prior to commencing work.

C. Upon completion of the work, the report forms shall be signed by the technicians and their supervisor and included in the final report and Owner's manual.

D. Submit four copies of the final report to the Architect/Engineer for approval within 10 working days of start-up.

E. Follow the manufacturer's start-up procedures.
1. Verify interlocks.
2. Test and verify operation of safety controls.
3. Calibrate controls.
4. Verify microprocessor based control operation.
5. Test, calibrate, and set the chilled water temperature controls.
6. Verify chilled water temperature reset sequence.
7. Verify operation of the integrated control panel.

F. Measure and record the following data:
1. Chilled water entering/leaving temperature.
2. Chilled water flow through the chiller.
3. Suction pressure/condensing pressure.
4. Suction pressure/unloading steps.
5. Air entering/leaving condenser; dry bulb temperature.
6. Outdoor ambient; dry bulb.
7. Motor nameplate voltage; phase and full load amperes.
8. Heater coil in starter (as applicable)
    a. Rating in amperes.
    b. Manufacturer's recommendation.
9. Power reading (voltage and amperes of legs at motor terminals).

G. Test and calibrate the operation of the electronic ground current sensing devices.

H. If the system has been shipped with a holding charge, provide the following:
1. Leak test.
2. Refrigerant pressure test.
3. Evacuate, dehydrate and charge.

I. Verify that accessories are installed and performing the specified functions. Insert certification in Owner's manual.

J. Instruct the Owner's operating personnel. Provide Owner with 8 hours of training prior to substantial completion.

K. Do not operate the equipment for any reason until the factory start-up service has been completed.

L. Provide a print-out from the unit micro-computer control system showing the correct operation of all system controls and components.

M. Provide minimum 24 hour history log displaying accuracy of temperature control system in 15 minute intervals and documented number of compressor cycles during the 24 hour period.

3.2 INSTALLATION

A. Install system in accordance with manufacturer's instructions. Install conduit and controls in bottom of unit electrical. No penetration into top of cabinet.

B. Where the chiller unit is mounted on a grade, a concrete pad shall be provided that is a minimum of 4" high and extends 6" all around the chiller.

C. Align chiller package on steel or concrete foundations.

D. Locate away from overhead restrictions. Maintain side clearances according to manufacturer's recommendations and maintain overhead clearance to allow full elimination of hot air discharge.

E. Install units on vibration isolation pads.

F. Arrange piping for easy dismantling to permit tube cleaning, removing and or repair.

G. Level chiller.

H. Install all electrical and control conduit into the bottom only of electrical cabinet. (No top or side cabinet penetrations)

END OF SECTION

SECTION 23 81 24 - WEATHERPROOF ROOF-MOUNTED AIR HANDLING UNIT

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Weatherproof roof-mounted air handling units. Units shall be constructed for outdoor installation.

1.2 RELATED WORK

A. Division 23 Mechanical
   1. Air Balance
   2. Ductwork
   3. Controls
   4. Electrical Provisions of Mechanical Work
   5. Air Filtration
   6. Heating and Cooling Coils
   7. Other applicable sections

1.3 PERFORMANCE

A. Unit capacities and characteristics as indicated.
   1. Units must be certified in accordance with ARI Standard 430-66.
   2. UL 1995 certification for safety including electric heat.
   3. ARI 430 listed and meet NFPA 90A requirements.

1.4 SHOP DRAWINGS

A. Indicate assembly, unit dimensions, weight loading required clearances, construction details, field connection details, and electrical characteristics and connection requirements.

B. Submit fan performance curve for each unit:
   1. Plot fan volume against static pressure, horsepower and efficiency.
   2. Show point of rating based on static requirements of the system.
   3. Chart of specific sound power level at each octave band center frequency.
   4. For variable volume units, plot fan volume over entire range.

C. Submit for review a unit internal static pressure loss calculation.
   1. Provide an itemized list of static pressure loss at the scheduled CFM for each unit component including and not limited to:
      a. Coils
      b. Dirty filters
      c. Fan and unit system effect
      d. Cabinet and cabinet inlet and outlet
      e. Unit mounted dampers
   2. If a unit mounted outside air pretreatment section without supply fan, “piggyback” is specified:
      a. Provide an itemized static pressure loss as indicated above.
      b. Determine losses for unit configuration, i.e. parallel or series.
      c. Include losses in the primary unit internal static pressure required by configuration.
   3. The air handling unit schedule indicates static pressure external to the unit and does not include any losses associated with the air handling equipment.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, condensate properly tapped, piping connections verified and leak tested, belts aligned and tensioned, all shipping braces have been removed, and fan has been tested under observation.

1.6 DELIVERY, STORAGE AND HANDLING

A. Inspect for transportation damage and store in a clean, dry location. Protect from weather and construction traffic.

1.7 WARRANTY

A. The Air Handling Unit manufacturer shall provide a full machine parts and labor warranty for a period of one (1) year from substantial completion.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Carrier

B. Daikin

C. Trane

2.2 MISCELLANEOUS REQUIREMENTS

A. Provide factory assembled units. Large units may be shipped in sections, at contractor's option for oversize shipping reasons only.

B. Furnish units with sealing and fastening hardware supplied by the manufacturer. Include written instructions needed to complete field assembly of the components.

C. Provide units designed and constructed so that coils, panels, fan housing and fans can be removed without affecting the structural integrity of the unit.

2.3 UNIT HOUSING

A. Construct the unit housing of galvanized steel sheets.
   1. Unitized structural steel frame and base with gusseted corners.
   2. Braced and of sufficient strength to prevent "breathing".
   3. Construct to accommodate the weight of a 250 lb. man at any location on the top.
   4. Completely weatherproof and sloped for drainage.
   5. Make casing joints water tight with approved sealant.

B. Unit casing panels shall be double wall construction with solid galvanized exterior and solid galvanized interior. Panels shall have a minimum thermal resistance of R-13. The casing shall not exceed 0.0042 inch deflection per inch of panel span at 1.5 times the design static pressure up to a maximum of +8 inches in all positive pressure sections and -8 inches in all negative pressure sections. Condensation on exterior of the air handling unit is not approved.

C. Fan assembly shall be provided with 1-inch deflection internally mounted spring vibration isolation under the fan and motor base on units with coils less than 8 sq. ft. and 2-inch

deflection internally mounted spring vibration isolation under the fan and motor base with coils greater than 8 sq. ft. Units with coils over 35 sq. ft. shall have spring thrust restraints securing the fan housing to the discharge opening panel on units. Fan motor shall be internally mounted. Provide internal flex connection of fan discharge.

D. Provide factory installed full size, gasketed, removable, hinged access doors in the following locations:
   1. Entering and leaving side of all coils to allow for cleaning of coils on both side of unit.
   2. Each side of filter compartment to allow changing of filters from either side.
   3. Each side of motor compartment to allow motor and isolation access.
   4. Each side of condensate drain pan to allow for cleaning and inspection.
   5. Swing the doors against the casing static pressure.

E. Provide all coil modules, including heating coil modules, with stainless steel drain pans to facilitate cleaning and maintenance of the coils. Drain pan to extend 10” minimum downstream of cooling coil.

F. Provide coils with stainless steel casings, end plates, tube supports and top and bottom plates.

G. Provide doors for motor and filter compartments with door swing away from piping connections.

H. Exterior of unit shall be weatherproof and shall pass a 500-hour salt spray test.

I. Use stainless steel fasteners with stainless steel piano hinges; latches with zinc plated, epoxy coated T-bar handles; and air tight gaskets.

J. Units shall meet ASHRAE III Class 6 Low Leakage Standard. Casing shall have less than a 1% leakage rate at plus or minus 8 inches W.G.

K. Provide each fan section with an additional 2” think perforated metal inner liner which utilizes fiberglass insulation. Liner shall be installed on all walls and top surface.

L. Provide outside air damper and outside air hood component. A motorized outside air damper actuator shall be provided in the Building Management and Controls specification.
   1. Storm proof louvers
   2. Outside air dampers as specified

2.4 SUPPLY FANS

A. Supply:
   1. Single width, single inlet, backward curved welded aluminum plenum fan.
   2. Statically and dynamically balanced to a BV-3 per AMCA 204 test standard.
   3. Tested after being installed in the fan sections.
   4. Selected for the design air quantities and pressure of the system.
   5. Mounted on a common shaft if multiple wheels.
   6. The fan shall be rated in accordance with AMCA 210 for performance and AMCA 260 for sound.
   7. Minimum of Class II fan.

B. Select fan to operate at or near its maximum efficiency point when handling the required air quantity and static pressure.

C. Nominal fan outlet velocities shall not exceed 1800 FPM.

D. Fan bearings:
   1. Remote grease fittings grouped on the coil connection side of the unit.
   2. Self-aligning.
   3. Selected for an average life of 200,000 hours.

2.5 OUTSIDE AIR AND RETURN AIR DAMPERS AND FLOW MEASUREMENT

A. Opposed blade dampers for 2 position and modulating control.
   1. Ruskin Model CD 60

B. Airflow Measurement Device
   1. Configured for mounting within Air Handling Unit to measure outside air flow.
   2. Provided with field selectable analog output signals and one isolated RS-485 Bacnet MSTP network connection.
   3. Utilize one or more sensor probe having multiple nodes per probe.
   4. Transmitters shall be microprocessor-based and operate automatically after brownouts and/or transient power interruptions
   5. All internal wiring in the probe tube shall be chemical and abrasion resistant coated copper.
   6. All connections to internal wires in the probe tube shall be solder joints or welds. Connectors of any type in the probe tube are not acceptable.
   7. Basis of Design: Ebtron or approved equal.

2.6 DRIVE ASSEMBLY

A. Size for 50% overload

2.7 FAN MOTOR

A. Motors and Control:
   1. Totally enclosed, fan cooled, Variable speed, 1750 rpm Maximum.
   2. Maximum operating point of 70 Hz.
   3. Minimum 90% nominal efficiency at loads of 70%-100%.
   4. Premium efficiency inverter duty
   5. NEMA B design, with Class B insulation, capable to operate continuously at 104 deg F without tripping overloads.
   6. +/- 10% voltage utilization range to protect against voltage variation.
   5. Cast iron frame and end plate
   6. Forged steel lifting eye
   7. Oversized conduit box with ground lug
   8. Provide with factory installed shaft grounding rings by Aegis
   9. Motor selected so that the brake horsepower required to deliver the design air quantity at the system static pressure will not exceed the motor nameplate rating.

2.8 FILTER SECTION

A. Constructed with substantial hinges.

B. Neoprene gasketing.

C. Permanent quick release latching devices.

D. Arranged to accommodate the 2" thick filters as specified.

2.9 COILS

A. Reference coil section of specifications.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Unit is to be provided with a through-the-bottom service connection accessory package and must be used for electrical connections to unit. Use bulkhead connectors to make a waterproof connection.

B. Seal all duct connections to unit for air tight connection. Provide and install gasketing around duct flanges.

C. Install air handling units according to manufacturer's instructions.

D. Provide additional drive packages as required by the Testing and Balancing firm.

E. Air leaks detectable by sound or touch are to be corrected.

F. Air handling units are to be properly supported to prevent flexing, bending or distorting base rails.

G. All coils and drain pans are to be cleaned prior to substantial completion if units are used during construction.

H. Clean all air handling units and return to original manufacturer's condition prior to substantial completion. Vacuum clean all debris from inside air handling equipment.

I. Install piping to unit with full size 6 inch long dirt leg with 1/2" valve at bottom for cleaning.

J. Provide for positive gravity drainage of coil condensate. Pipe full size of unit connection.

K. Adjust fan drives as required to obtain scheduled capacities as directed by the Test and Balance Firm to include sheave and belt replacement.

L. Align belts to eliminate wear and vibration of belts.

M. Verify correct drainage of condensate from condensate pan.

N. Verify correct rotation of fan and wiring of motor.

O. Lubricate all greaseable ball bearings with manufacturer’s suggested lubricant.

P. Replace filters as required if units are used during construction.

Q. Provide piping installation so that after piping is completed and insulated there is full access to service unit and remove fan housing. Piping to coils shall not block fan section access or cause damage to piping insulation during access.

R. AHU motors must be wired with Kernay connections inside motor terminal boxes. No wire nuts. Kernay connections must be wrapped with rubber and electrical tape for insulation.

3.2 IDENTIFICATION

A. Furnish each unit with a durable, deep etched, .025” thick, factory installed aluminum identification plate, permanently mounted with the following information:
   1. Unit identification as indicated on Contract Drawings.
   2. Area served by unit
   3. Serial Number.
   4. Model Number.
   5. Capacity (CFM) and static pressure.
   6. Motor HP.
   7. Unit power supply: Volts / PH / Amps.
   8. Supply Fan Type.
   9. Coil GPM and pressure drop.
   10. Size and number of filters
   11. Sales Order #.
   12. Date unit manufactured.

END OF SECTION

SECTION 23 82 16 - HEATING AND COOLING COILS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install heating and cooling coils.

1.2 SUBMITTALS

A. Submit manufacturer's product data sheets and unit capacity information as specified.

B. Submit manufacturer's Installation, Start-Up and Service Instructions.

C. Submit internal wiring diagram.
   1. Electrical interlocks. *

1.3 RELATED WORK

A. Division 23 Mechanical.
   1. Air Handling Units.
   2. Fan Coil Units.
   3. Weatherproof Roof Mounted Air Handling Units.
   4. Ductwork.
   5. Terminal Boxes.

PART 2 - PRODUCTS

2.1 HOT WATER COILS

A. Hot water coils:
   1. Constructed of copper tubes and aluminum fins.
   2. Designed and circuited for hot water.
      a. Maximum temperature 200°F.

B. Where coils are installed in fan powered VAV boxes, unit heaters and other locations where the incoming air is not filtered, the maximum approved fin spacing is 8 fins per inch.

C. Non-trapping circuit design:
   1. Working pressure 200 psi
   2. Tappings for drain and air vent

D. Provide a Peterson Pete's Plug with retainer strap on the inlet and outlet of each coil.
   1. Positioned to permit accurate pressure readings.

E. Coils shall be constructed in casings as required for installation.

2.2 DIRECT EXPANSION COOLING COILS

A. DX cooling coils:
   1. Constructed of copper tubes and aluminum fins.
   2. Designed and circuited for use with direct expansion refrigeration.

B. Cooling coil face velocity:
   1. Not of magnitude to cause moisture to be carried off the coil.

2. Maximum velocity as scheduled.

C. Circuit cooling coil with interlaced tubes so the entire face is active under all modes of unloading. Refer to the schedule on the drawings.

D. Coils shall be constructed in casings as required for installation.

E. Where coils are stacked, provide intermediate drain pans with drop tubes to drain condensate to the main drain pan without flooding the lower coil.

2.3 ELECTRIC HEATERS

A. Capacity shall be as scheduled on the drawings. Heater shall have 80% nickel, 20% chromium, open resistance coils insulated by floating ceramic bushings, and be supported in an aluminum steel frame.

B. Ceramic bushings shall be recessed into embossed openings and staked into supporting brackets spaced 3-1/2" maximum center to center.

C. Coil shall be machine-crimped into threaded terminals and insulated with phenolic bushings. All terminal hardware shall be stainless steel.

D. Heater shall be listed by the Underwriters Laboratories for zero clearance to combustible surfaces and for use with central air conditioners.

E. For primary protection, furnish a disk-type automatic reset thermal cutout for pilot duty only.

F. For secondary protection, load-carrying manual reset thermal cutouts shall be wired in series with each heater circuit. Cutouts shall be rated at 480 volts minimum.

G. Voltage, phase and number of heating stages shall be furnished in accordance with duct heater schedule. Three-phase heaters shall have single-phase circuits for operation from a 3-phase, 4-wire power source. Circuits shall be rated at 48 amperes maximum. Furnish one set of line terminals to feed all circuits. Heater shall be tested dielectrically at 2000 volts before shipment. Field-installed conductors feeding the heater shall be sized for 125% of the connected load.

H. Built-in components shall be factory wired to terminal blocks for field connection. All internal wiring shall be insulated for 105°C. Built-in magnetic contactors shall disconnect all ungrounded conductors to each circuit. Furnish heaters with an air flow switch that will not allow heaters to energize without proof of air flow. Built-in transformer shall be dry industrial type, sized to carry full contactor holding coil load. Primary windings shall be fused at the factory. Built-in fuses shall be factory wired to each circuit to protect all underground conductors. Type NON or NOS fuses to be factory installed in phenolic fuse blocks. Built-in disconnect switch to be snap action, industrial type. Provide a door interlock mechanism to prevent hinged terminal box cover from being opened when the switch is on. Switch shall be unfused.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install the duct heaters in accordance with the manufacturer's Installation, Start-Up and Service Instructions.

END OF SECTION

SECTION 26 01 05 - ELECTRICAL OPERATING AND MAINTENANCE MANUALS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Compile electrical product data and related information appropriate for Owner's operation and maintenance of products furnished under Contract. Prepare electrical operating and maintenance data as specified in this Section and as referenced in other sections of specifications.

B. Instruct Owner's personnel in operation and maintenance of equipment and systems.

C. Submit 3 copies of complete manual in final form.

1.2 ELECTRICAL OPERATING AND MAINTENANCE MANUAL SUBMITTAL SCHEDULE

A. Thirty (30) days after receipt of reviewed submittals bearing the Architect / Engineer's stamp of acceptance (including re-submittals), submit for review 1 copy of the first draft of the Electrical Operating and Maintenance Manual. This copy shall contain as a minimum:
   1. Table of Contents for each element
   2. Contractor information
   3. All shop drawings, coordination drawings and product data, bearing the Architect / Engineer's stamp of acceptance.
   4. All parts and maintenance manuals for items of equipment
   5. Warranties (without starting dates)
   6. Certifications that have been completed; submit forms and outlines of certifications that have not been completed
   7. Operating and maintenance procedures.
   8. Form of Owner's Training Program Syllabus (including times and dates)
   9. Control operations / equipment wiring diagrams
   10. Coordination Drawings
   11. Schedule of Lamps, Light Engines
   12. Schedule of Ballasts and Drivers
   13. Schedule of Fuses
   14. Other required operating and maintenance information that are complete.

B. Copy will be returned to the Contractor within 15 days with comments for corrections.

C. Submit the (3) completed manuals in final form to the Architect / Engineer.
   1. Prior to substantial completion for Owner's use after the Owner accepts facility maintenance.
   2. Include all specified data, test reports, drawings, dated warranties, certificates, along with other materials and information.

D. The Architect / Engineer shall review the manuals for completeness within 15 days.

E. The Contractor shall be notified of any missing or omitted materials. The Manuals shall be reworked by the Contractor, as required, in the office of the Architect / Engineer. The manuals will not be retransmitted.

F. Three complete manuals shall be delivered to the Owner prior to substantial completion.

PART 2 - PRODUCTS

2.1 BINDERS

A. Commercial quality black, 3-ring binders with clear, durable, cleanable plastic covers.

B. Minimum ring size: 1"; Maximum ring size: 3".

C. When multiple binders are used, correlate the data into related groupings.

D. Label contents on spine and face of binder with full size insert. Label under plastic cover.

PART 3 - EXECUTION

3.1 ELECTRICAL OPERATION AND MAINTENANCE MANUAL

A. Form for Manuals:
1. Prepare data in form of an instructional manual for use by Owner's personnel.
2. Format:
   a. Size: 8-1/2" x 11"
   b. Text: Manufacturer's printed data or neatly typewritten.
3. Drawings:
   a. Provide reinforced punched binder tab and bind in text.
   b. Fold larger drawings to size of text pages.
4. Provide flyleaf indexed tabs for each separate product or each piece of operating equipment.
5. Cover: Identify each volume with typed or printed title "Operating and Maintenance Instructions". List:
   a. Title of Project
   b. Identity of separate structures as applicable
   c. Identity of general subject matter covered in the manual.
6. Binder as specified

B. Content of Manual:
1. Neatly typewritten Table of Contents for each volume arranged in systematic order as outlined in the specifications.
   a. Contractor, name of responsible principal, address and telephone number
   b. A list of each product required to be included, indexed to content of the volume.
   c. List with each product, name, address and telephone number of:
      1) Subcontractor or installer
      2) Maintenance contractor as appropriate
      3) Identify area of responsibility of each.
      4) Local source of supply for parts and replacement
   d. Identify each product-by-product name and other identifying symbols as set forth in Contract Documents.
2. Product Data:
   a. Include those sheets pertinent to the specific product.
   b. Annotate each sheet to:
      1) Identify specific product or part installed.
      2) Identify data applicable to installation.
      3) Delete references to inapplicable information.
3. Drawings:
   a. Supplement product data with drawings as necessary to illustrate:
      1) Relations of component parts of equipment and systems

2) Control and flow diagrams
b. Coordinate drawings with information in Project Record Documents to assure correct illustration of completed installation.
c. Do not use Project Record Documents as maintenance drawings.
4. Written text as required to supplement product data for the particular installation:
a. Organize in consistent format under separate headings for different procedures.
b. Provide logical sequence of instructions for each procedure.
5. Copy of each warranty, bond and service contract issued
a. Provide information sheet for Owner's personnel, giving:
1) Proper procedures in event of failure
2) Instances that might affect validity of warranties or bonds
6. Shop drawings, coordination drawings and product data as specified.

C. Sections for Equipment and Systems
1. Content for each unit of equipment and system as appropriate:
a. Description of unit and component parts:
1) Function, normal operating characteristics, and limiting conditions.
2) Performance curves, engineering data and tests.
3) Complete nomenclature and commercial number of replaceable parts.
b. Operating procedures:
1) Start up, break-in, routine / normal operating instructions
2) Regulation, control, stopping, shut down and emergency instructions
3) Summer and winter operating instructions
4) Special operating instructions
c. Maintenance procedures:
1) Routine operations
2) Guide to trouble-shooting
3) Disassembly, repair and reassembly
4) Alignment, adjusting and checking
5) Routine service based on operating hours
d. Servicing and lubrication schedule
1) List of lubricants required
e. Manufacturer's printed operating and maintenance instructions.
f. Copies of typed circuit directories of panel board to reflect actual room graphics numbers and room names (not architectural room numbers from the drawings).
1) Electrical
2) Controls
3) Communications
g. Original manufacturer's parts list, illustrations, assembly drawings and diagrams required for maintenance.
1) Predicted life of part subject to wear
2) Items recommended to be stocked as spare parts
h. Schedule of fuses
i. Complete equipment field accessible internal wiring diagrams
j. Schedule of lamps
k. Schedule of ballasts
l. Each Contractor's coordination drawings
m. List of original manufacturer's spare parts and recommended quantities to be maintained in storage
n. Other data as required under pertinent sections of the specifications

2. Prepare and include additional data when the need for such data becomes apparent during instruction of Owner's personnel.
3. Additional requirements for operating and maintenance data as outlined in respective sections of specifications
4. Provide complete information for products specified in Division 26.
5. Provide certificates of compliance as specified in each related section.
6. Provide start up reports as specified in each related section.
7. Provide signed receipts for spare parts and material.
8. Provide training report and certificates.

END OF SECTION

SECTION 26 05 00 - ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Except as modified in this Section, General Conditions, and Supplementary Conditions, applicable provisions of Division 1 General Requirements, and other provisions and requirements of the Contract Documents apply to work of Division 26 Electrical.

B. Applicable provisions of this section apply to all sections of Division 26, Electrical.

1.2 CODE REQUIREMENTS AND FEES

A. Perform work in accordance with applicable statutes, ordinances, codes and regulations of governmental authorities having jurisdiction.

B. Electrical work shall comply with applicable inspection services:
1. Underwriters Laboratories
2. National Fire Protection Association
3. State Health Department
4. Local Municipal Building Inspection Department adopted codes with amendments
5. National Electrical Code with local amendments
6. State Regulatory Agencies
7. Where the project is located outside a municipal jurisdiction, and has no municipal inspection services, the National Electrical Code with amendments of the municipality with extraterritorial jurisdiction shall govern.
8. Where the project is located outside any municipal jurisdiction, including extraterritorial jurisdictions, the National Electrical Code with local adopted amendments of the largest municipality located in the same county or parish shall govern.
9. International Energy Conservation Code
10. National Electrical Safety Code

C. Resolve any code violations discovered in contract documents with the Engineer prior to award of the contract. After Contract award, any correction or additions necessary for compliance with applicable codes shall be made at no additional cost to the Owner.

D. This Contractor shall be responsible for being aware of and complying with asbestos NESHAP regulations, as well as all other applicable codes, laws and regulations.

E. Obtain all permits required.

1.3 CONTRACTOR'S QUALIFICATIONS

A. An approved contractor for the work under this division shall be:
1. A specialist in this field and have the personnel, experience, training, and skill, and the organization to provide a practical working system.
2. Able to furnish evidence of having contracted for and installed not less than 3 systems of comparable size and type that has served their Owners satisfactorily for not less than 3 years.

1.4 REFERENCE SPECIFICATIONS AND STANDARDS

A. Materials which are specified by reference to Federal Specifications; ASTM, ASME, ANSI, APWA, or AWWA Specifications; Federal Standards; or other standard specifications

must comply with latest editions, revisions, amendments or supplements in effect on date proposals are received. Referenced specifications and standards are minimum requirements for all equipment, material and work. In instances where specified capacities, size or other features of equipment, devices or materials exceed these minimums, meet specified capacities.

B. Use electrical materials and equipment that is constructed and tested in accordance with the standards of NEMA, ANSI, ASTM, or other recognized commercial standard. If materials and equipment is labeled, listed, or recognized by any Nationally-Recognized Testing Laboratory (NRTL) acceptable to the Occupational Safety and Health Administration (OSHA), then provide NRTL-labeled, listed, or recognized material and equipment. Acceptable NRTLs include but are not limited to:
   1. Underwriters Laboratories, Inc. (UL)
   2. Factory Mutual Research Corp. (FMRC) (also referred to as "Factory Mutual Global," or "FM Global")
   3. Intertek Testing Services NA, Inc. (ITSNA, formerly ETL)
   4. Canadian Standards Association (CSA)
   5. A complete listing of acceptable NRTLs is published on the OSHA website at http://www.osha.gov/dts/otpca/nrtl/.

C. Where material and equipment is not labeled, listed, or recognized by any NRTL, provide a manufacturer's Certificate of Compliance indicating complete compliance of each item with applicable standards of NEMA, ANSI, ASTM, or other recognized commercial standard.

D. Do not install or use electrical material or equipment for any use other than that for which it was designed, labeled, listed, or identified unless formally approved for such use by the Owner's AHJ. This *National Electrical Code*® requirement is re-stated for emphasis.

E. Codes and Standards applicable to this Division:
   1. ANSI – American National Standards Institute
      a. ANSI Z535.1, Safety Colors
      b. ANSI Z535.2, Environmental and Facility Safety Signs
      c. ANSI Z535.3, Criteria for Safety Symbols
      d. ANSI Z535.4, Product Safety Signs and Labels
   2. ASHRAE – American Society of Heating, Refrigeration, and Air Conditioning Engineers:
      a. ASHRAE Standard 90.1, *Energy Standards for Buildings Except for Low Rise Residential Buildings [ANSI, IESNA]*
   3. ASTM – American Society for Testing and Materials
   4. CBM – Certified Ballast Manufacturers
   5. ICC – International Code Council
      a. International Building Code® (IBC)
      b. International Existing Building Code® (IEBC)
   6. ICEA – Insulated Cable Engineers Association
      a. ICEA S-93-639, *Shielded Power Cables 5-46kV* (NEMA WC-74)
   7. IEEE® - Institute of Electronics and Electrical Engineers
      a. IEEE C2™, *National Electrical Safety Code* (NESC) [ANSI]
      b. IEEE Std 141™, *Recommended Practice for Electric Power Distribution for Industrial Plans* ("Red Book")
      c. IEEE Std 143™, *Recommended Practice for Grounding of Industrial and Commercial Power Systems* ("Green Book")
      d. IEEE Std 241™, *Recommended Practice for Electric Power Systems in Commercial Buildings* ("Gray Book")
      e. IEEE Std 242™, *Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems* ("Buff Book")

f. IEEE Std 315™, *Graphic Symbols for Electrical and Electronics Diagrams*
g. IEEE Std 399™, *Recommended Practice for Power Systems Analysis* ("Brown Book")
h. IEEE Std 446™, *Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications* ("Orange Book")
i. IEE Std 493™, *Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems* ("Gold Book")
j. IEEE Std 519™, *Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems*
k. IEEE Std 739™, *Recommended Practice for Energy Management in Industrial and Commercial Facilities* ("Bronze Book")
l. IEEE Std 902™, *Guide for Maintenance, Operation , and Safety of Industrial and Commercial Power Systems* ("Yellow Book")
m. IEEE Std 1015™, *Recommended Practice Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems* ("Blue Book")
n. IEEE Std 11oo™, *Recommended Practice for Powering and Grounding Electronic Equipment* ("Emerald Book")
o. IEEE Std 1584™, *Guide for Performing Arc-Flash Hazard Calculations*

8. IESNA – Illuminating Engineering Society of North America
   a. IESNA *Lighting Handbook*, Ninth Edition
   b. IESNA RP-1, *American National Standard Practice for Office Lighting*
   c. IESNA RP-7, *American National Standard Practice for Lighting Industrial Facilities*
9. NECA – National Electrical Contractors Association:
   a. NECA 1, *Good Workmanship in Electrical Construction* [ANSI]
   b. NECA 90, *Recommended Practice for Commissioning Building Electrical Systems* [ANSI]
   c. NECA 100, *Symbols for Electrical Construction Drawings* [ANSI]
   d. NECA 101, *Standard for Installing Steel Conduits (Rigid, IMC, EMT)* [ANSI]
   e. NECA 104, *Recommended Practice for Installing Aluminum Building Wire and Cable* [ANSI]
   f. NECA / NEMA 105, *Recommended Practice for Installing Metal Cable Tray Systems* [ANSI]
   g. NECA 111, *Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC)* [ANSI]
   h. NECA / NACNA 120, *Standard for Installing Armored Cable (Type AC) and Metal-Clad Cable (Type MC)*[ANSI]
   i. NECA 202, *Recommended Practice for Installing and Maintaining Industrial Heat Tracing Systems* [ANSI]
   j. NECA 230, *Standard for Selecting, Installing and Maintaining Electric Motors and Motor Controllers* [ANSI]
   k. NECA 331, *Standard for Building and Service Entrance Grounding and Bonding*
   l. NECA 400, *Standard for Installing and Maintaining Switchboards* [ANSI]
   m. NECA 402, *Standard for Installing and Maintaining Motor Control Centers* [ANSI]
   n. NECA / EGSA 404, *Standard for Installing Generator Sets* [ANSI]
   o. NECA 407, *Recommended Practice for Installing and Maintaining Panelboards* [ANSI]
   p. NECA 408, *Recommended Practice for Installing and Maintaining Busways* [ANSI]

q. NECA 409, *Recommended Practice for Installing and Maintaining Dry-Type Transformers* [ANSI]
r. NECA 410, *Recommended Practice for Installing and Maintaining Liquid-Filled Transformers* [ANSI]
s. NECA 411, *Recommended Practice for Installing and Maintaining Uninterruptible Power Supplied (UPS)* (ANSI]
t. NECA 420, *Standard for Fuse Applications* [ANSI]
u. NECA 430, *Standard for Installing Medium-Voltage Metal-Clad Switchgear* [ANSI]
v. NECA / IESNA 500, *Recommended Practice for Installing Indoor Lighting Systems* [ANSI]
w. NECA / IESNA 501, *Recommended Practice for Installing Exterior Lighting Systems* [ANSI]
x. NECA / IESNA 502, *Recommended Practice for Installing Industrial Lighting Systems* [ANSI]
y. NECA / MACSCB 600, *Recommended Practice for Installing and Maintaining Medium-Voltage Cable* [ANSI]
z. NECA / NEMA 605, *Installing Underground Nonmetallic Utility Duct* [ANSI]

10. NEMA – National Electrical Manufacturers Association
11. NETA – International Electrical Testing Association, Inc.:
    a. NETA ATS, *Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems*
    b. NETA MTS, *Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems*
    c. NETA ETT, *Standard for Certification of Electrical Testing Technicians* [ANSI]
12. NFPA – National Fire Protection Association:
    a. NFPA 20®, *Standard for the Installation of Stationary Pumps for Fire Protection®*
    b. NFPA 70™, *National Electrical Code® (NEC®)*
    c. NFPA 70E, *Standard for Electrical Safety in the Workplace.*
    d. NFPA 101®, Life Safety Code®
    e. NFPA 110, *Standard for Emergency and Standby Power Systems*
    f. NFPA 111, *Standard on Stored Electrical Energy Emergency and Standby Power Systems*
    g. NFPA 780, *Standard for the Installation of Lightning Protection Systems*
    h. All other NFPA codes and standards except NFPA 5000
13. OSHA – Occupational Safety and Health Administration
14. IECC – International Energy Conservation Code
15. ISO – International Organization for Standardization
16. State and Local Energy Conservation Code
17. Applicable County and Municipal Codes

1.5 CONTRACT DRAWINGS

A. Contract drawings are diagrammatic only and do not give fully dimensioned locations of various elements of work. Determine exact locations from field measurements.

B. Every effort has been made by the Engineer to indicate wiring of all receptacles, light fixtures, switches, telephone outlets, HVAC equipment, other equipment, elevator equipment, and all other devices / appliances requiring electrical power. It is the intent of the Engineer that all light fixtures be powered and controlled unless specifically noted on the plans; that all wiring devices (receptacles and direct connected equipment) be circuited to a power source of the correct voltage and that all HVAC, elevator equipment and other equipment be properly wired to the correct voltage power source; that all

communications and security systems devices and equipment and all fire alarm system devices and equipment are installed, wired and systems are fully operational.

C. It is the responsibility of the Contractor to review the construction drawings (reflected ceiling plans) for light fixtures, casework elevation details for electrical devices which are not indicated on the electrical drawings; to review the mechanical and plumbing documents and all other drawings to determine the electrical rough-ins for all equipment requiring power connections, and to include in their proposals the correct and complete electrical rough-ins for all of these items which were inadvertently not indicated on the electrical drawings, OR the Contractor shall specifically enumerate each item requiring electrical rough-in which is not specifically shown on the electrical drawings, and indicate the electrical provisions of these items as specifically excluded from his proposal.

D. It is the responsibility of the Contractor to compare the scale of all electrical drawings with the scale of the architectural drawings and make adjustments to all electrical drawings which have the incorrect drawing scale so that his material takeoffs are not in error due to an incorrectly labeled drawing scale and his proposal is complete.

E. No proposal shall be accepted which specifically excludes any of the provisions of paragraphs B, C, or D above.

1.6 PROJECT RECORD DOCUMENTS

A. Maintain at the job site a separate set of white prints (black line) of the contract drawings for the sole purpose of recording the "as-built" changes and diagrams of those portions of work in which actual construction is significantly at variance with the contract drawings. Mark the drawings with a colored pencil. Prepare, as the work progresses and upon completion of work, reproducible drawings clearly indicating locations of various major and minor feeders, equipment, and other pertinent items, as installed. Record underground and under slab service and feeders installed, dimensioning exact location and elevation of such installations.

B. At conclusion of project, obtain without cost to the Owner, electronic PDF and AutoCAD 2014 and / or Revit CAD files of the original drawings and transfer as-built changes to these. Provide the following as-built documents including all contract drawings regardless of whether corrections were necessary and include in the transmittal: “2 sets of CDs and prints for Owner’s use, one set of CDs, prints, and mylars for Architect / Engineers Records”. Delivery of these as-built electronic, reproducibles and prints is a condition of final acceptance.
   1. 3 sets of electronic AutoCAD (2014 dwg) and / or Revit CAD drawing files, on CD-ROM media, of each contract as-built drawing.
   2. One reproducible Dayrex Mylar film positive of each contract as-built drawing.
   3. Three sets of blue-line prints of each contract as-built drawing.
   4. Three sets of pdf prints of each contract as-built drawing on CD.

C. As-Built Drawings should indicate the following information as a minimum:
   1. Indicate all addendum changes to documents.
   2. Remove Engineer’s Seal, name, address, and logo from drawings.
   3. Mark documents RECORD DRAWINGS.
   4. Clearly indicate: DOCUMENT PRODUCED BY:
   5. Indicate all changes to construction during construction. Indicate actual routing of all conduits, etc. that was deviated from construction drawings.
   6. Indicate exact location of all underground electrical raceways, and elevations.
   7. Correct schedules to reflect (actual) equipment furnished and manufacturer.

8. During the execution of work, maintain a complete set of Drawings and specifications upon which all locations of equipment, devices, and all deviations and changes from the construction documents in the work shall be recorded.
9. Exact location of all electrical equipment in building. Label panel schedules to indicate actual location.
10. Exact location of all electrical equipment in and outside of the building.
11. Exact location of all outdoor lighting poles and equipment.
12. Location, size and routing of all feeder conduits, equipment, etc. shall be accurately and neatly shown to dimension.
13. Exact location of all roof mounted equipment, wall, roof and floor penetrations.
14. Cloud all changes.
15. Update all panel schedules with all additional circuits added or deleted through construction. Identify each circuit to include all information specified for directory cards for circuit identification in panelboards.

1.7 SPACE REQUIREMENTS

A. Consider space limitations imposed by contiguous work in selection and location of equipment and material. Do not provide equipment or material that is not suitable in this respect.

1.8 RELATION WITH OTHER TRADES

A. Carefully study all matters and conditions concerning the project. Submit notification of conflict in ample time to prevent unwarranted changes in any work. Review other Divisions of these specifications to determine their requirements. Extend electrical services and final connections to all items requiring same.

B. Because of the complicated relationship of this work to the total project, conscientiously study the relation and cooperate as necessary to accomplish the full intent of the documents.

C. Provide sleeves and inserts in forms as required for the work. Stub up and protect open ends of pipe before any concrete is placed. Furnish sizes of required equipment pads. Furnish and locate bolts and fittings required to be cast in them.

D. Locate and size openings required for installation of work specified in this Division in sufficient time to prevent delay in the work.

E. Refer to other Divisions of the specifications for the scope of required connections to equipment furnished under other Division. Determine from the General Contractor / Construction Manager for the various trades, the Owner, and by direction from the Architect / Engineer, the exact location of all items. The construction trades involved shall furnish all roughing-in drawings and wiring diagrams required for proper installation of the electrical work.
1. Make final electrical connections to all electrically operated equipment indicated on the drawings, except as noted.
2. The responsibility for alignment of motor and driven equipment is specified in the related division.

F. Request all Shop Drawings required in ample time to permit proper installation of all electrical provisions.

G. Extend services as indicated to the various items of equipment furnished by others. Rough-in for the various items and make final connections ready for operation upon placing of the equipment.

1.9 CONCEALED AND EXPOSED WORK

A. When the word "concealed" is defined as hidden from sight as in chases, furred spaces or above ceilings. "Exposed" is defined as open to view, in plain sight.

1.10 GUARANTEE

A. Guarantee work for 1 year from the date of substantial completion of the project. During that period make good any faults or imperfections that may arise due to defects or omissions in material, equipment or workmanship. Replacement of failed parts or equipment shall be provided.

1.11 MATERIAL AND EQUIPMENT

A. Furnish new and unused materials and equipment meeting the requirements of the paragraph specifying acceptable manufacturers. Where two or more units of the same type or class of equipment are required, provide units of a single manufacturer.

1.12 NOISE AND VIBRATION

A. Select equipment to operate with minimum noise and vibration. If noise or vibration is produced or transmitted to or through the building structure by equipment, piping, ducts or other parts of work, and judged objectionable by the Owner, Architect, or Engineer, rectify such conditions at no additional cost to the Owner. If the item of equipment is judged to produce objectionable noise or vibration, demonstrate at no additional cost that equipment performs within designated limits on a vibration chart.

1.13 ACCEPTABLE MANUFACTURERS

A. Manufacturers names and catalog number specified under sections of Division 26 are used to establish standards of design, performance, quality and serviceability and not to limit competition. Equipment of similar design, materials, energy efficiency characteristics (where applicable) and lighting performance characteristics (where applicable) equal to that specified, manufactured by a named manufacturer shall be acceptable on approval. A request for prior approval of equipment not listed must be submitted ten (10) days before proposal due date. Submit a marked-up set of the relevant specification section indicating all variances, a comparison to the specified product, and of construction and performance criteria, complete design and performance data for the specified product and the proposed substitution for comparison to the Engineer. The Architect issues approvals of acceptable manufacturers as addenda to the Construction Proposal Documents.

1.14 UTILITIES, LOCATIONS AND ELEVATIONS

A. Locations and elevations of the various utilities included within the scope of this work:
   1. Obtained from utility maps and other substantially reliable sources.
   2. Are offered separate from the Contract Documents as a general guide only without guarantees to accuracy.

B. Examine the site and verify the location and elevation of all utilities and of their relation to the work. Existing utilities indicated on the site plans are for reference only and shall be field verified by the Contractor with the respective public or private utility.

1.15 OPERATING TESTS

A. After all electrical systems have been completed and put into operation, subject each system to an operating test under design conditions to ensure proper sequencing and operation throughout the range of operation. Tests shall be made in the presence of the Architect / Engineer and Owner. Provide minimum 24-hour advance notice of scheduling of all tests. Make adjustments as required to ensure proper functioning of all systems. Special tests on individual systems are specified under individual sections. Submit 3 copies of all certifications and test reports adequately in advance of completion of the work to allow for remedial action as required to correct deficiencies discovered in equipment and systems.

1.16 WARRANTIES

A. All normal and extended warranties shall include parts, labor, miscellaneous materials, travel time, incidental expenses, normal freight / shipping, refrigerant, oils, lubricants, belts, filters and any expenses related to service calls required to diagnose and correct warranty problems.

B. Manufacturer’s warranty shall be from one year from date of substantial completion. Contractor shall be responsible for extending the warranties regardless of date of installation or commissioning.

C. Submit 3 copies of all warranties and guarantees for systems, equipment, devices and materials. These shall be included in the Operating and Maintenance Manuals.

1.17 BUILDING CONSTRUCTION

A. It shall be the responsibility of the sub-contractor to consult the Contract Drawings, details and specifications and thoroughly familiarize himself as to the construction and all job related requirements. All construction trades shall cooperate with the General Contractor / Construction Manager Job site superintendent and lay out work so that all raceways and other items are placed in the walls, furred spaces, chases, etc., so that there shall be no delay in the job.

1.18 TEMPORARY FACILITIES

A. General: Refer to Division 1 for general requirements on temporary facilities.

B. Temporary Wiring: Temporary power and lighting for construction purposes shall be provided under this Division. Installation of temporary power shall be in accordance with NEC Article 527.

C. Temporary facilities, wire, lights and devices are the property of this Contractor and shall be removed by this Contractor at the completion of the Contract.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 IDENTIFICATION OF EQUIPMENT

A. Identification of Equipment:
   1. All major equipment shall have a manufacturer's label identifying the manufacturer's address, equipment model and serial numbers, equipment size, and other pertinent data. Take care not to obliterate this nameplate. The legend on all nameplates or tags shall correspond to the identification shown on the Operating Instructions. All panels, cabinets, or equipment requiring 120 volt or

higher power shall be labeled as required which includes circuit designation and circuit panelboard location, regardless of which discipline installs the equipment.

2. Three layer laminated plastic engraved identifying nameplate shall be permanently secured to each switchboard, distribution panel, motor control center, transformer, panelboard, safety disconnect switch, enclosed circuit breaker, transfer switches, remote generator transfer deices not installed inside light fixtures, wireway, busduct plug, terminal cabinet, surge protective device, capacitor, individual motor controller, contactor, fire alarm panels (main and remote booster), and communications (voice, data, video) cabinet or rack, security panels, time clocks, BMCS cabinets, sound reinforcement cabinets and racks, miscellaneous control cabinets, equipment integral disconnect switches, toggle or motor switches, disconnects for equipment, exterior junction boxes, exterior pull boxes, exterior wireways and gutters, and rooftop equipment (i.e.: supply and exhaust fans, rooftop HVAC equipment) with stainless steel screws.
   a. Utility Power: White letters on black background
      Generator Power (White letters on red background
      UPS Power: White letters on blue background
      Load Bank Circuits: White letters on green background
      Solar or Wind Power Generation: White on orange background
   b. Identifying nameplates shall have 1/2-inch high, engraved letters for equipment designation and ¼-inch letters indicating source circuit designation, (i.e.: “PANEL HA –fed from MDP-6 located in Mech. Rm. 100”). The words “fed from” and “located” shall be included in the labeling.
   c. Each switchboard, distribution panel, transfer switch, generator transfer device (GTD) for emergency lighting, and motor control center feeder or branch circuit device shall have a nameplate showing the load and location of load served in ¼-inch high, engraved letters. Circuit breaker name and kirk key designation if applicable
   d. Each section of multiple section panelboards shall also indicate panelboard section number (i.e.: Panel “HA-Section 2 – fed from MDP-6 located in Mech. Rm. 100”)
   e. Motor Controllers, starters, and contactors: Provide neatly typed label inside each motor controller and contactor enclosure door identifying motor or load served, nameplate horsepower, full load amperes, code letter, service factor, and voltage / phase rating.
   f. Individual motor controller and contactor nameplates shall include load served, location of load served, panel and circuit numbers serving load, location of panel serving load, panel and circuit number serving control circuit, location of panel serving control circuit (if different from panel serving load), description and location (if applicable) of control controlling contactor (i.e. Controlled: Switch in RM 100, and Controlled: BMCS). Contactor nameplate is to include whether it is a lighting or receptacle contactor and name of contactor. i.e. C-1.

Lighting Contactor Example	Receptacle Contactor Example
Lighting Contactor C1	Receptacle Contactor C2
West Parking Lot Pole Lights	Table Recpts Lab Rm 100
Fed From Panel HA-2,4,6	Fed From Panel LA-2,4,6,8
Located Main Elec. Rm. 100	Located Mech. Rm. 110
Control Circuit-Panel LA 42	Control Circuit-Panel LA-42
Located Main Elec. Rm. 100	Controlled-Emer Shut Off Mushroom
Controlled-BMCS	Switch Rm 101

   g. Exterior J-boxes, pull boxes, and gutters shall have panel identification, circuit numbers, and location of panel listed on name plate. Low voltage shall be identified per contents, examples: DATA, BMCS, F/A

h. Name plates on equipment served from switchboards, distribution panels, I-Line panels, and motor control centers are not to include circuit numbers shown on drawings as the circuit numbers are for construction drawing purposes only.

i. Panel names for 277/480v shall start with the letter “H” and 120/208v, 120/240v shall start with the letter “L”. No panel shall be named to include a number other than multi sectional panels, example HA-section 2. New panels installed in renovation or site additions shall have names approved or designated by Owner’s electrical representative. Panel names shall not include the letter “I”. Transformer names shall start with the letter “T” followed by the panel name it serves, i.e. TLA.

j. Main service ATS label shall include equipment name, emergency source and location, normal power source and location, panel served and location. Wall mounted ATS serving lighting loads shall include type of lighting and location, emergency panel and circuit ID and location of panel, normal panel and circuit ID and location of panel.

Main Service ATS Example ATS-1	Wall Mounted Lighting ATS Example ATS
Emer Power-Emer Generator	Exterior Wall Packs/Soffit Lights
Located Chiller Yard	North/West Metal Canopy Lights
Normal Power-MSB	Fed from EHA-2
Located-Mech Rm 100	Located Mech Rm 200
Serves Panel EHA	Fed From HB-4
Located-Mech Rm 100	Located Mech Rm 150

k. Name plates shall include rated bus amperage, voltage, number of phases, number of wires and type of essential electrical system as applicable.

l. Switchgear, switchboards, panelboards, motor control centers, or service equipment available fault current labeling: Provide a 2x3 inch permanently affixed (notice) label with white lettering on contrasting blue background permanently affixed to the equipment prior to energizing the equipment. The label shall include the date of installation and the date of calculation and comply with ANSI Z535.4 current standards design and durability. The date of calculation shall be the date indicated by the Engineer of Record’s seal on the Construction Documents. Example:

AVAILABLE FAULT CURRENT: ##, ### AMPS
DATE OF INSTALLATION: MM/DD/YY
DATE OF CALCULATION: MM/DD/YY

3. Cardholders and directory cards shall be furnished for circuit identification in panelboards. Cardholder shall be located on inside of panel door and shall be in a metal frame with clear plastic front. Circuit lists shall be typewritten. Circuit descriptions shall include explicit description and identification of items controlled by each individual breaker, including final graphics room number or name designation and name of each item served. If no building appointed room number or name is given, list locations per the following examples – A. Storage in Rm 100 – B. Office in Rm 100 – C. Storage west of Rm. 100. List corridors as “corridors”. Identify circuits controlled by contactors using a separate notation for each contactor used. List notation at bottom of schedule stating the circuits are controlled by a contactor, list exact location of contactor, and how switched. Do not use architectural room number designation shown on plans. Obtain final graphics room number identification from Architect’s final room number graphics plan. All locations served by breakers shall be listed on schedule. Panel schedule shall be large enough to contain all information required. Also refer to Section 26 24 16.

4. Permanent, waterproof, black markers shall be used to identify each lighting and power grid junction box, gutter and wireway. Clearly indicate the panel and branch circuit numbers available at that junction box, gutter or wireway. Where low voltage relay panels are used for lighting control, identify the low voltage relay panel and number in addition to the branch circuit panel and number.
5. Pull Boxes, Transformers, Disconnect Switches, etc.: Field work each with a name plate showing identity, voltage and phase and identifying equipment connected to it. The transformer rating shall be shown on the panels or enclosures. For an enclosure containing a motor starter, the nameplate shall include the Owner's motor number, motor voltage, number of motor phases, motor load being serviced, motor horsepower, and motor full load current. Nameplates shall also indicate where panel is fed from.

B. Prohibited Markings: Markings intended to identify the manufacturer, vendor, or other source from whom the material has been obtained are prohibited for installation in public, tenant, or common areas within the project. Also prohibited are materials or devices that bear evidence that markings or insignias have been removed. Certification, testing (example, Underwriters Laboratories), and approval labels are exceptions to this requirement.

C. Warning Signs: Provide warning signs where there is hazardous exposure associated with access to or operation of electrical facilities. Provide text of sufficient size to convey adequate information at each location; mount permanently in an appropriate and effective location. Comply with industry standards for color and design.

D. Wire and Cable Markers: Provide vinyl cloth markers with split sleeve or tubing type, except in manholes provide stainless steel with plastic ties.

E. Wire and Cable Labeling: Provide wire markers on each conductor in all boxes, pull boxes, gutters, wireways, contactors, and motor controllers and load connection. Identify with panelboard / switchboard branch circuit or feeder number for power and lighting circuits, and with control wire number as indicated on equipment manufacturer's shop drawings for control wiring.

F. Underground Warning Tape: Thomas and Betts or approved equal. Six-inch wide plastic tape, colored red for 50 volts or above electrical, or orange for communications and control with suitable warning legend describing buried electrical lines; telephone lines and data lines per APWA recommendations. All underground electrical conduits shall be so identified. Tape shall be buried at a depth of 6-inches below grade and directly above conduits or ductbanks. Provide magnetic marking tape below all underground electrical conduits.

G. Lighting Controls and Equipment: Provide self-adhesive machine typed tape labels with ¼" high white letters on ½" tall black background for digital lighting modules as "DLM". Modules or relays located above ceiling: adhere label to bottom of ceiling T-grid below relay location. Modules or relays located in mechanical or electrical rooms or other areas other than above ceiling: Adhere label to the cover of the module or relay and identify the area they control as "MAIN GYM", "BAND HALL", or "CORRIDOR 100", etc. Remote lighting control switches or push button stations located remotely from the area they control: Adhere label to device face plate, not obstructing screw fasteners, and intuitively identify function such as "GYM LTG LOW-HIGH" or "CAFE LTG DIM", etc.

3.2 CUTTING AND PATCHING

A. General: Comply with the requirements of Division 1 for the cutting and patching of other work to accommodate the installation of electrical work. Except as authorized by the

Architect / Engineer, cutting and patching of electrical work to accommodate the installation of other work is not permitted.

3.3 INSTRUCTION OF OWNER'S PERSONNEL

A. Prior to substantial completion, conduct an on-site training program to instruct Owner's operating personnel in the operation and maintenance of the electrical systems.
   1. Provide the training during regular working day.
   2. The Instructors shall be experienced in their phase of operation and maintenance of the electrical systems and with the project.
   3. Refer to other specification sections for additional training and commissioning requirements.

B. Time to be allocated for instructions.
   1. Minimum of 6 hours dedicated instructor time
   2. 2 hours on each of 3 days.
   3. Additional instruction time for specific systems as specified in other Sections.

C. Before on-site training, submit the program syllabus; proposed time and dates; for review and approval, minimum 48 hours prior to proposed training time and date.
   1. One copy to the Owner
   2. One copy to the Architect / Engineer

D. The Owner shall provide a list of personnel to receive instructions, and shall coordinate their attendance at the agreed upon times.

E. Use operation and maintenance manuals as the basis of instruction. Review manual with personnel in detail. Explain all aspects of operation and maintenance.

F. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shut down of each item of equipment.

G. Demonstrate equipment functions (both individually and as part of the total integrated system).

H. Prepare and insert additional data in the operating and maintenance manuals when the need for additional data becomes apparent during instructions.

I. Submit a report within one week after completion of training. List time and date of each demonstration, hours devoted to the demonstration, and a list of people present, with their respective signatures.

J. At the conclusion of the on-site training program, have the person designated by the Owner sign a certificate to certify that he / she has a proper understanding of the system, that the demonstrations and instructions have been satisfactorily completed, and the scope and content of the operating and maintenance manuals used for the training program are satisfactory.

K. Provide a copy of the report and the certificate in an appropriately tabbed section of each Operating and Maintenance Manual.

3.4 OPENINGS

A. Framed, cast or masonry openings for boxes, equipment or conduits are specified under other divisions. Drawings and layout work for exact size and location of all openings are included under this division.

3.5 HOUSEKEEPING PADS

A. Provide concrete equipment housekeeping pads under all floor and outdoor mounted electrical equipment.

B. Concrete and reinforcing steel shall be as specified in Division 3, or as indicated or noted.

C. Concrete pads:
   1. 6-inches thick minimum indoors; 8-inches thick minimum outdoors, or match existing if indicated on the drawings to extend existing pads, or in other sections of the specifications.
   2. Chamfer strips at edges and corner of forms.
   3. Smooth steel trowel finish.
   4. Extend 3-inches minimum indoors beyond perimeter of equipment unless otherwise shown.
   5. 6-inch x 6-inch #8 wire reinforcement mesh.

3.6 OBSTRUCTIONS

A. The drawings indicate certain information pertaining to surface and subsurface obstructions, which has been taken from available drawings. Such information is not guaranteed, however, as to accuracy of location or complete information.
   1. Before any cutting or trenching operations are begun, verify with Owner's representative, utility companies, municipalities, and other interested parties that all available information has been provided.
   2. Should obstruction be encountered, whether shown or not, alter routing of new work, reroute existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition.

B. Assume total responsibility for and repair any damage to existing utilities or construction, whether or not such existing facilities are shown.

3.7 VANDAL RESISTANT DEVICES

A. Where vandal resistant screws or bolts are employed on the project, deliver to the Owner 2 suitable tools for use with each type of fastener used, and 25 percent spare fasteners.

B. Proof of delivery of these items to the Owner shall be included in the Operating and Maintenance Manuals.

3.8 PROTECTION

A. Protect work, equipment, fixtures, and materials. At work completion, work must be clean and in original manufacturer's condition.

B. Do not deliver equipment to this project site until progress of construction has reached the stage where equipment is actually needed or until building is closed in enough to protect the equipment from weather. Equipment allowed to stand in the weather shall be rejected, and the contractor is obligated to furnish new equipment of a like kind at no additional cost to the Owner.

3.9 COORDINATION OF BRANCH CIRCUIT OVERCURRENT AND PROTECTION DEVICES

A. Review with equipment specified which requires electrical connections. Review equipment shop drawings and manufacturer's nameplate data and coordinate exact branch circuit overcurrent protective device and conductors with equipment provided.
   1. Provide equipment manufacturer's recommended overcurrent protective device indicated on nameplate at no additional cost to the Owner.
   2. If branch circuit conductors and / or conduit sizing is less than the minimum required by equipment manufacturer, notify the Architect / Engineer immediately, prior to rough-in.
   3. If equipment manufacturer is a substitution to the specified equipment manufacturer, provide the greater of the conductors specified or those required for the installed equipment manufacturer's minimum circuit conductors, at no additional cost to the Owner.
   4. If conductors indicated on plans are in excess of that permitted by equipment manufacturer, notify Architect / Engineer immediately, prior to rough-in.
   5. If conductors indicated on plans are in excess of that permitted by the equipment manufacturer, provide the maximum conductors permitted by the equipment manufacturer based on NEC ampacity tables, either in a single set, or as a set of parallel conductors as permitted by the NEC. Conductor size and quantity entering the equipment enclosures shall not exceed the equipment manufacturer's maximum recommendations.

3.10 FAULT CURRENT AND ARC FLASH STUDY FOR OVERCURRENT DEVICE COORDINATION

A. Contractor shall provide a coordination study, fault current analysis, and Arc-Flash study report for new electrical distribution equipment downstream to the last new overcurrent device in each feeder or branch circuit, conducted and prepared by the switchgear manufacturer. The coordination study and fault current analysis shall include the manufacturer's recommendations for all adjustable overcurrent devices specified or provided. Study does not require inclusion of existing switchgear, except it shall include existing or new overcurrent devices in existing switchgear serving new switchgear. Contractor shall submit the report results prior to submitting switchgear submittals to allow changes or modifications to equipment selection.

B. Contractor shall adjust all overcurrent device settings based on manufacturer's recommendations, or as directed by Owner / Architect at no additional cost to Owner. Settings for GFI shall be set at maximum as permitted by the NEC.

C. Arc-Flash & Shock-Hazard Warning Labels: Provide arc-flash and shock hazard-warning labels that comply with ANSI Z535.4 on switchgear, switchboards, transformers, motor control centers, panelboards, motor controllers, safety switches, industrial control panels and other equipment that is likely to require examination, adjustment, servicing, or maintenance while energized. Locate the marking to be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment. On renovation projects, install arc-flash warning labels on existing equipment where lock-out / tag-out will be required for the renovation work. Provide the information listed below on each label. Specify that arc-flash warning label information be produced by the electrical equipment manufacturer or supplier as a part of the final power system studies to be submitted by the Contractor in accordance with the electrical acceptance testing.
   1. Note: In addition to the final arc-flash analysis, the final power system studies include load flow and fault-current calculations, and an overcurrent protective device (OCPD) coordination study based on the actual equipment to be installed for the project.

D. Information to be determined and applied to electrical equipment:
   1. Arc-Flash Protection Boundary
   2. Arc-Flash incident energy calculated in accordance with IEEE Std 15841 ™

3. Working distance calculated in accordance with IEEE Std 1584a ™
4. NFPA 70E Hazard / Risk Category Number or the appropriate personal protective equipment (PPE) for operations with doors closed and covers on.
   a. Typical operations include operating circuit breakers, fused switches, and meter selector switches.
5. System phase-to-phase voltage
6. Condition(s) when a shock hazard exists (e.g. “With cover off”)
7. Limited Approach Boundary as determined from NFPA 70E, Table 130.2(C)
8. Restricted Approach Boundary as determined from NFPA 70E, Table 130.2(C)
9. Prohibited Approach Boundary as determined from NFPA 70E, Table 130.2(C)
10. Unique equipment designation or code (described under “Component Identification”
11. Class for insulating gloves based on system voltage (e.g., Class 00 up to 500V)
12. Voltage rating for insulated or insulating tools based on system voltage (e.g., 1000V)
13. Date that the hazard analysis was performed.
14. “Served from” circuit directory information including the serving equipment designation, location (e.g., room number), circuit number, and circuit voltage / number of phases / number of wires.
15. If applicable, the “serves” circuit directory information including the served equipment designation, location (e.g., room number), circuit number, and circuit voltage / number of phases / number of wires.
16. An abbreviated warning label may be used where it has been determined that no dangerous arc-flash hazard exists in accordance with IEEE 1584a ™, paragraph 9.2.3.
17. Use a “DANGER” label where the calculated arc-flash incident energy exceeds 40 cal/cm.

E. Submittals: Submit four copies of coordination study and certified fault current study results to the Architect for review.

3.11 EQUIPMENT BACKBOARDS

A. Backboards: ¾ inch, fire retardant, exterior grade plywood, painted gray, both sides.
   1. Provide minimum of two 4-ft. by 8-ft. sheets of plywood for each new telephone equipment terminal location.
   2. Provide minimum of two 4-ft. by 4-ft. sheets of plywood for each new data / voice / video / communications equipment location / cable TV head end equipment, or security equipment location.

3.12 TESTING

A. The contractors for the various sub-systems shall submit proposed testing procedures for their systems, subject to review and approval and Owner acceptance. The contract will not be declared to be substantially complete until the functional operation of the subsystems have been demonstrated and verified and reports have been provided, reviewed and accepted.

B. The project will not be declared substantially complete until the following has taken place.
   1. The “As-Built” drawings have been submitted, reviewed and accepted by the Architect / Owner / Owner’s Construction Representative.
   2. The building emergency lighting system and other systems including but not limited to those listed below have been tested, completed factory start-up and programming and adjusting as required for a complete and fully operational system acceptable to the Architect and Owner.
      a. Occupancy Sensor and Lighting Controls

b. Surge protective device equipment
c. Overcurrent devices
d. Motor Controllers
e. Emergency Lighting
f. Building Fire Alarm System
g. Clock System
h. Television Distribution System
i. Building Data / Voice Cabling System
j. Surveillance and Security System
k. Intercom / Telephone
l. Sound Reinforcement Systems
m. Building Lightning protection System

3.13 LOAD BALANCING

A. Balance the loads on each low-voltage feeder so that the voltage on each phase is within +/- 1.0% of the average voltage of the three phases. Refer to the DOE Office of Industrial Technologies, “Motor Tip Sheet #7” dated September 2005 available for download to PDF format at no charge at: http://www1.eere.energy.gov/industry/bestpractices/pdfs/eliminate_voltage_un_balanced_motor-systemts7.pdf

END OF SECTION

SECTION 26 05 05 - ELECTRICAL ALTERATIONS PROJECT PROCEDURES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Inspection and service of existing equipment and materials to remain or be reused.

B. Handling of equipment and materials to be abandoned.

C. Handling of equipment and materials to be removed.

1.2 QUALITY ASSURANCE

A. Coordination with the Contractor prior to the disconnection or shutdown of existing equipment, or to the modification of existing operational systems.

1.3 CONTRACT DRAWINGS

A. There is the possibility that there exist conditions and devices that are affected by the work indicated on the drawings and called for in the specifications (project manual) that do not appear on the drawings. It is the Contractors responsibility to visit the site and determine all of the existing conditions and to consider these existing conditions when making and presenting a proposal, to have a complete proposal.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Material used to upgrade and repair existing equipment shall conform to that specified.

B. Material used to upgrade and repair existing equipment shall not void existing warranties or listings of the equipment to be upgraded or repaired.

C. Material used to upgrade and repair existing equipment shall be new and shall be of the same manufacturer of the existing equipment, shall be acquired through the existing original equipment manufacturer’s approved distribution channels, shall have manufacturer’s warranties for the new material being used, and shall be listed for the use intended.

PART 3 - EXECUTION

3.1 INSPECTION

A. Existing materials and equipment indicated on the drawings or in the specifications to be reused shall be inspected for damaged or missing parts. Notify the Architect / Engineer, in writing, accordingly.

B. If using materials specified or shown on the drawing voids or diminishes the warranty or operation of remaining equipment or systems, the Contractor shall notify the Architect / Engineer, in writing.

C. Verify field measurements and circuiting arrangements.

D. Verify that abandoned wiring, panelboards, and switchboards, disconnect switches, and equipment serve only abandoned facilities. Where abandoned wiring, panelboards,

switchboards, and equipment which serve existing facilities are to remain, Contractor shall provide means and methods to ensure existing facilities remain energized with the correct voltage, overcurrent protection, conductors, and circuit ampacity required by the existing facilities to remain.

E. Demolition Drawings are based on casual field observation, and when available, existing record documents. Report discrepancies to Architect before disturbing existing installation, and immediately after such discrepancies are discovered.

3.2 APPLICATION

A. Existing materials and equipment indicated on the drawings or in the specification to be reused shall be cleaned and reconditioned, including tightening of feeder and bus bar lugs prior to installation and reuse in the modified system.

B. Remove existing luminaries for alterations/renovations. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. For each luminarie that is taken down for alteration and then reinstalled, replace damaged parts, provide new lamps and, with matching paint, touch-up scratched or abraded areas, and replace cracked, broken or missing lenses or diffusers. Replace unrepairable fixtures with new fixtures

C. Material and equipment removed that is not to be salvaged for Owner's use or for reuse on the project shall become the property of the Contractor and shall be removed from the site.

D. Prior to start of construction, Contractor shall walk areas to be renovated with Owner to identify and document items to be salvaged for Owner’s use.

E. Material or equipment salvaged for Owner's use shall be carefully handled and stored where directed by the Owner.

F. Materials and equipment not indicated to be removed or abandoned shall be reconnected to the new system.

G. Clean and repair existing materials and equipment that remain or are to be reused.

H. Panelboards Reused and Modified for Renovation: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

3.3 SEQUENCING AND SCHEDULING

A. Coordinate utility service outages with Utility Company, Architect and Owner.

B. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits use personnel experienced in such operations.

C. Existing Electrical Service: Refer to drawings for work in remodeled areas. Where facilities in these areas are to remain in service, any related work to keep the facilities in operation is specified in this Division. Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain written permission from Owner at least 10 business days before partially or completely disabling system. Minimize outage duration. Make temporary

connections to maintain service in areas adjacent to work area. Disclose the extent, exact time and expected duration of the outage in a written request to the Owner.

D. Remove and replace existing conduit, wiring, outlets, devices, lighting fixtures, panels and appurtenances as occasioned by new or remodeled construction. Re-establish service to lights, switches and devices that may be interrupted by remodeled construction.

E. Disconnect electrical systems in walls, floors and ceilings scheduled for removal. When outlets are removed, wire shall be pulled out of the conduit back to the nearest remaining box or cabinet.
   1. Remove exposed conduit that has been abandoned.
   2. Cap conduit beyond the finish line.
   3. Provide unswitched circuit leg for emergency battery powered equipment; circuit from same branch circuit breaker as switched normal lighting circuit.

F. Where new/existing luminaries or devices are shown being connected to existing circuits:
   1. Field verify existing system voltage
   2. Provide ballast / device to match system voltage

G. Verify the loading of each circuit affected by remodeling work. The maximum load of any branch circuit shall not exceed 80% of its rating.

H. Remove equipment, systems, conductors, wiring, raceways, etc. abandoned or not required for existing or new systems. Coordinate with Architect / Owner for salvage by Owner. Remove abandoned / not required raceways and wiring back to nearest box serving load to remain, or back to panel if not serving remaining load.

I. Existing Power, and Lighting and Appliance Branch Circuit Distribution System: Maintain existing system in service unless as noted or specified otherwise. Disable system only to make switchovers and connections. Notify Owner at least 72 hours before partially or completely disabling system. Minimize outage duration. Make connections to maintain service in areas adjacent to work area.

J. Existing Lighting System: Maintain existing system in service unless as noted or specified otherwise. Disable system only to make switchovers and connections. Notify Owner at least 72 hours before partially or completely disabling system. Minimize outage duration. Make connections to maintain service in areas adjacent to work area.

K. Existing Fire Alarm System: Maintain existing system in service. Disable system only to make switchovers and connections. Notify Owner and local fire service at least 72 hours before partially or completely disabling system. Minimize outage duration. Make connections to maintain service in areas adjacent to work area.

L. Existing Telephone System: Maintain existing system in service. Disable system only to make switchovers and connections. Notify Owner and Telephone Company at least 72 hours before partially or completely disabling system. Minimize outage duration. Make connections to maintain service in areas adjacent to work area.

M. Existing Paging and Sound Reinforcement Systems: Maintain existing system in service. Disable system only to make switchovers and connections. Notify the Owner at least 72 hours before partially or completely disabling system. Minimize outage duration. Make connections to maintain service in areas adjacent to work area.

N. Existing Data Network: Maintain existing system in service. Disable system only to make switchovers and connections. Notify the Owner at least 72 hours before partially or

completely disabling system. Minimize outage duration. Make connections to maintain service in areas adjacent to work area.

O. Existing Video Distribution System: Maintain existing system in service. Disable system only to make switchovers and connections. Notify the Owner at least 72 hours before partially or completely disabling system. Minimize outage duration. Make connections to maintain service in areas adjacent to work area.

P. Existing Security System: Maintain existing system in service. Disable system only to make switchovers and connections. Notify the Owner at least 72 hours before partially or completely disabling system. Minimize outage duration. Make connections to maintain service in areas adjacent to work area.

Q. Existing Video Surveillance System: Maintain existing system in service. Disable system only to make switchovers and connections. Notify the Owner at least 72 hours before partially or completely disabling system. Minimize outage duration. Make connections to maintain service in areas adjacent to work area.

3.4 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. The Contractor shall modify, remove, and/or relocate all materials and items so indicated on the drawings or required by the installation of new facilities. All removals and/or dismantling shall be conducted in a manner as to produce maximum salvage. Salvage materials shall remain the property of the Owner, and shall be delivered to such destination as directed by the Owner's representative unless they are not wanted, then it will be the responsibility of this Contractor to remove such items and properly dispose of them. Materials and/or items scheduled for relocation and which are damaged during dismantling or reassembly operations shall be repaired and restored to good operative condition. The Contractor may, at his discretion, and upon approval of the Owner's representative substitute new materials and/or items of like design and quality in lieu of materials and/or items to be relocated.

1. Remove abandoned electrical distribution equipment, utilization equipment, outlets and accessible portions of wiring, raceway systems, and cables back to the source panelboard, switchboard, switchgear, communications closet, or cabinet. Abandoned wiring and raceways can result from actions that include the following:
   a. Equipment is removed or relocated
   b. Fixtures are removed or relocated
   c. System is no longer used
   d. There is no demonstrable near term future use for the existing circuit or raceway system.
2. Leave abandoned electrical equipment, conductors, and material in place only if one or more of the following conditions exist:
   a. The removal requires the demolition of other structures, finishes, or equipment that is still in use. An example is abandoned conduit above an existing plaster ceiling.
   b. Removal is not feasible due to hazards, construction methods, or restricted access.
   c. Removal of abandoned conductors may damage conductors that must remain operational.
3. Remove conduits, including those above accessible ceilings, to the point that building construction, earth, or paving covers them. Cut conduit beneath or flush with building construction or paving. Plug, cap, or seal the remaining unused conduits. Install blank covers for abandoned boxes and enclosures not removed.
4. Extend existing equipment connections using material and methods compatible with the existing electrical installation and this division.

5. Restore the original fire rating of floors, walls, and ceilings after electrical demolition.
6. Use approved lock-out / tag-out procedures to control hazardous energy sources. Assure that an electrically safe work condition exists in the demolition area before beginning demolition. Where possible, disconnect the building from all sources of electrical power before beginning demolition.

B. All items to be relocated shall be carefully removed in reverse to original assembly or placement and protected until relocated. The Contractor shall clean, repair, and provide all new materials, fittings, and appurtenances required to complete the relocations and to restore them to good operative order. All relocations shall be performed by workmen skilled in the work and in accordance with standard practice of the trades involved.

C. When items scheduled for relocation and/or reuse are found to be in damaged condition before work has been started on dismantling, the Contractor shall call the attention of the Owner's representative to such items and receive further instructions before removal. Items damaged in repositioning operations are the contractor's responsibility and shall be repaired or replaced by the contractor as approved by the owner's representative, at no additional cost to the Owner.

D. Conduit and wiring to items to be removed, salvaged, or relocated shall be removed to points indicated on the drawings, specified, or acceptable to the Owner's representative. Conduit and wiring not scheduled for reuse shall be removed to the points at which reuse is to be continued or service is to remain. Such services shall be sealed, capped, or otherwise tied-off or disconnected in a safe manner acceptable to the Construction Inspector. All disconnections or connections into the existing facilities shall be done in such a manner as to result in minimum interruption of services to adjacent occupied areas. Services to existing areas or facilities that must remain in operation during the construction period shall not be interrupted without prior specific approval of the Owner's representative hereinbefore specified.

E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed. Replace existing wiring devices and cover plates with new wiring devices and new cover plates in renovated areas. Any corridor, room, or area indicated to have any new wiring devices installed shall have all of the existing wiring devices and cover plates replaced with new wiring devices and new cover plates.

F. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

G. Disconnect and remove abandoned luminaries. Remove brackets, stems, hangers, and other accessories.

H. Repair adjacent construction and finishes damaged during demolition and extension work.

I. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

J. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

K. Existing conduit raceway found to need additional hangers installed and/or junction box covers shall be added at no additional cost to the Owner.

L. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

3.5 PROTECTION OF THE WORK

A. Provide adequate temporary support and auxiliary structure as necessary to ensure structural value or integrity of affected portion of work.

B. Provide devices and methods to protect other portions of work from damage.

C. Execute fitting and adjustment of products to provide a finished installation to comply with specified products, functions, tolerances and finishes.

3.6 IDENTIFICATION OF EQUIPMENT IN RENOVATED AREAS

A. Identification of Equipment: Provide new, typed panel directory cards (and card holders if needed) for existing panelboards located within the renovated areas. Ring out all new and existing circuits within these panelboards as specified in Section 26 05 00 Electrical General Provisions. Do not include the description “existing”. Provide new nameplates for all existing electrical equipment in renovated areas as specified in Section 26 05 00 Electrical General Provisions.

3.7 TESTING AND CORRECTIVE MEASURES FOR DAMAGE DURING CONSTRUCTION IN EXISTING LOW VOLTAGE SYSTEMS

A. Pre-construction testing of existing low voltage systems:
   1. Provide a complete operational test of the following systems prior to demolition and renovation. Verify operation of each circuit, device, panel, console, distribution equipment, and associated accessories. Test shall be performed by a contractor and technicians, each certified by the respective manufacturer of the existing special system to perform test, programming, and repairs to the respective manufacturer’s system. Testing of the existing system shall include all areas served by the existing system including but not limited to the main campus, remote buildings, and temporary buildings:
      a. Paging System.
      b. Telephone System
      c. Fire Alarm System
      d. Data Network Communications System
      e. Video Distribution System
      f. Security Access Control System
      g. Video Surveillance System.
      h. Sound Reinforcement System
   2. Provide a complete written report to the Architect, indicating any deficiencies of the existing system in relation to each component’s intended function. Include in the written report evidence of current certification by the respective manufacturer for the contractor and individuals performing the tests. Provide the written report within 14 days of notice to proceed and prior to any demolition or renovation work.

B. Substantial completion testing of existing low voltage systems:
   1. Provide complete operational tests of the following systems within 14-days prior to estimated date of substantial completion. Verify operation of each circuit, device, panel, console, distribution equipment, and associated accessories. Test shall be performed by a contractor and technicians each certified by the respective manufacturer of the existing system to perform test, programming, and repairs to the respective manufacturer’s system. Testing of the existing system

shall include all areas served by the existing system including but not limited to the main campus, remote buildings, and temporary buildings:
   a. Paging System.
   b. Telephone System
   c. Fire Alarm System
   d. Data Network Communications System
   e. Video Distribution System
   f. Security Access Control System
   g. Video Surveillance System.
   h. Sound Reinforcement System
2. Provide a complete written report to the Architect, indicating any deficiencies of the existing system in relation to each component's intended function. Include in the written report evidence of current certification by the respective manufacturer for the contractor and each individual performing the tests. Provide the written report within 14 days of expected date for substantial completion.

C. Repairs, equipment replacements, and corrections to low voltage systems due to damage caused by contractor:
1. Notify the Owner immediately of any disruption or damage to any low voltage system.
2. Any disruption or damage to the existing access control system or fire alarm system shall be corrected the same day as the disruption or damage occurred. The access control system and fire alarm system shall be tested daily in the presence of the owner prior to the Contractor leaving the job site each day.
3. For each low voltage system other than access control or fire alarm system, a manufacturer certified contractor and certified technicians shall perform corrective measures to each system component that was functional prior to demolition and renovation and found defective or non-functional within 14-days prior to estimated date of substantial completion.
4. Corrective measures to all low voltage systems to correct components of the low voltage systems found damaged by the contractor shall be completed to the satisfaction of the Owner and Architect / Engineer prior to acceptance of substantial completion at no additional cost to the Owner.

END OF SECTION

SECTION 26 05 10 - CONTRACT QUALITY CONTROL

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Contract quality control including workmanship, manufacturer's instructions, mock-ups and demonstrations.

1.2 QUALITY CONTROL PROGRAM

A. Maintain quality control over supervision, subcontractors, suppliers, manufacturers, products, services, site conditions and workmanship to produce work in accordance with contract documents. Submit a narrative outline of the Quality Control Program or Plan.

1.3 WORKMANSHIP

A. Comply with industry standards except when more restrictive tolerances or specified requirements indicate more rigid standards or more precise workmanship.

B. Perform work by persons qualified to produce workmanship of specified quality. Persons performing electrical work shall be required to be licensed. There shall be on-site supervision at all times, including punch list work, with that person having a minimum of journeyman license. Helpers, apprentices shall have a minimum of apprentice license.

C. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, and racking. Under no conditions shall material or equipment be suspended from structural bridging.

D. Provide finishes matching approved samples; all exposed finishes shall be approved by the Architect / Engineer. Submit color samples as required.

1.4 MANUFACTURER'S INSTRUCTIONS

A. Comply with instructions in full detail, including each step in sequence.

B. Should instruction conflict with Contract Documents, request clarification from Architect / Engineer before proceeding.

1.5 MANUFACTURER'S CERTIFICATES

A. When required in individual Specification Sections, submit manufacturer's certificate in duplicate, certifying that products meet or exceed specified requirements.

1.6 MANUFACTURER'S FIELD SERVICES

A. When required in individual Specification Sections, manufacturer shall provide manufacturer’s qualified personnel to observe:
   1. Field conditions
   2. Condition of installation
   3. Quality of workmanship
   4. Start-up of equipment
   5. Testing, adjusting, and balancing of equipment

B. Manufacturer’s qualified personnel shall make written report of observations and recommendations to Architect / Engineer.

1.7 MOCK UPS

A. Assemble and erect the specified equipment and products complete, with specified anchorage and support devices, seals and finishes.

B. Do not proceed with any work involving a mock-up, until the related mock up has been approved in writing.

C. Acceptable mock-ups in place shall be retained in the completed work where possible.

D. Perform tests and submit results as specified.

1.8 SCHEDULING OF MOCK-UPS

A. Schedule demonstration and observation of mock-ups, in phases, with Architect / Engineer.
   1. Rough-in
   2. Finish with all appurtenances in place
   3. Demonstrations

B. Refer to other specification sections for pre-functional checklist for requirements to aid in preparing mock-ups.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIAL

A. Comply with recognized National rating and approval agencies as well as all codes and ordinances at the federal, state and city levels.

PART 3 - EXECUTION

3.1 ADJUSTMENTS AND MODIFICATIONS

A. Contractor shall provide all adjustments and modifications as requested by the manufacturer’s qualified personnel at no additional cost to Owner.

B. Coordination Drawings:
   1. Electrical room size and location required and to scale
   2. Equipment and accessories, switchgear and piping
   3. Indicate clearances and service access.

3.2 ELECTRICAL ACCEPTANCE TESTING

A. Perform electrical acceptance testing and inspections in accordance with the current edition of the International Electrical Testing Association (NETA), *Acceptance Testing Specification* (ATS).

B. Perform acceptance testing, inspection, function tests, and calibration to assure that installed electrical systems and components, both Contractor and user-supplied are:
   1. Installed in accordance with design documents and manufacturer’s instructions.
   2. Tested and inspected in accordance with applicable codes and standards (e.g. NFPA 110 and NFPA 111).
   3. Ready to be energized.
   4. Operational within industry and manufacturer’s tolerances.

3.3 INSPECTIONS BY LOCAL AUTHORITY HAVING JURISDICTION (AHJ)

A. Contractor shall notify design prime consultant and associated Architect / Owner's Construction Manager when he requests an inspection by the AHJ.

3.4 MOCK-UPS

A. Mock up the light fixture fireproofing for each type of light fixture to be located in fire rated ceilings. Demonstrate that the fire proofing material does not interfere with the mechanical operation of light fixture doors, hinges, or latches.

END OF SECTION

SECTION 26 05 12 - SHOP DRAWINGS, COORDINATION DRAWINGS & PRODUCT DATA

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Prepare submittals as required by Division 1 and as outlined below.

B. Submit product data shop drawings only for the following and for items specifically requested elsewhere in the Contract Drawings and Specifications. Architect / Engineer reserves the right to refuse shop drawings not requested for review and to imply that materials shall be provided as specified without exception.

C. The term submittal, as used herein, refers to all:
1. Shop Drawings
2. Coordination Drawings
3. Product data

D. Submittals shall be prepared and produced for:
1. Distribution as specified
2. Inclusion in the Operating and Maintenance Manual, as specified, in the related section

1.2 ARCHITECT / ENGINEER REVIEW OF IDENTIFIED SUBMITTALS

A. The Architect / Engineer will:
1. Review identified submittals with reasonable promptness and in accordance with schedule. Specific equipment submittals that may be required to be expedited shall be submitted separately without other submittal items not requiring the same prompt attention.
2. Affix stamp and initials or signature, and indicate requirements for resubmittal or approval of submittal
3. Return submittals to Contractor for distribution or for resubmission

B. Review of submittals will not extend to design data reflected in submittals that is peculiarly within the special expertise of the Contractor or any party dealing directly with the Contractor.

C. Architect / Engineer's review is only for conformance with the design concept of the project and for compliance with the information given in the contract.
1. The review shall not extend to means, methods, sequences, techniques or procedures of construction or to safety precautions or programs incident thereto.
2. The review shall not extend to review of quantities, dimensions, weights or gauges, fabrication processes or coordination with the work of other trades.

D. The review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.

1.3 SUBSTITUTIONS

A. Do not make requests for substitution employing the procedures of this Section.

B. The procedure for making a formal request for substitution is specified in Division 1.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 SPECIFICATION COMPLIANCE REVIEW

A. Mark up a complete copy of the specification section for the product to indicate a) acknowledgement of the specification requirement (Comply), or b) acknowledgement that the particular specification requirement does not apply to this specific project (Not Applicable) or, c) acknowledgement that the specification requirement cannot be made or that a variance is being submitted for review to the Architect / Engineer / Owner (Does Not Comply, Explanation:) Do not submit an outline form of compliance, submit a complete copy with the product data.

3.2 COMPOSITE COORDINATION DRAWINGS

A. Produce a set of composite coordinate drawings for review and comment within four (4) weeks of receipt of Owner's official Notice to Proceed. Show coordination of structural and architectural elements with HVAC piping, ductwork, mechanical equipment, electrical conduit, low voltage systems cabling, lighting, electrical switchgear and panels, security and CCTV systems, domestic water piping, roof drains and storm sewer piping, sanitary sewer piping and fire sprinkler piping and a composite above-ceiling plan, below slab coordination drawings, and a composite mechanical and electrical equipment room floor plan.
   1. Prepare the composite plans at one-quarter inch (1/4") equals one-foot scale. Include larger scale sections with vertical elevations of elements as required to confirm coordinate of all elements.
   2. For each room containing major electrical switchgear and each outside equipment area with major electrical switchgear and other equipment also include NEC working space, NEC equipment space, and NEC access to NEC working space, and housekeeping pad location and dimensions.
   3. Prepare coordination drawings to coordinate installations for efficient use of available space allowing for future additional equipment wherever possible, for proper sequence of installation, and to resolve conflicts. Coordinate with work specified in other sections and other divisions of the specifications.
   4. Identify field dimensions. Show relation to adjacent or critical features of work or products.

B. Submit composite coordination shop drawings in plan, elevation and sections, showing receptacles, outlets, electrical and telecommunication devices in casework, cabinetwork and built-in furniture.
   1. Verify location of wiring devices and outlets, communication devices and outlets, safety and security devices, and other work specified in this Division.
   2. Coordinate with drawing details, site conditions, composite coordination drawings, and millwork other equipment shop drawings prior to installation.
   3. Submit coordination and shop drawings prior to rough-in and fabrication.

3.3 EQUIPMENT SHOP DRAWINGS AND PRODUCT DATA

A. Submittals shall not be combined or bound together with any other material submittal.

B. Submittal Specification Information:
   1. Every submittal document shall bear the following information as used in the project manual:
      a. The related specification section number
      b. The exact specification section title
   2. Submittals delivered to the Architect / Engineer without the specified information will not be processed. The Contractor shall bear the risk of all delays, as if no

submittal had been delivered.

C. All product options specified shall be indicated on the product data submittal. All options listed on the standard product printed data not clearly identified as not part of the product data submitted shall become part of the Contract and shall be provided.

D. Mark each copy of standard printed data to identify pertinent products, referenced to specification section and article number.

E. Show reference standards, performance characteristics and capacities; wiring and piping diagrams and controls; component parts; finishes; dimensions and required clearances.

F. Modify manufacturer's standard schematic drawings and diagrams to supplement standard information and to provide information specifically applicable to the work. Delete information not applicable.

G. Submit drawings in a clear and thorough manner. Identify details by reference to sheet and detail, schedule, or room numbers shown on Contract Drawings.

H. Show all dimensions of each item of equipment in its to be installed assembled condition with all components assembled. Include a series of drawings of individual components as necessary for reference.

I. Identify field dimensions; show relation to adjacent or critical features or work or products.

J. Submit individually bound shop drawings and product data for the following when specified or provided. The Fault Current and Overcurrent Device Coordination Analysis shall be submitted prior to other switchgear.
   1. Fault Current and Overcurrent Device Coordination Analysis. Submit this analysis three (3) weeks prior to any overcurrent device submittal to allow modifications to overcurrent device product selection submittal based on the manufacture’s analysis and recommendations at no additional cost to the Owner.
   2. Enclosed Switches and Circuit Breakers
   3. Enclosed Motor Controllers
   4. Panelboards, load centers, and enclosures
   5. Wiring devices
   6. Lighting fixtures
   7. Lighting Controls and Occupancy Sensors
   8. Surge Protection Devices
   9. Site Lighting Poles, Fixtures, Drivers, and Lamps
   10. Electrical controls and time switches
   11. Electrical Contactors
   12. Motor control centers
   13. Transformers
   14. Switchboards
   15. RTRC and/or PVC coated galvanized steel conduit and fittings conduit and fittings
   16. Emergency/Standby generator sets and transfer switches
   17. Surface Raceways
   18. Architectural Dimming Systems
   19. Theatrical Lighting Systems
   20. Electrical cable trays
   21. Sports Lighting Equipment, Fixtures, Poles, Ballast and Lamps
   22. Busway
   23. Lightning protection system
   24. Fire Rated Cables and Connectors
   25. Medium Voltage Cable and Connectors

26. Metering equipment for energy monitoring and usage

3.4 MANUFACTURERS INSTRUCTIONS

A. Submit Manufacturer's instructions for storage, preparation, assembly, installation, start-up, adjusting, calibrating, balancing and finishing.

3.5 CONTRACTOR RESPONSIBILITIES

A. Review submittals prior to transmittal.

B. Determine and verify:
1. Field measurements
2. Field construction criteria
3. Manufacturer's catalog numbers
4. Conformance with requirements of Contract Documents

C. Coordinate submittals with requirements of the work and of the Contract Documents.

D. Notify the Architect / Engineer in writing at time of submission of any deviations in the submittals from requirements of the Contract Documents.

E. Do not fabricate products, or begin work for which submittals are specified, until such submittals have been produced and bear contractor's stamp. Do not fabricate products or begin work scheduled to have submittals reviewed until return of reviewed submittals with Architect / Engineer's acceptance.

F. Contractor's responsibility for errors and omissions in submittals is not relieved whether Architect / Engineer reviews submittals or not.

G. Contractor's responsibility for deviations in submittals from requirements of Contract Documents is not relieved whether Architect / Engineer reviews submittals or not, unless Architect / Engineer gives written acceptance of the specific deviations identified by the Contractor on reviewed documents.

H. Submittals shall show sufficient data to indicate complete compliance with Contract Documents:
1. Proper sizes and capacities
2. That the item will fit in the available space in a manner that will allow proper service
3. Construction methods, materials and finishes

I. Schedule submissions at least 15 days before date reviewed submittals will be needed by the Contractor for processing or for making corrections for re-submittal.

J. Contractor’s Stamp of Approval
1. Contractor shall stamp and sign each document certifying to the review of products, field measurements and field construction criteria, and coordination of the information within the submittal with requirements of the work and of Contract Documents.
2. Contractor's stamp of approval on any submittal shall constitute a representation to Owner and Architect / Engineer that Contractor has either determined and verified all quantities, dimensions, field construction criteria, materials, catalog numbers, and similar data or assumes full responsibility for doing so, and that Contractor has reviewed or coordinated each submittal with the requirements of the work and the Contract Documents.

3. Do not deliver any submittals to the Architect / Engineer that do not bear the Contractor's stamp of approval and signature.
4. Submittals delivered to the Architect / Engineer without Contractor's stamp of approval and signature will not be processed. The Contractor shall bear the risk of all delays, as if no submittal had been delivered.

3.6 SUBMISSION REQUIREMENTS

A. Make submittals promptly in accordance with approved schedule, and in such sequence as to cause no delay in the Project or in the work of any other Contractor. Product and equipment related to site work or other trades which require extensive rough-in, foundations, or structural support shall be submitted as soon as possible after given notice to proceed with construction.

B. Number of submittals required:
1. Shop Drawings and Coordination Drawings: Submit one electronic data file (pdf) and three opaque reproductions.
2. Product Data: Submit the number of copies the contractor requires, plus those to be retained by the Architect / Engineer, and/or electronic data (pdf) files.

C. Accompany submittals with transmittal letter, in duplicate, containing:
1. Date
2. Project title and number
3. Contractor's name, address and telephone number
4. The number of each Shop Drawing, Project Datum and Sample submitted
5. Other pertinent data

D. Submittals shall include:
1. The date of submission
2. The project title and number
3. Contract Identification
4. The names of:
   a. Contractor
   b. Subcontractor
   c. Supplier
   d. Manufacturer
5. Identification of the product
6. Field dimensions, clearly identified as such
7. Relation to adjacent or critical features of the work or materials
8. Applicable standards, such as ASTM or federal specifications numbers
9. Identification of deviations from contract documents
10. Suitable blank space for General Contractor and Architect / Engineer stamps
11. Contractor's signed and dated Stamp of Approval

E. Coordinate submittals into logical groupings to facilitate interrelation of the several items.
1. Finishes which involve Architect / Engineer selection of colors, textures or patterns
2. Associated items requiring correlation for efficient function or for installation

3.7 RESUBMISSION REQUIREMENTS

A. Make resubmittals under procedures specified for initial submittals. Re-submittals shall be a complete submittal as if it were the initial submittal unless otherwise instructed in the review comments on the original submittal.
1. Indicate that the document or sample is a resubmittal
2. Identify changes made since previous submittals

B. Indicate any changes which have been made other than those requested by the Architect / Engineer.

END OF SECTION

SECTION 26 05 19 - CONDUCTORS AND CONNECTORS – 600 VOLT

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide electrical conductors, wire and connector work as shown, and specified.

B. Types: The types of conductors and connectors required for the project include the following:
   1. 600V building conductors
   2. 600V building conductor connectors

C. Application: The applications for conductors and connectors required on the project are as follows:
   1. Power distribution circuitry
   2. Lighting branch circuitry
   3. Appliance, receptacle, and equipment branch circuitry
   4. Motor branch circuitry
   5. Control wiring
   6. Line voltage

D. Refer to other specific specification sections for voice, video, data, alarm and instrumentation cables.

1.2 QUALITY ASSURANCE

A. UL Label: Conductors and connectors shall be UL labeled.

1.3 REFERENCES

A. Refer to other specific specification sections regarding specialized wiring and connections.

PART 2 – PRODUCTS – Provide products manufactured in the USA

2.1 CONDUCTORS AND CONNECTORS

A. General: Except as indicated, provide conductors and connectors of manufacturer's standard materials, as indicated by published product information, designed and constructed as instructed by the manufacturer, and as required for the installation.

B. Cable Lubricant: Fire resistant, nonflammable, water-based type for standard building conductors. Provide cable lubricants for fire rated cables as recommended by the cable manufacturer.

C. Conductors: Provide factory-fabricated conductors of the size, rating, material, and type as indicated for each use. Conductors shall be soft or annealed copper wires meeting, before stranding, the requirements of ASTM B 3, Standard Specification for Soft or Annealed Copper Wire for Electrical Purposes, latest edition.
   1. Conductors for control wiring sized #14 AWG through #10 AWG shall be stranded.
   2. Conductors for power and lighting shall be stranded. Stranding shall be Class B meeting the requirements of ASTM B 8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, or Soft.

D. Insulation for standard building conductors: Insulation shall meet or exceed the requirements of UL 83, Standard for Thermoplastic Insulated Wires.
   1. All wiring inside lighting fixtures shall be temperature rated per NEC.
   2. Insulation for copper conductors shall be UL Type THHN/THWN, 90 degrees C.

2.2 COLOR CODES FOR CONDUCTORS FOR BRANCH CIRCUITS AND FEEDERS

A. Color coding for conductors as required by NEC 210.5. Color coding for phase and voltage shall be as required by local codes and local standards. Where such standards do not exist, color coding shall be as follows:

Color Code Table	**USE CONTINUOUS COLOR CODED INSULATION THROUGHOUT**					
System/ Phase	**A**	**B**	**C**	**N**	**G**	**IG**
120/208 3 Ph	Black	Red	Blue	White	Green	Green/Yellow Stripe
120/240 3 Ph	Black	Orange	Blue	White	Green	Green/Yellow Stripe
120/240 1 Ph	Black	N/A	Blue			
277/480	Brown	Purple	Yellow	Gray	Green	Green/Yellow Stripe

Notes to Color Code Table:
1. 120/208, 120/240, and 277/480 Volt Systems shall be routed in separate raceways.
2. Switched legs of phase conductors for lighting and appliance branch circuits shall be of the same color as described above throughout the entire circuit.
3. Conductors shall be the same color from breaker to device or outlet.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install electrical conductors and connectors as shown, in accordance with the manufacturer's written instructions, the requirements of NEC, the NECA Standard of Installation, and industry practices.

B. Coordination: Coordinate conductor installation work with electrical raceway and equipment installation work, as necessary for interface.

C. Conductors:
   1. Provide a grounded (neutral) conductor for each branch circuit. Do not share grounded (neutral) conductors.
   2. No more than six phase conductors shall be installed in a single raceway. Any combination of phase conductors and grounded (neutral) conductors in any raceway shall not exceed nine.
   3. When any combination of four or more phase and grounded (neutral) conductors are installed in a raceway, the minimum size for all conductors including equipment ground conductor shall be #10 AWG, and they shall be de-rated accordingly.
   4. When more than four (4) conductors are size #10 AWG, they shall be installed in a one-inch conduit.
   5. Pull conductors together when more than one is being installed in a raceway.

Whenever possible, pull conductors into their respective conduits by hand. Use pulling lubricant when necessary.

6. Before any conductor is pulled into any conduit, thoroughly swab the conduit to remove foreign material and to permit the wire to be pulled into a clean, dry conduit.
7. Run feeders their entire length in continuous section without joints or splices.
8. No wire smaller than #12 AWG shall be permitted for any lighting or power circuit. No wire smaller than #14 AWG shall be used for any control circuit, unless shown otherwise.
9. Provide the same size wire form the panelboard to last outlet on circuit. For 20 amp branch circuits operating at 150V or less, provide #10 AWG wire when the first outlet is over 75-feet from the panelboard. For branch circuits operating at 150 to 600 volts, provide #10 AWG wire when the first outlet is over 150-feet from the panelboard.
10. Branch circuit voltage drop shall not exceed 3% of rated voltage.
    a. Total voltage drop from the point of service to the last outlet or utilization equipment of the same voltage shall not exceed five-percent of rated voltage.
    b. Total voltage drop from the point of service to transformers with adjustable taps, buck-boost transformers, uninterruptable power supplies (UPS), or voltage regulators shall not exceed five-percent of rated voltage.
    c. Total voltage drop from a separately derived system, transformer with adjustable taps, buck-boost transformer, uninterruptable power supply (UPS), or voltage regulator to the last outlet or utilization equipment of the same voltage shall not exceed five-percent of rated voltage.
    d. Total voltage drop from the point of service to distribution equipment of the same voltage shall not exceed two-percent of rated voltage.
    e. Branch circuit voltage drop from distribution equipment to the last outlet or utilization equipment shall not exceed three-percent of rated voltage.
    f. Provide the same size branch circuit conductors to last outlet on circuit unless specifically noted or indicated otherwise on the drawings. For 20 amp branch circuits operating at 150-Volts or less, provide #10 AWG wire when the first outlet is over 75-feet from the panelboard. For branch circuits operating above 150-Volts to 600-Volts, provide #10 AWG wire when the first outlet is over 150-feet from the panelboard.
11. No tap or splice shall be made in any conductor except in outlet boxes, pull boxes, junction boxes, splice boxes, or other accessible locations. Make taps and splices using an approved compression connector. Insulate taps and splices equal to the adjoining conductor. Make splices or taps only on conductors that are a component part of a single circuit, protected by approved methods. Taps or splices in feed through branch circuits for connection to light switches or receptacles shall be made by pigtail connection to the device.
12. Support conductors in vertical raceways, as required by the NEC.
13. Do not permit conductors entering or leaving a junction or pull box to deflect to create pressure on the conductor insulation.
14. Make joints in branch circuits only where circuits divide. These shall consist of one through circuit to which the branch from the circuit shall be spliced.
15. Make connections in conductors up to a maximum of one #6 AWG wire with two #8 AWG wires using twist-on pressure connectors of required size.
16. Make connections in conductors or combinations of conductors larger than specified using cable fittings of type and size required for specific duty.
17. After a splice is made, insulate entire assembly with UL-approved insulating tape to a value equivalent to the adjacent insulation.
18. Make splices and connections in control circuit conductors using UL-approved

solderless crimp connectors.

19. All conduits shall be installed with an insulated grounding conductor per NEC 250.122. Where green conductor insulation is not available, the ground conductor shall be identified with green phasing tape at all accessible locations.
20. Neatly train and lace wiring inside boxes, equipment and panelboards. Provide tie-straps around conductors with their shared neutral conductor where there are more than two neutral conductors in a conduit.
21. Clean conductor surfaces before installing lugs and connectors.
22. Make splices, taps and terminations to carry full ampacity of conductors with no perceptible temperature rise.
23. Provide stranded conductors connected with pressure type connectors / compression fittings and terminal lugs UL listed for the type of conductor used (AL-CU) and correctly sized to the diameter of the bare conductors.
24. Run mains and feeders their entire length in continuous pieces without splices or joints.
25. Color code conductors.
26. Do not install a pull string in conduits containing conductors.
27. Conductors shall be the same color from load side of overcurrent protection device to outlet or utilization equipment.
28. Spare conductors shall not be installed in any conduit, gutter, raceway, panel or enclosure unless noted otherwise.

D. Identification: Label each phase conductor in each junction box with corresponding circuit number, using self-adhesive wire markers.

E. Splices and Joints:
1. In accordance with UL 486A, C, D, E, and NEC.
2. Aboveground Circuits (No. 10 AWG and smaller):
   a. Connectors: Solderless, screw-on, reusable pressure cable type, rated 600 V, 220˚ F, with integral insulation, approved for copper and aluminum conductors.
   b. The integral insulator shall have a skirt to completely cover the stripped wires.
   c. The number, size, and combination of conductors, as listed on the manufacturers' packaging, shall be strictly followed.
3. Motor connections:
   a. All AHU motors connections shall be split bolt connectors.
   b. All non-AHU motors 10 HP and larger shall be split bolt connectors.
   c. All non-AHU motors less than 10 HP shall be split bolt connectors or as recommended by the manufacturer.

F. Aboveground Circuits (No. 8 AWG and larger):
1. Connectors shall be indent, hex screw, or bolt clamp type of high conductivity and corrosion resistant material, listed for use with copper and aluminum conductors.
2. Provide field-installed compression connectors for cable sizes 250 kcmil and larger with not less than two clamping elements or compression indents per wire.
3. Insulate splices and joints with materials approved for the particular use, location, voltage, and temperature. Splice and joint insulation level shall be not less than the insulation level of the conductors being joined.
4. Plastic electrical insulating tape: Per ASTM D2304, flame-retardant, cold and weather resistant.

G. Underground Branch Circuits and Feeders:
1. Submersible connectors in accordance with UL 486D, rated 600 V, 190˚F, with integral insulation.

3.2 TESTING

A. Pre-Energization Check: Before energizing, check cable and conductors for circuit continuity and short circuits. Correct malfunctions.

B. Service Entrance and Feeder Insulation Resistance Test: Each main service entrance conductor and each feeder conductor shall have its insulation resistance tested after the installation is complete except for connection at its source and point of termination. Testing shall be performed by qualified technicians who have been trained in testing procedures and in the use of all test equipment.

1. Make tests using a Biddle Megger or equivalent test instrument at a voltage of not less than 1000 VDC; measure resistance from conductor to conductor, conductor to neutral (if present) and from conductor to ground. Insulation resistance shall not be less than the following:

Wire Size (AWG)	Insulation Resistance (Ohms)
#8	250 K
#6 through #2	100 K
#1 through #4/0	50 K
Larger than #4/0	25 K

2. Conductors that do not meet or exceed the insulation resistance values listed above shall be removed, replaced, and retested.

C. Submittals: Contractor shall furnish instruments and personnel required for tests. Submit 4 copies of certified test results to Architect for review. Test reports shall include conductor tested, date and time of test, relative humidity, temperature, and weather conditions.

D. Voltage and Current Values: The voltage and current in each conductor shall be measured and recorded after connections have been made and the conductor is under load.

SAMPLE DC HIGH VOLTAGE CABLE TEST REPORT
(Specification Paragraph 3.2, C)

Date_____

Contract and Work Location: ___
Contract (Project) No.: _
Circuit Identification: ___
(Dwg., Title, Number and Ckt. Number)

Test Equipment: _____
(Make, Model, Serial No., Etc.)
Applied Test Voltage _____
Normal Oper. Voltage _____
Cable Installation: New _____ Used _____
(Date) (No. Years)
Cable Size _____AWG
Cable Length _____Ft.
Cable Material _____Cu _____Al
Temperature _____ Humidity _____

TEST DATA - RESISTANCE IN KILO OHMS

CONDUCTOR PER PHASE	A-N	B-N	C-N	A-G	B-G	C-G	A-B	B-C	A-C

END OF SECTION

SECTION 26 05 27 - EXPANSION OF EXISTING ELECTRICAL GROUNDING SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Grounding shall conform to the requirements of:
   1. National Electrical Code
   2. Governing local codes
   3. Local Utility Company

B. Ground effectively and permanently.
   1. Verify existing neutral conductor bonding at the main service disconnect and at other new/relocated or reused separately derived systems.
   2. All new/relocated conduit or cable tray systems and busway
   3. All new/relocated electrical equipment and related current carrying supports or structures
   4. All new / relocated metal piping systems
   5. All new building structural metal frames

1.2 REFERENCE STANDARDS

A. ANSI/IEEE Standard 142 - "Recommended Practice for Grounding of Industrial and Commercial Power Systems."

B. ANSI/UL 467 - "Safety Standard for Grounding and Bonding Equipment."

C. Article 250 of the NEC (NFPA 70) for grounding.

D. NECA – Standard of Installation

E. NETA ATS – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems

F. EIA / TIA 607

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Copperweld

B. nVent ERICO

C. Burndy

D. O.Z. Gedney

E. Eaton

2.2 GROUNDING ELECTRODES

A. Driven Rod Electrode
   1. 3/4" x 10'-0" copper clad grounding electrode, UL listed
   2. UL listed grounding electrode connector
   3. Approved thermal fusion methods (exothermic)

B. Metal Frame of Building

C. Existing grounding electrode system

2.3 DRIVEN ELECTRODE ACCESS BOX AND COVER

A. Hubbell Tier 22 FRP 20-inch round bolt down cover with “GROUND” embossed on top.

2.4 MATERIALS AND COMPONENTS

A. Reference other sections of this specifications for materials specified there.

B. Heavy-duty, copper, two bolt type, copper alloy or bronze compression lugs for grounding and bonding applications, in configurations required for particular installation.

PART 3 - EXECUTION

3.1 SYSTEMS 600 VOLTS OR LESS

A. In the existing service equipment, field verify existing condition of ground bus.
   1. Field verify existing bond of the ground bus to the existing service grounding conductor, to the neutral bar.
   2. Tighten existing ground lugs and connections.

B. Connect the grounding electrode conductor between the ground bus and the grounding electrode system.
   1. In rigid PVC conduit.
   2. Provide thermo fusion connection for each rod ground electrode.
      a. All rod electrodes shall be located outside the building in non-paved areas where available. Access cover top shall be flush with finish grade or floor.
      b. Install rod electrodes as indicated. Install additional rod electrodes as required to achieve specified resistance to ground.
      c. The minimum distance between driven ground rod electrodes shall be 10'.
   3. The total ground resistance shall not exceed 10 Ohms for service entrance grounds and for equipment grounds.
      a. Where this condition cannot be obtained with one electrode, install a longer electrode, deep-driven sectional electrodes, or additional grounding electrodes until the required ground resistance is obtained.
      b. Refer to drawings for project specific ground resistance requirements.

C. Field verify the grounding electrode conductor between the ground bus and the grounding electrode systems are in compliance with the NEC.

D. Provide an insulated grounding conductor inside all new conduits, raceways, surface raceways and cables used for power distribution. The ground wire shall be bonded to each box. All bonding jumpers shall be routed inside conduit or raceway.

E. Provide an insulated, isolated equipment grounding conductor in addition to the insulated equipment grounding conductor for all isolated grounding feeders, branch circuits, outlets and receptacles.

F. Provide all new/relocated conduits terminating in switchgear, transformers, switchboards, and panelboards with grounding bushings, where required and ground wire extended to

ground bus in equipment.

G. Where modifications to the main service disconnect are required, main bus and building grounding electrode conductor installation shall be witnessed by the Architect / Engineer.

H. Interface with lightning protection system when lightning protection system is specified.

I. Locate and install anchors, fasteners, and supports in accordance with NECA “Standard of Installation”.

J. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.

K. Do not use spring steel clips and clamps.

L. Do not use powder-actuated anchors.

M. Do not drill or cut structural members.

N. Do not use compression or mechanical connectors underground.

3.2 MISCELLANEOUS REQUIREMENTS

A. Continuity of the building equipment grounding system shall be maintained throughout the project. Grounding jumpers shall be inside conduit, fittings and boxes and shall be installed across conduit expansion fittings, liquid-tight flexible metal and flexible metal conduit, light fixture pigtails in excess of 6', and other non-electrically continuous raceway fittings.

B. Grounding conductors and grounding electrode conductor shall be stranded copper conductors and run in a suitable PVC raceway. Grounding conductors and grounding electrode conductor shall be continuous, without joints or splices over their entire length, except as allowed by NFPA 70/NEC.

C. For separately derived alternating current system grounds, bond the case and neutral of each transformer secondary winding directly to the nearest available effectively grounded structural metal member as required in NEC 250.

D. Technology/Data/Voice Communications, CATV, CCTV, and MATV Equipment Grounding: Provide grounding electrode conductor from the communications service equipment to the building grounding system as required. Provide #6 ground conductor from telephone/voice/CATV/data company demarcation point to building electrical service entrance ground electrode connection and as required by all local utility companies.
   1. New MDF Closets Telecommunications Main Ground Bar (TMGB): Provide Erico Cadweld #B544A028 ground bar with 7/16-inch holes, wall mounted to the telecommunications plywood backboard. Provide one #3 AWG insulated ground conductor from ground bar to building steel. Provide #2/0 AWG insulated ground conductor to the building electrical service ground at the main electrical service disconnect.
   2. New IDF Closets Telecommunications Ground Bar (TGB): Provide Erico Cadweld #B542A004 ground bar with 7/16-inch holes, mounted to the telecommunications plywood backboard. Provide one #6 AWG insulated ground conductor from ground bar to building steel.
   3. Provide #2/0 AWG insulated ground conductor between each TMGB and all TGBs.
   4. Provide #2/0 AWG insulated ground conductor from TMGB to electrical service ground bus at main electrical service switch.

5. Bond each equipment rack with #6 AWG insulated ground conductor to the TMGB / TGB.
6. Route TMGB – TGB ground conductor using the shortest route practical with long radius curves.

E. Ground new and removed/replaced lighting fixture bodies to the conduit grounding system.

F. Receptacles: Provide a ground wire bonded to the conduit ground system, except where and insulated isolated grounding receptacle is specified.

G. Motor Frames: Ground the frame of each motor with a properly sized separate ground wire around flexible conduit.

H. Provide grounding access well for each driven ground electrode, not located in manholes or pull boxes.
1. Access well top shall be flush with finish paved surfaces.
2. Ground access wells located in non-paved areas shall be set two-inches above surrounding finished grade. Provide 12-inch wide by 8-inch deep reinforced concrete crown around neck or opening and sloped down away from pull box opening.
3. Provide thermal fusion (exothermic) connectors approved for direct burial.

I. Ground all light poles and all exterior metal structures supporting conduit, switchgear, or light fixtures.

J. Exterior Electrical Equipment Racks:
1. Provide driven ground electrode for racks mounted remote from building structure.
2. Where mounted on roof, ground to be building structural steel.

K. Ground connections to building steel, grounding electrodes and all underground connections shall be by thermal fusion (exothermic).

L. Transformers: Provide driven ground electrode and building steel electrode at each transformer.

M. Bond hot water and cold water piping together at each domestic water heater.

3.3 COORDINATION

A. General: Coordinate installation of grounding connections for equipment with equipment installation work.

3.4 TESTING

A. Ground Resistance Test: Perform a ground resistance test for comparison to future inspection and testing data by the Owner. Test shall be performed using a Biddle Megger Earth Tester or equivalent test instrument. The test shall not be performed within 48 hours after the last rainfall.
1. Inspect and test in accordance with NETA ATS except Section 4
2. Grounding and Bonding: Perform inspections and tests listed in NETA ATS, Section 7.13

B. The Root Mean Square (RMS) AC measurements: The True RMS AC Measure test should be performed for all bonding conductors. The recommended maximum AC current

value on any bonding conductor should be less than 1 ampere (A). The recommended maximum DC current value should be less than 500 milliamperes (mA). If abnormally high AC current levels are present on any bonding conductor, a dangerous faulty wiring condition likely exists within the room.

C. Two-Point Bonding Measurements: The two-Point Bonding test shall be performed for all bonding conductors. This test should be performed using an earth grounding resistance tester configured for a continuity test. The test is performed by connecting the meter leads between the nearest available grounding electrode (e.g., structural steel) and the TMGB or TGB. The recommended maximum value for the bonding resistance between these two points is 0.1 ohms (100 milliohms).

D. Submittals: Furnish instruments and personnel required for tests. Personnel shall be trained in all aspects of testing grounding systems and shall be formally trained on using all test equipment required. Submit 2 copies of certified test results for Owner's record and submit 4 copies of certified test results to Architect / Engineer for review. Test reports shall include date and time of tests, relative humidity, temperature, and weather conditions.

END OF SECTION

SECTION 26 05 33 - CONDUIT SYSTEMS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install a complete system of electrical conduits and fittings.

1.2 REFERENCE STANDARDS

A. National Electrical Code

B. Local codes and ordinances

C. UL

D. ETL

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS – Provide products manufactured in the USA

A. Raceways:
1. Allied, International Metal Hose, Ipex, Heritage Plastics, Wheatland, Can-Tex, Carlon, Certain-Teed, Anamet, Inc., Electri-Flex Co., Western Tube and Conduit
2. PVC Coated RGC: Robroy Perma Cote, Robroy Plasti-Bond, or Calbond – no exceptions
3. Stainless Steel: Robroy, Calbrite, Gibson
4. Aluminum: Penn Aluminum, American Conduit, Wheatland, Eaton B-Line, Patriot Aluminum Products
5. Reinforced Thermosetting Resin Conduit (RTRC): FRE Composites, Champion Fiberglass, United Fiberglass

B. Fittings:
1. Appleton, Crouse Hinds, Topaz, Steel City, O.Z. Gedney, Carlon, Heritage Plastics, Raco, Ipex, International Metal Hose, Lew Electric Fittings Co.
2. PVC Coated ferrous fittings: Robroy Perma Cote, Robroy Plasti-Bond, or Calbond – no exceptions
3. Stainless Steel: Robroy, Calbrite, Gibson, Crouse Hinds
4. Aluminum: Penn Aluminum, American Conduit, Wheatland, Eaton B-Line, Patriot Aluminum Products
5. Reinforced Thermosetting Resin Conduit (RTRC): FRE Composites, Champion Fiberglass

C. Condulets and Conduit Bodies:
1. Appleton, Form 85
2. PVC Coated: Robroy Perma-cote or Plasti-Bond, – no exceptions
3. Stainless Steel: Robroy, Calbrite, Gibson, Crouse Hinds
4. Reinforced Thermosetting Resin Conduit (RTRC): FRE Composites, Champion Fiberglass

D. Steel MC Cable for light fixture whips:
1. AFC
2. Southwire
3. General Cable
4. Kaf-Tech

2.2 GENERAL

A. The minimum conduit size shall be ¾-inch unless indicated otherwise in Divisions 26, 27 or 28.
   1. Branch Circuits: Minimum conduit size shall be ¾-inch.
   2. Feeder Circuits: Minimum conduit size shall be ¾-inches.
   3. Technology, telecommunications, and low voltage systems: The minimum conduit size shall be ¾-inches unless noted or indicated otherwise.
   4. The minimum conduit size between buildings for technology, voice, data, fire alarm, video, security, surveillance, BMCS, and other telecommunications shall be 2-inch unless indicated otherwise.

B. The minimum conduit size for flexible metallic conduit for tap connections to individual light fixtures shall be ½ inch, or steel metal clad (MC) cable with insulated ground conductor maximum 6 feet.

C. Electrical nonmetallic tubing, flexible polyethylene or PVC tubing shall not be used on this project.

D. BX and AC cable shall not be used on this project.

E. PVC elbows shall not be used on this project.

F. Intermediate metal conduit (IMC) shall not be used on this project.

2.3 RIGID METAL CONDUIT

A. UL labeled, Schedule 40:
   1. Mild steel pipe, zinc coated inside and out
   2. Aluminum Alloy 6063, T-1 temper
   3. Threaded ends
   4. Insulated bushings

B. Fittings shall meet the same requirements as rigid metal conduits.
   1. UL labeled
   2. Threaded fittings

2.4 ELECTRICAL METALLIC TUBING (EMT)

A. UL labeled, standard weight:
   1. Cold rolled steel tubing, zinc coated inside and out
   2. Aluminum Alloy 6005, 6063. Temper T-1

B. Fittings shall meet the same requirements as EMT conduits.
   1. UL labeled
   2. Insulated throat connectors
   3. Steel fittings with setscrews with lock nuts on threaded ends, no snap locks
   4. Cast metal fittings are not approved
   5. Uni-couple type connectors are not approved
   6. Split ring, anti-short bushings are not approved

2.5 RTRC CONDUIT FITTINGS AND CONDUIT BODIES

A. UL listed

B. Standard wall thickness sizes ¼-inch through 4-inch

C. Underground medium wall thickness sizes 5 and 6-inch

D. Conduit interface joints above grade, gasket joint below grade

E. Extra heavy wall for above ground and/or UL Class 1 Division 2 and Class 1 Zone 2 applications.

2.6 PVC COATED RIGID STEEL WITH URETHANE INTERIOR COATING

A. The PVC coated galvanized rigid conduit and fittings must be ETL Listed and Verified. The PVC coating must have been investigated and verified by ETL as providing the primary corrosion protection for the rigid metal conduit. Ferrous fittings for general service locations must be ETL Listed with PVC as the primary corrosion protection. Hazardous location fittings, prior to plastic coating must be UL listed for the hazard conditions to which they are to be used. All conduit and fittings must be new, unused material. Applicable UL standards may include UL 6 Standard for Safety, Rigid Metal Conduit, and UL514B Standard for Safety, Fittings for Conduit and Outlet Boxes.

B. The PVC coated galvanized rigid conduit and fittings must be ETL Verified to the Intertek ETL SEMKO High Temperature H_2O PVC Coating Adhesion Test Procedure for 200 hours. The PVC coated galvanized rigid conduit must bear the ETL Verified PVC-001 label to signify compliance to the adhesion performance standard.

C. The conduit shall be hot dip galvanized inside and out with hot galvanized threads.

D. A PVC sleeve extending one pipe diameter or two inches, whichever is less, shall be formed at every female fitting opening except unions. The inside sleeve diameter shall be matched to the outside diameter of the conduit.

E. The PVC coating on the outside of conduit couplings shall have a series of longitudinal ribs 40 mils in thickness to protect the coating from tool damage during installation.

F. Form 8 Condulets, ½-inch through 2-inch diameters, shall have a tongue-in-groove gasket to effectively seal against the elements. The design shall be equipped with a positive placement feature to ease and assure proper installation. Certified results confirming seal performance at 15 psig (positive) and 25 inches of mercury (vacuum) for 72 hours shall be available.

G. Form 8 Condulets shall be supplied with plastic encapsulated stainless-steel cover screws.

H. A urethane coating shall be uniformly and consistently applied to the interior of all conduit and fittings. This internal coating shall be a nominal 2 mil thickness. Conduit or fittings having areas with thin or no coating shall be unacceptable.

I. The PVC exterior and urethane interior coatings applied to the conduit shall afford sufficient flexibility to permit field bending without cracking or flaking at temperatures above 30°F (-1°C).

J. All male threads on conduit, elbows and nipples shall be protected by application of a urethane coating.

K. All female threads on fittings or conduit couplings shall be protected by application of a urethane coating.

L. Independent certified test results shall be available to confirm coating adhesion under the following conditions
   1. Conduit and condulet exposure to 150°F (65°C) and 95% relative humidity with a minimum mean time to failure of 30 days. (ASTM D1151)
   2. The interior coating bond shall be confirmed using the Standard Method of Adhesion by Tape Test (ASTM D3359).
   3. No trace of the internal coating shall be visible on a white cloth following six wipes over the coating which has been wetted with acetone (ASTM D1308).
   4. The exterior coating bond shall be confirmed using the methods described in Section 3.8, NEMA RN1. After these tests the physical properties of the exterior coating shall exceed the minimum requirements specified in Table 3.1, NEMA RN1.

M. Right angle beam clamps and U bolts shall be specially formed and sized to snugly fit the outside diameter of the coated conduit. All U bolts shall be provided with plastic encapsulated nuts that cover the exposed portions of the threads.

N. All fittings, clamps, straps, struts, and hardware used with PVC coated conduit shall be PVC coated or 316 stainless steel

2.7 STEEL FLEXIBLE CONDUIT

A. Steel flexible metallic conduit:
   1. Zinc coated inside and out
   2. 18-inches minimum length, 24-inches maximum length

B. Steel flexible metallic conduit for tap connections to light fixtures where steel MC Cable fixture whips are not used:
   1. 18 inches minimum length; 6 feet maximum length

C. Liquid tight flexible steel conduit
   1. Type L.A. - Grounded - UL Approved
   2. 18-inches minimum length, 24-inches maximum length

2.8 PVC CONDUIT

A. UL labeled Schedule 40 and Schedule 80

B. PVC fittings and solvent welded joints

C. Acceptable PVC condulet manufacturer: Ipex, Cantex

2.9 CONDULETS AND CONDUIT BODIES

A. UL Labeled

B. Form 85

C. PVC Coated: Form 8

D. LBC Condulets shall be used for size 2 inch and above.

E. LL and LR Condulets shall not be used for 2 inch and above

2.10 ROOF MOUNTED CONDUIT AND BOX SUPPORTS

A. Conduit supports and pads suitable for direct sunlight, conduit size, weight, quantity and roof system with unistrut supports and accessories. Conduit supports shall allow for conduit expansion and contraction.

B. Refer to roofing specifications for additional information. The limitations and restrictions contained in any roofing specification shall prevail and supercede these specifications for roof mounted supports for conduits and boxes.

C. Approved Manufacturer:
   1. Portable Pipe Hangers
   2. Eaton B-Line
   3. Miro Industries, Inc.

2.11 ALUMINUM CONDUIT

A. UL Labeled

B. Aluminum fittings shall meet the same requirements of aluminum conduits, compatible steel fittings.
   1. UL Labeled for use with aluminum conduit.

2.12 STAINLESS STEEL CONDUIT

A. UL Labeled

B. Rigid Stainless Steel:
   1. Type 304 Stainless Steel
   2. Threaded ends
   3. Insulated Bushings

C. EMT:
   1. Type 304 Stainless Steel
   2. Compression Fittings
   3. Insulated Bushings

D. Fittings, elbows, nipples, strut, device box, clamps straps, etc.
   1. Type 304 Stainless Steel

2.13 ELECTRICAL NON-METALLIC TUBING (ENT)

A. UL labeled Schedule 40

B. PVC fittings and solvent welded joints

C. Acceptable manufacture: Carlon

2.14 EXTERIOR IN-GRADE PULL BOXES

A. Enclosures, boxes and covers are required to conform to all test provisions of the most current American Association of State Highway and Transportation Officials (AASHTO) standards for H-20 loading applications.
   1. AASHTO H-20 certified precast concrete, cast iron or other AASHTO recognized materials, rated for deliberate traffic.
   2. Conduit entry knock-outs as required
   3. Bolt down galvanized steel/cast iron covers

4. Thin wall knocks outs as required
4. Integral bottom
5. Box height as required for specified conduit depth and required top elevation.
6. Concrete design strength of minimum 5,500 PSI at 28-days
7. Place enclosures on a minimum of 6 inches of coarse gravel with a border of 6-inches beyond the enclosures exterior dimension.
8. Size and volume as required for application.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install electrical conduits and fittings for all wiring of any type unless specifically specified or instructed to do otherwise. Install conduits and fittings in accordance with local codes and applicable sections of the NECA “Standard of Installation”, concealed where possible.
1. Fasten conduit supports to building structure and surfaces; do not support to roof deck.
2. Arrange supports to prevent misalignment during wiring installation.
3. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.
4. Do not attach conduit to ceiling support wires.
5. Arrange conduit to maintain head room and present neat appearance.
6. Maintain 4-inch clearance between conduit and rooftop surfaces.
7. Cut conduit square using saw or pipe cutter; de-burr cut ends.
8. Bring conduit to shoulder of fittings; fasten securely.
9. Conduit penetrations to all individual motor controllers, VFDs, and motor control cabinets shall only be made at the bottom of the enclosure. For other equipment, provide listed water sealing conduit hubs to fasten conduit to sides or tops of electrical equipment enclosures, device box, gutter, wireway, disconnect, etc.
10. Use suitable caps to protect installed conduit against entrance of dirt and moisture.
11. Ground and bond conduit as required.
12. Identify conduit as required.
13. Route all conduits above building slab perpendicular or parallel to building lines.
14. Do not use no-thread couplings and connectors for galvanized steel, PVC coated galvanized steel, or aluminum rigid conduit.

B. Group related conduits; support using conduit rack. Construct rack using steel channel; provide space on each for 25 percent additional conduits.

C. In areas where raceway systems are exposed and acoustical or thermal insulating material is to be installed on walls, partitions, and ceilings, raceways shall be blocked out proper distance to allow insulating material to pass without cutting or fitting. Also provide Kindorf galvanized steel channels to serve as standoffs for panels, cabinets and gutters.

D. Securely fasten conduits, supports and boxes, to ceiling (not roof deck), walls, with Rawl Plugs or approved equal anchors. Use lead cinch anchors or pressed anchors. Use only cadmium plated or galvanized bolts, screws. Plastic anchors and lead anchors shall not be used for overhead applications.

E. Provide separate raceway systems for each of the following when specified, indicated or required:
1. 120/208 volt circuits
2. 277/480 volt circuits
3. Emergency

a. Life safety branch
b. Critical branch
c. Equipment branch

4. Voice/Data
5. Sound reinforcement
6. Theatrical and Architectural Dimming Controls
7. MATV/CATV
8. Security CCTV
9. Security System
10. Communications / PA Systems / Sound System Line Input and Speakers
11. Fire Alarm
12. Lighting and Building Management Control Systems

F. Unless shown otherwise, do not install conduit in or below concrete building slabs.

G. Unless shown otherwise, do not install conduit horizontally in concrete slabs.

H. Roof penetrations shall be made in adequate time to allow the roofing installer to make proper flashing. Conduit for equipment mounted on roof curbs shall be routed through the roof curb. Conduit, gutters, pull boxes, junction boxes, etc. shall not be routed on roof unless specified otherwise. Where specifically indicated to be routed or mounted on the roof, supports shall be as specified, as recommended by roofing manufacturer and roof support manufacturer and as required by NEC. Place supports every five feet along conduit run and within 3 feet of all bends, condulets, and junction boxes. Provide roofing pad under stands at directed by Architect and as recommended by roofing manufacturer and roof support manufacturer. Provide additional unistrut supports and accessories as required.

I. PVC coated conduit shall have all nicks and cuts to the protective coating repaired using manufacturer's approved touch-up material as recommended by manufacturer. Provide a minimum of two-wraps of 3M-50 type tape over touch-up.

J. Installation of the PVC Coated Conduit System shall be performed in accordance with the Manufacturer's Installation Manual. To assure correct installation, the installer shall be certified by Manufacturer to install coated conduit. Submit copies of training certification with submittal. Contractor shall coordinate installation with manufacturer's representative for field training and observation of installed PVC coated rigid galvanized conduit and fittings. Manufacturer's representative shall certify the installation is in accordance with manufacturer's installation instructions. Submit copies of installation certification prior to cover-up of underground installation.

K. All conduit terminations at locations including but not limited to, switchgear, pull boxes, outlet boxes, stub-up, and stub-outs:
1. Provide insulated throat connectors for EMT conduits.
2. Provide insulated bushing on all rigid conduit terminations.
3. Provide locknuts inside and outside of all boxes and enclosures.
4. Provide threaded type plastic bushing at all boxes and enclosures

L. In suspended ceilings, support conduit runs from the structure, not the ceiling system construction.
1. Do not support from structural bridging.
2. Do not support from metal roof deck.

M. Completely install each conduit run prior to pulling conductors. All boxes are to be accessible after completion of construction.

N. All conduits must be kept dry and free of water or debris with approved pipe plugs or caps. Cap or plug conduit ends prior to concrete pours.

O. Ream ends of conduits after cutting and application of cutting die to remove rough edges.

P. Install all above concrete slab conduits perpendicular or parallel to building lines in the most direct, neat and workmanlike manner.
   1. Cable Tension:
      a. 0.008 lb./cmil for up to 3 conductors, not to exceed 10,000 pounds.
      b. 0.0064 lb./cmil for more than 3 conductors, not to exceed 10,000 pounds
      c. 1000 lbs. per basket grip.
   2. Sidewall pressure: 500 lbs./ft.
   3. Conduit runs within the following limits of bends and conduit length between pull points shall not exceed the above installation pulling tension and sidewall pressure limits.
      a. Three (3) equivalent 90-degree bends: not more than fifty feet (50') between pull points.
      b. Two (2) equivalent 90-degree bends: not more than one hundred feet (100') between pull points.
      c. One (1) equivalent 90-degree bend: not more than one hundred fifty feet (150') between pull points.
      d. Straight pull: not more than two hundred feet (200') between pull points.
   4. Indicate sizes of conduits, wireway sections, and cable tray sections on the as-built drawings.
   5. Hold horizontal and vertical conduits as close as possible to walls, ceilings and other elements of the building construction. Conduits shall be kept a minimum of 6 inches clear of roof deck / insulation, and 2 inches clear of above floor deck / insulation.
   6. Install conduits to conserve building space and not obstruct equipment service space or interfere with use of space. Conduit shall not be routed on floors, paved areas or grade.
   7. Where a piece of equipment is wired from a switch or box on adjacent wall, the wiring shall go up the wall from the box, across at or near the ceiling, and back down to the equipment. Wiring shall not block the walkway between wall and equipment.
   8. Horizontal runs of conduit on exposed walls shall be kept to a minimum.
   9. Conduit for mechanical / plumbing equipment installed outdoors shall be routed with the associated mechanical / plumbing pipe support rack system where practical, coordinate with Divisions 22 and 23.
   10. Conduits installed in public areas, not concealed by architectural ceilings, shall be supported by galvanized steel channel racks to bottom of roof deck or floor deck. Conduits shall be grouped for neat workman-like appearance.

Q. Install expansion and deflection fittings and bonding jumpers on straight runs which exceed 200-feet, on center, and at 200-feet maximum, on center, on straight runs which exceed 400-feet, and where conduits cross building expansion joints.

R. Provide grounding bushings at concentric/eccentric knockouts or where reducing washers are used.

S. Run conduit to avoid proximity to heat producing equipment, piping surfaces with temperatures exceeding 104 degrees F., and flues, keeping a minimum of 13-inches clear.

T. Install conduit as a complete system, without conductors, continuous from outlet to outlet and from fitting to fitting. Make up threaded joints of conduit carefully in a manner to

ensure a tight joint. Fasten the entire conduit system into position. A run of conduit between outlet and outlet, between fitting and fitting, or between outlet and fitting shall not contain more than the equivalent of four quarter bends, including those bends located immediately at the outlet or fitting.

U. Conceal conduit systems in finished areas. Conduit may be exposed in mechanical and electrical rooms, and where otherwise shown or indicated only. Run the conduit parallel and perpendicular to the structural features of the building and support with malleable iron conduit clamps at intervals as required by NEC or on conduit racks, neatly racked and bent in a smooth radius at corners.

V. Conduit bends shall be factory elbows or shall be bent using equipment specifically designed to bend conduit of the type used to maintain the conduit's UL listing. Conduit hanger spacing shall be 10 feet or less and as required by the NEC for all conduit. Beam clamp attachments to steel joist chords is prohibited. Beam clamps may only be used at beams, no exceptions. Connections to joists shall be made with galvanized channel extended between joist chords or with galvanized channel bearing on the vertical legs of joist chord angles.

W. Support conduit on galvanized channel, using compatible galvanized fittings (bolts, beam clamps, and similar items), and galvanized threaded rod pendants at each end of channel and secure raceway to channel and channel to structure. Where rod pendants are not used, channel supports are to be secured to structure at each end. Conduit supports are to be secured to structure using washers, lock washers, nuts and bolts or rod pendants; use of toggle bolt "wings" are not acceptable. Support single conduit runs using a properly sized galvanized conduit hanger with galvanized closure bolt and nut and threaded rod. Raceway support system materials shall be galvanized and manufactured by Kindorf, Unistrut, Superstrut, Caddy, or Spring Steel Fasteners, Inc. Provide chrome or nickel-plated escutcheon plates on conduit passing through walls and ceilings in finished areas. Do not support conduit from other conduit, structural bridging or fire rated ceiling system. Do not support more than one conduit from a single all-thread rod support. Provide electrical insulating sleeve or wrapping for aluminum conduit supported by zinc coated supports or fasteners. Channel supports shall have cut ends filed smooth. When installed outside of the building, or in areas subject to moisture, the cut ends shall be painted with ZRC galvanized paint or equivalent.

X. Terminate all motor connection conduits in mechanical room spaces with a floor pedestal and with "Tee" conduit at motor outlet height for flexible conduit.

Y. Where conduit is not embedded in concrete or masonry, conduit shall be firmly secured by approved clamps, half-straps or hangers. Tie wire and short pieces of conduit used as supports and or hangers are not approved.

Z. Where "LB" condulets are used, 2-inches and larger shall be type "LBD".

AA. No more than 12 conduits containing branch circuits may be installed in junction boxes, pull boxes or gutters.

BB. Flexible metal conduit and liquid tight flexible metal conduit shall only be used for final connections from junction box to equipment, light fixtures, power poles, etc. They are not to be used in lieu of conduit runs. They shall not be used for wall or roof penetrations unless they are installed in a PVC coated RGC conduit sleeve at least one size larger than the OD of the flexible conduit.

CC. Where 3-1/2-inch conduit is specified and the required or specified material is Schedule 80 PVC, provide 4-inch conduit.

DD. “Daisy Chaining” light fixtures installed for lay-in ceiling areas is not allowed. Each light fixture shall have its own fixture whip from junction box. The only exception being light fixtures installed end to end using chase nipples between them, or light fixtures recessed in non-accessible ceilings.

EE. In above ceiling applications, do not install raceways, junction boxes, gutters, disconnects, etc. within 36 inches directly in front of HVAC control boxes or other equipment requiring access from a point starting from the top of control box / equipment down to ceiling.

FF. Do not install conduit, junction boxes, etc. within 18 inches of outside edges of roof access openings.

GG. Install minimum size 2-inch nipple, at least one, between multi-sectional panels for branch circuit independent of feeder conductors.

3.2 CONDUITS

A. Conduit above grade indoors:
   1. Concealed Conduits: EMT with set screw fittings
   2. Exposed conduits:
      a. Below nine feet AFF where not directly attached and against building walls, ceiling, or structure: Rigid metal conduit or x-wall RTRC.
      b. Where subject to physical damage: Rigid metal conduit or x-wall RTRC.
      c. Wet locations: PVC coated galvanized rigid steel or aluminum conduit
      d. Damp Locations: Aluminum rigid conduit or x-wall RTRC.
      e. Exposed conduits in mechanical rooms or electrical rooms shall be rigid galvanized steel or x-wall RTRC when installed below 18-inches above finished floor.

B. Conduit installed above grade outdoors:
   1. Galvanized rigid steel or x-wall RTRC for conduits up utility poles and where subject to physical damage or where located less than four feet above finished floor.
   2. Aluminum or x-wall RTRC where not subject to physical damage and where located four feet above finished floor.

C. Conduit where indicated underground:
   1. PVC Coated Galvanized rigid steel or RTRC conduit elbows and Schedule 80 PVC, RTRC, or PVC coated galvanized steel straight run conduits. PVC conduits for underground branch circuits shall be Schedule 80 or Schedule 40 PVC.
      a. PVC conduit and fittings shall be used only for straight horizontal runs and for vertical risers at site lighting pole bases. Bending straight sections of PVC conduit to less than 25-foot radius or the use of PVC factory bends is not allowed.
      b. Change in direction of conduit runs, either vertical or horizontal, shall be with RTRC or PVC coated galvanized steel elbows or long sweep bends of straight PVC conduit sections. Long sweep bends of straight PVC 20-foot sections shall have a minimum radius of curvature of 25 feet and a maximum arc of 22.5degrees. Multiple long sweep bends of straight PVC sections shall be separated by a minimum of 20-feet of straight, linear, PVC sections.
      c. Provide RTRC or PVC coated rigid galvanized steel conduit elbows and fittings with urethane interior coating at all changes in direction with radius of less than 25-feet and at all vertical runs to 18 inches above

finished floor elevation. For interior slab penetrations, provide continuous RTRC or PVC coated rigid galvanized steel conduit and fittings with urethane interior coating from change in direction to 18 inches above finished floor elevation, except where stubbed-up under and inside equipment or switchgear where conduit shall be terminated at minimum two inches above concrete housekeeping pad.

d. Elbows for underground electrical service entrance, feeders, transformer primary / secondary, telecommunication, and low voltage conduits shall be RTRC or PVC coated rigid galvanized steel with long radius as follows:
   1) Up to 1-inch conduit, minimum 12-inch radius.
   2) 1.5-inch conduit, minimum 18-inch radius.
   3) 2-inch conduit, minimum 24-inch radius.
   4) 2.5-inch conduit, minimum 30-inch radius.
   5) 3-inch conduit, minimum 36-inch radius.
   6) 3.5 to 6-inch conduit, minimum 48-inch radius.

e. Conduit for all floor boxes shall be routed below building slab from floor box to nearest column, wall, or as indicated.

f. Conduits shall not be routed horizontally in building slab, grade beams or pavement.

2. Encase all underground conduits in concrete.
   a. Concrete shall be tinted red throughout with a ratio of 10 pounds of dye per yard of concrete unless prohibited by utility for utility conduits. Concrete encasement for utility installed conductors shall be as specified by the utility and comply with their standards and specifications. Where utility does not require but allows concrete encasement of conduits, provide concrete encasement as specified herein.
   b. Provide minimum 3-inch concrete encasement around conduits.
   c. Provide conduit spacers for parallel branch/feeder conduits.
   d. When prior written approval from Owner and Architect to omit concrete encasement of conduits below building slab is given, conduits either specified or approved in writing to be routed under building slab without concrete encasement for electrical branch circuits or voice / data / video / communications horizontal drops or outlets shall be installed 18 inches below finished floor and on select fill. All other conduits, including but not limited to electrical feeders, voice / data / video / communications vertical, riser, tie, trunk, or service cable conduits shall be installed 48-inches below finished floor and on select fill.
   e. Use suitable manufactured separators and chairs installed 4 feet on centers. Securely anchor conduit at each chair to prevent movement during backfill placement.
3. Install building voice / data / video / communications main service conduits and electrical service transformer primary and secondary conduits with top of concrete encasement minimum 48-inches below finished grade or pavement. Voice / data / video / communications conduits and electrical service primary conduits for utility owned electrical service transformers shall also comply with the respective utility company requirements and standards. All other underground conduits outside of building other than voice / data / video / communications main service conduits and electrical service transformer primary and secondary conduits shall have top of concrete encasement at 36 inches minimum below finished grade or pavement.
4. Provide two “caution” plastic tapes at 6-inches and 18-inches below finished slab, grade, or pavement; identify as specified in Section 26 05 00.
5. Conduits located outside building, provide magnetic locator tape at top of first compacted layer of backfill or concrete.
6. During construction, partially completed underground conduits shall be protected

from the entrance of debris such as mud, sand, and dirt by means of conduit plugs. As each section of the underground conduit is completed, a testing mandrel with diameter ¼-inch smaller than the conduit, shall be drawn through each conduit. A brush with stiff bristles shall be drawn through until conduit is clear of particles of earth, sand, or gravel. Conduit plugs shall then be installed.

7. Utility underground conduit for Utility Company cable shall be installed per Utility Company standards, and their specifications for this project.
8. Concrete shall be Portland Cement conforming to ASTM-C-150, Type 1, Type III or Type V if specified. Cement content shall be sufficient to product minimum strength of 2,500 PSI.
9. Contractor shall stake out routing and location of underground conduits using actual field measurements. He shall obtain approval of the Owner and Architect before beginning trenching, horizontal drilling, and excavation.
10. Verify location and routing of all new and existing underground utilities with the Owner and Architect on the job site. Stake out these existing utilities so that they will not be damaged. Stake out new utilities to provide coordination with other trades and with new and existing utilities, easements, property lines, restricted land use areas, and right-of-ways. Verify existing public utilities with Call811.

D. Conduit shown in concrete walls, floor or roof slab:
   1. PVC Coated Galvanized Rigid steel.

E. Conduits that penetrate concrete slab, or within 100 feet of cooling towers, or at designated corrosive locations.
   1. RTRC
   2. PVC coated galvanized rigid steel

F. Connections to equipment mounted on roof, rotating equipment, transformers, and kitchen or food processing equipment, or where flexible conduit is required outdoors.
   1. Liquid tight flexible metal conduit (1/2 inch may be used for roof top supply / exhaust fans only)
   2. Liquid tight flexible metal conduit for 24-inch maximum length
   3. Conduit for roof-mounted equipment shall be routed inside the roof curb assembly roof opening. Provide permanent lock-off device at panelboard circuit breakers serving roof equipment and accessories to enable tag-out procedures for all power routed through roof curb and to the roof mounted equipment and accessories.

G. Light fixture whips:
   1. Accessible ceilings and open structure: ½-inch flexible steel conduit or steel MC cable, length not to exceed 6-feet.
   2. Non-accessible ceilings: ½-inch flexible steel conduit. Length as required to make a tap at an accessible j-box. Recessed light fixtures in non-accessible ceilings may be daisy chained using the light fixture's integral, UL listed j-box or internal wire way that is accessible through fixture from below the ceiling.
   3. Dedicated insulated ground wire.
   4. Light fixture whips shall not rest on ceiling grid or tile.
   5. Light fixture whips shall not be supported from the ceiling suspension system. Support from the structure with #13 AWG galvanized iron wire pendants and Caddy clips. Do not support conduit from structural bridging. Flexible conduit and steel MC cable shall be kept a minimum of 2 inches clear of roof deck.

H. Conduits at Natatorium or therapeutic pool areas:
   1. Underground conduit shall be as specified in this section.
   2. Exterior conduits and boxes within 100 feet of exhaust openings shall be x-wall RTRC or PVC coated galvanized rigid steel or stainless steel.

3. Exposed conduits in chemical storage rooms, pool mechanical equipment (pump rooms, and pool equipment storage rooms shall be Schedule 80 PVC. Boxes shall be PVC, or 304 Stainless Steel.
4. Exposed conduits and boxes in indoor pool areas and all other indoor public areas shall be Type 304 Stainless Steel.

I. Conduits located inside greenhouses and natatorium pump and water treatment rooms:
1. X-wall RTRC
2. Schedule 80 PVC
3. PVC coated galvanized rigid steel conduit and fittings.

J. Conduits in classified hazardous (Classified) locations:
1. Conduit fittings and seals UL listed for the classification

K. Conduits embedded in parking structure traffic wearing surface and concrete support structures:
1. Schedule 40 PVC, RTRC, PVC coated rigid galvanized conduit.
2. Schedule 40 ENT may only be used for flat runs embedded in traffic wearing surface concrete topping.
2. Solvent welded fittings only for PVC conduit and ENT.
3. Verify with Structural Engineer prior to construction for any additional limitations for raceway installation restrictions installed in parking structure including but not limited to maximum outside diameter of raceways permitted to be used in the wearing surface, and field cutting or drilling through parking structure structural members or support structures.
4. All raceways shall be securely fastened to prevent floating during concrete installation. ENT raceways shall be completely embedded in concrete material to maintain fire and smoke integratory as required by the NEC.
5. When using ENT or PVC conduits, provide transition to x-wall RTRC or PVC coated rigid galvanized conduit elbows and vertical risers to ensure that only flat horizontal runs of PVC conduit or ENT are used along the top of the parking structure structural support deck and that they are completely concealed and embedded by the wearing surface concrete material topping.

3.3 CONDUIT PENETRATIONS, SLEEVES AND ESCUTCHEONS

A. Furnish sleeves for placing in construction for all conduit passing through concrete or masonry walls, partitions, beams, all floors other than grade level, and roofs. A conduit sleeve shall be one size larger than the size of conduit, which it serves except where larger sizes are required for manufactured water, fire, or smoke stop fittings.
1. Sleeves set in concrete floor construction shall be minimum Schedule 40 galvanized steel.
2. Sleeves shall extend 3-inches above the finished floor.

B. Sleeves in concrete or masonry walls shall be RTRC or Schedule 40 galvanized steel. Sleeves shall be set flush with finished wall.

C. Install manufactured UL listed water, fire, and smoke stop fittings, or caulk around conduit or cables in sleeves with sufficient UL listed fire safe insulation or foam to maintain wall or floor slab fire or smoke rating. Refer to Architecture drawings for locations of rated walls.

D. Provide Linkseal Mechanical Seals around conduit penetrations through walls below grade. Provide a pull box to install a water stop inside wall penetration. Internally seal low voltage cabling conduit penetrations with waterproof caulking.

E. Sleeves penetrating walls below grade shall be Schedule 40 black steel pipe with ¼-inch

thick steel plate secured to the pipe with continuous fillet weld. The plate shall be located in the middle of the wall and shall be 2-inches wider all around than the sleeve that it encircles. The sleeve should extend a minimum of 24-inches on either side of the penetration. The entire assembly shall be hot-dipped galvanized after fabrication. Do not sleeve or penetrate grade beams.

F. Conduit passing through the housing on connected equipment shall pass through a cleanly cut hole protected with a threaded steel bushing. Route conduit through roof openings, for piping and ductwork or through suitable roof jack, with pitch pocket. Coordinate location with roofing installation as required.

G. Conduit passing through fire rated wall shall be sealed with Fire Stop. Route conduit to preserve fire resistance rating of partitions and other elements, using materials and methods under the provisions of Division 7.

3.4 POWER DISTRIBUTION UNDERGROUND FEEDER CONDUIT AND UNDERGROUND SERVICE ENTRANCE CONDUIT

A. Power underground feeder and service entrance shall be of individual conduit encased in concrete. Unless shown otherwise, the type of conduit used shall not be mixed in any one underground conduit and shall be the size indicated on the drawings. The concrete encasement surrounding the underground conduit shall be rectangular in cross-section, having a minimum concrete thickness of 3-inches, except that conduit for 120V and above shall be separated from control and signal conduits by a minimum concrete thickness of 3-inches. Encasement concrete shall be tinted in red.

B. During construction, partially completed underground conduits shall be protected from the entrance of debris such as mud, sand, and dirt by means of conduit plugs. As each section of the underground conduit is completed, a testing mandrel shall be drawn through until each conduit is clear of particles of earth, sand, or gravel. Conduit plugs shall then be installed.

C. Furnish the exact dimensions and location of power underground conduit to be encased in time to prevent delay in the concrete work.

D. Conduit for service entrance underground conduits shall be as indicated on the drawings.

E. Primary power underground conduit shall be installed in accordance with utility company standards and the utility company specifications for this project.

3.5 TELECOMMUNICATIONS, LOW VOLTAGE AND EMPTY CONDUIT SYSTEM RACEWAYS

A. Conduit shall be installed in accordance with the specified requirements for conduit and with the additional requirements that no length of run shall exceed 100-feet for 1 inch or smaller trade sizes and shall not contain more than two 90-degree bends or the equivalent. Pull or junction boxes shall be installed to comply with these requirements. Provide plastic bushings at all conduit terminations. Provide a grounding bushing on each data and voice conduit.

B. Conduits shall be installed from outlet box to above an accessible ceiling. All cables routed through open spaces (no-ceiling below roof deck or above floor deck) shall be routed in conduit. Telecommunications systems, CATV, CCTV, fire alarm and BMCS cables can be installed above accessible ceilings without conduit. Cables installed above accessible ceiling shall be plenum rated. Conduit rough in of these cables shall include a 90-degree turn-out to an accessible location with insulated bushings on the end of the conduit.

1. Provide conduit from each telecommunications outlet box to accessible ceiling plenum.
2. Provide conduit from each security / surveillance device outlet box to accessible ceiling plenum.
3. Provide two conduits for each multi-media outlet box and each outlet box indicated to contain more than four data, audio, or video drops to accessible ceiling plenum.
4. Provide the following minimum conduits for telecommunications and multi-media wall, floor, and ceiling mounted outlet boxes. Use the largest diameter conduit indicated below unless instructed otherwise in writing from the Architect:
    a. Non-masonry outlet box: Two 1-inch conduits.
    b. Masonry outlet box: Two 1-inch conduits, or three 3/4-inch conduits.
    c. Where indicated differently on plans or where conflicts arise, notify the Architect / Engineer prior to installation.

C. All conduit in which cable is to be installed by others shall have pull string installed. The nylon pull string shall have not less than 200 lb. tensile strength. Not less than 12-inches of slack shall be left at each end. Provide blank cover plate before substantial completion if box is for a future installation after substantial completion of the project. Conduit shall extend to a minimum six inches above nearest accessible ceiling and be turned horizontally with plastic bushing at terminations.

3.6 EXTERIOR IN-GRADE PULL BOXES

A. Provide pull boxes where specified and as required.

B. Pull boxes located in pavement shall be set with proper extensions so that top of cover is flush with pavement.

C. Pull boxes located in non-paved areas shall be set two-inches above surrounding finished grade. Provide 12-inch wide by 8-inch deep reinforced concrete crown around neck or opening and sloped down away from pull box opening.

3.7 IDENTIFICATION

A. Conduit Systems: Provide adequate marking of conduit larger than one inch exposed or concealed in interior accessible spaces to distinguish each run as either a power (120/208V or 277/480V) or signal / telecommunication conduit (Fire Alarm, BAS, BMCS, Security, CCTV, Access Control, Intrusion Detection, Telecom, etc.). Except as otherwise indicated, use orange banding with black lettering. Provide self-adhesive or snap-on type plastic markers. Locate markers at ends of conduit runs, near switches and other control devices, near items of equipment served by the conductors, at points where conduit passes through walls or floors or enters non-accessible construction, and at spacing of not more than 50-feet along each run of exposed conduit. Switch-leg conduit and short branches for power connections need not be marked, except where conduit is larger than 1-inch.

END OF SECTION

SECTION 26 05 35 - ELECTRICAL CONNECTIONS FOR EQUIPMENT

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Electrical connections as required and scheduled, and as specified.

1.2 RELATED WORK

A. Refer to other Divisions for specific individual equipment electrical requirements.

1.3 QUALITY ASSURANCE

A. UL Label: Products shall be UL listed to the extent possible.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS

A. General: For each electrical connection indicated, provide a complete assembly including, but not limited to, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, solderless wire nuts, and other items and accessories needed to complete splices and terminations.

B. Raceways: Refer to related sections.

C. Conductors and Connectors: Refer to related section. Conductors at equipment terminations shall be copper.

D. Terminals: Provide electrical terminals as indicated by the terminal manufacturer for the application.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL CONNECTIONS

A. General: Install electrical connections as shown, in accordance with applicable portions of the NECA Standard of Installation, and industry practices.

B. Conductors: Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Where possible, match conductors of the electrical connection for interface between the electrical supply and the installed equipment.

C. Splice Insulation: Cover splices with electrical insulation equivalent to, or of a higher rating than, insulation on the conductors being spliced.

D. Appearance: Prepare conductors by cutting and stripping covering, jacket, and insulation to ensure a uniform and neat appearance where cables and wires are terminated.

E. Routing: Trim cables and wires to be as short as practical. Arrange routing to facilitate inspection, testing, and maintenance.

F. Motor Connections: Where possible, terminate conduit in conduit boxes at motors. Where motors are not provided with conduit boxes, terminate the conduit in a suitable condulet,

and make motor connections. Conduit passing through the housing on connected equipment shall pass through a cleanly cut hole protected with an approved grommet. For all AHU or fan motors and all other motors 10 HP and larger, at the motor connection do not use wire nuts. Provide copper alloy split bolt connectors or compression lugs and bolts. Insulate connection with Scotch Super 88 vinyl electrical tape over rubber tape, or Tyco Gelcap Motor Connection Kit.

G. Conduit connections to equipment including, but not limited to, Variable Frequency Drives, Manual and Automatic Transfer Switches, Surge Suppression Devices, motor controllers, electrical disconnects, food service / processing equipment, electronics, control panels and Owner furnished equipment:
   1. Make conduit penetrations only at the bottom flat surface of the equipment and only where permitted by the equipment manufacturer to avoid un-intentional water entry. Coordinate installation of electrical connections for equipment with equipment installation work. Where equipment manufacture does not permit a bottom conduit entry, verify with Owner/Engineer and locate the conduit entry at the side surface as close as possible to the bottom of the enclosure.
   2. Where conduit originates from an elevation above the conduit entry, provide a “T” condulet below the enclosure’s bottom elevation. Provide conduit from the condulet up to the enclosure bottom horizontal surface for electrical connection.

H. Identification: Refer to Electrical General Provisions for identification of electrical power supply conductor terminations with markers approved as to type, color, letter and marker size by the Architect. Fasten markers at each termination point, as close as possible to each connecting point.

I. Equipment and Furnishings: Refer to other Divisions. Coordinate power and control provisions shown for equipment and furnishings with the provisions required for the furnished equipment and furnishings. Where the power and control requirements are less than or equal to those specified, modifications to power and control provisions shall be made at no cost as a part of coordination. Where power and control requirements are in excess of those shown, notify the Architect in writing of the requirements.

END OF SECTION

SECTION 26 05 37 - ELECTRICAL BOXES AND FITTINGS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide electrical box and fitting work as required, scheduled, indicated, and specified.

1.2 QUALITY ASSURANCE

A. UL Label: Electrical boxes and fittings shall be UL listed.

PART 2 - PRODUCTS– Provide products manufactured in the USA

2.1 FABRICATED MATERIALS

A. Interior Outlet Boxes: Provide galvanized steel interior outlet wiring boxes, of the type, shape, and size, including depth of box, to suit respective locations and installation. Construct with stamped knockouts in back and sides. Provide gang boxes where devices are shown grouped. Single box design; sectional boxes are not acceptable, except for wall mounted electronic displays.
   1. Type of Various Locations:
      a. Wall mounted interactive media boards, video displays, televisions, electronic signage and similar installations; recessed wall mounted box for power and/or multi-media (low voltage) outlets: Arlington Industries #TVBS 613, 4-gang steel box with white trim plate.
      b. Technology, data, voice, video and multi-media outlet boxes at locations other than wall mounted interactive media boards, video displays, televisions, electronic signage and similar installations: minimum 4-inch square (2-gang), 3-inch deep interior outlet boxes. Raco #260H large capacity box with ½ through 2-inch knockouts.
      c. Security, access control, and video surveillance outlet boxes: single gang, 3-inch deep outlet boxes mounted long axis vertically.
      d. All other applications: minimum 4-inch square (2-gang) 2-1/8-inch deep boxes.
      e. Masonry Walls: Galvanized switch boxes made especially for masonry installations; depths of boxes must be coordinated for each installation.
      f. Surface: Type FS or FD box with surface cover.
      g. Corrosive locations or natatorium areas: 316 stainless steel construction suitable for the installation.
      h. Hazardous (Classified) Locations: Explosion proof boxes, seals and fittings.
      i. Special: Where above types are not suitable, boxes as required, taking into account space available, appearance, and Code requirements
   2. Interior Outlet Box Accessories: Outlet box accessories required as for installation, including covers or wall device plates, mounting brackets, wallboard hangers, extension rings, plaster rings for boxes in plaster construction, fixture studs, cable clamps and metal straps for supporting outlet boxes. Accessories shall be compatible with outlet boxes used and meet requirements of individual wiring.

B. Damp Location Outlet and Damp or Wet Location Switch Boxes: Deep type, hot dipped galvanized cast-metal weatherproof outlet wiring boxes, of type, shape, and size required. Include depth of box, threaded conduit ends, and stainless steel cover plate with spring-hinged waterproof caps suitable for application. Include faceplate gasket and corrosion-resistant, tamper / vandal proof fasteners.

C. Wet Location Outlet Boxes: Hot dipped galvanized cast-iron weatherproof outlet wiring boxes, of type, shape, and size required. Include depth of box, threaded conduit ends.

D. Junction and Pull Boxes: Galvanized sheet steel junction and pull boxes, with screw-on covers, of type, shape, and size, to suit respective location and installation.
   1. Type for Various Locations:
      a. Minimum Size: 4-inch square, 2-1/8-inches deep.
      b. 150 Cubic Inches in Volume or Larger: Code gauge steel with sides formed and welded, screw covers unless shown or required to have hinged doors. All boxes mounted above ceiling shall have screw covers. Boxes in all other areas with covers larger than 12-inches shall have hinged with screw covers. Knockouts factory stamped or formed in field with a cutting tool to provide a clean symmetrically cut hole.
      c. Exterior or Wet Areas: 304 stainless steel NEMA 4X construction with gaskets and corrosion-resistant fasteners

E. Conduit Bodies: Provide galvanized cast-metal conduit bodies, of type, shape, and size, to suit location and installation. Construct with threaded conduit ends, removable cover, and corrosion-resistant screws.

F. Bushings, Knockout Closures, and Locknuts: Provide corrosion-resistant punched-steel box knockout closures, conduit locknuts, and insulated conduit bushings of type and size to suit use and installation.

G. Outlet boxes in fire rated walls: Provide 2-hour rated gasket within box and below cover, equal to Rectorseal Metacaulk box guard and cover guard.

PART 3 - EXECUTION

3.1 INSTALLATION OF BOXES AND FITTINGS

A. Install electrical boxes and fittings as shown and as required, in compliance with NEC requirements, in accordance with the manufacturer's written instructions, in accordance with industry practices.

B. Provide recessed device boxes for wall mounted interactive media boards, video displays, televisions, electronic signage and similar installations.

C. Provide minimum 4-inch square (2-gang), 3-inch deep interior outlet boxes for technology, data, voice, video, and multi-media outlet boxes at locations other than wall mounted interactive boards, video or visual displays. Provide single gang only, 3-inch deep outlet boxes mounted long axis vertically for security, access control, and video surveillance, coordinate with security equipment installation. Provide minimum 4-inch square (2-gang) 2-1/8-inch deep boxes for all other applications. Where indicated differently on plans or where conflicts arise, notify the Architect / Engineer prior to installation. Box extenders or plaster rings shall not be used to increase size. Provide increased box size as required.

D. Junction and pull boxes, condulets, gutters, located above grid ceilings shall be mounted within 18-inches of ceiling grid. Junction and pull boxes above grid ceilings shall be mounted in the same room served. Junction boxes and pull boxes required for areas with inaccessible ceilings shall be located above the nearest accessible ceiling area. All junction box or pull box openings shall be side or bottom accessible. Removal of light fixtures, mechanical equipment or other devices shall not be required to access boxes. Outlet boxes above ceiling for low voltage terminations shall face towards the floor.

E. Use outlet and switch boxes for junctions on concealed conduit systems except in utility areas where exposed junction or pull boxes can be used.

F. Determine from the drawings and by measurement the location of each outlet. Locate electrical boxes to accommodate millwork, fixtures, marker boards, and other room equipment at no additional cost to the Owner. The outlet locations shall be modified from those shown to accommodate changes in door swing or to clear interferences that arise from construction as well as modifying them to center in rooms. The modifications shall be made with no cost as part of coordination. Check the conditions throughout the job and notify the Architect of discrepancies. Verify modifications before proceeding with installation. Set wall boxes in advance of wall construction, blocked in place and secured. Set all wall boxes flush with the finish and install extension rings as required extending boxes to the finished surfaces of special furring or wall finishes. Provide wall box support legs attached to stud to prevent movement of box in wall.

G. Unless noted or directed otherwise at installation, place outlet boxes as indicated on architectural elevations and as required by local codes.

H. Outlets above counters, mount long axis horizontally. Refer to architectural elevations and coordinate to clear backsplash and millwork.

I. Provide pull boxes, junction boxes, wiring troughs, and cabinets where necessary for installation of electrical systems. Surface mounted boxes below 9 feet and accessible to the public shall not have stamped knockouts.

J. Provide weatherproof boxes for interior and exterior locations exposed to weather or moisture.

K. Provide knockout closures to cap unused knockout holes in boxes.

L. Locate boxes and conduit bodies to ensure access to electrical wiring. Provide minimum 12-inch clearance in front of box or conduit body access.

M. Secure boxes to the substrate where they are mounted, or embed boxes in concrete or masonry.

N. Boxes for any conduit system shall not be secured to the ceiling system, HVAC ductwork or piping system.

O. Provide junction and pull boxes for feeders and branch circuits where shown and where required by NEC, regardless of whether or not boxes are shown.

P. Coordinate locations of boxes in fire rated partitions and slabs to not affect the fire rating of the partition or slab. Notify the Architect in writing where modification or construction is required to maintain the partition or slab fire rating.

Q. Exterior boxes installed within 50-feet of cooling towers or water treatment areas shall be of 304 stainless steel, weatherproof NEMA 4X construction.

R. Identification: Paint the exterior and cover plates of building interior junction boxes and pull boxes located above accessible ceilings or non-finished areas to correspond to the following colors:
   1. Orange: - 480/277 VAC systems
   2. Light Blue: - 240 VAC three phase delta systems.
   3. Red – All Emergency circuits, regardless of voltage, and fire alarm system.

4. Light Green - 120/208 VAC 3 phase and 120/240 VAC single-phase systems
5. Yellow – Building Management and Control System - BMCS
6. White - Security and Surveillance equipment circuits

S. All box covers shall be labeled with Panel ID and circuit numbers of all circuits available in box using permanent black marker. Boxes containing main feeders are to list where fed from and load (example “MSB to Panel HA”). Information listed is to be legible, markovers are not acceptable. Multi-sectional panel numbers are not to be listed on covers (example “LA2” referring to Panel LA sec. 2 is to be listed as “LA”). Label covers for special applications explaining contents (example “Emerg. Gen. Annunciator controls”, “IDF ground”). Do not attach box covers that have both sides painted or labeled differently. In public areas where boxes are painted same color as room per architect, label inside covers. Boxes that are not used shall be labeled as not used and include panel ID. Example “Not Used Panel LA”. Unused raceways not in sight of panel shall be terminated in a box and labeled not used and include panel identification.

T. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

U. Use flush mounting outlet box in finished areas unless specifically indicated as being used with exposed conduit.

V. Locate flush-mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

W. Do not install flush mounting box back-to-back in walls; provide minimum 6 inches with stud separation. Provide minimum 24 inches with separation in acoustic rated walls.

X. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness. Provide UL listed materials to support boxes in walls to prevent movement. Ensure box cannot be pushed inside wall.

Y. Use stamped steel bridges to fasten flush mounting outlet box between studs.

Z. Install flush mounting box without damaging vapor barriers, wall insulation or reducing its effectiveness.

AA. Use adjustable steel channel fasteners for hung ceiling outlet box.

BB. Do not fasten boxes to ceiling support wires.

CC. Support systems are to hang vertically straight down. All-thread supports, when used, are not to be installed at an angle or bent.

DD. Use gang box where more than one device is mounted together. Do not use sectional box.

EE. Use gang box with plaster ring for single device outlets.

FF. Support outlets flush with suspended ceilings to the building structure.

GG. Mount boxes to the building structure with supporting facilities independent of the conduits or raceways.

HH. Where multiple feeders are in one pull box, conductors shall be wrapped with 3M No. 7700 Arc and fireproof tape.

II. Provide plaster rings of suitable depth on all outlet boxes. Face of plaster ring shall be within 1/8 inch from finished surface.

JJ. Equip boxes supporting fixtures designed to accept fixture studs with 3/8-inch stud (galvanized malleable iron) inserted through back of box and secured by locknut. Boxes not equipped with outlets shall have level metal covers with rust-resisting screws.

KK. Do not mount junction boxes above inaccessible ceilings or in inaccessible spaces. Do not mount junction boxes above ceilings accessible only by removing light fixture, mechanical equipment or other devices. At inaccessible spaces use junction box furnished with light fixture or light fixture wiring compartment UL listed for through wiring.

LL. No more than 12 conduits containing branch circuits may be installed in any junction or pull box.

MM. All junction boxes shall be protected from building finish painters' over spray and from fire proofing overspray. Remove protective coverings when painting and fire proofing are complete.

NN. Bond equipment grounding conductor to all junction and pull boxes.

OO. Do not mount boxes or conduit bodies on walls directly above electrical panels or switchgear located next to walls.

PP. Do not mount boxes or conduit bodies within 18 inches of outside edges of roof access openings.

QQ. Box extenders or plaster rings shall not be used to increase the Code mandated cable capacity of a box. Provide proper size box.

3.2 ADJUSTING

A. Adjust flush-mounting outlets to make front flush with finished wall material.

B. Install knockout closures in unused box openings.

END OF SECTION

SECTION 26 05 50 - FIRESTOPS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide firestop as required, and as specified. Refer to Architectural drawings for all fire and smoke rated partitions, walls, floors, etc.

B. Types: Firestop required for the project includes smokestop.

1.2 QUALITY ASSURANCE

A. UL Label: Firestops shall be UL labeled.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Nelson

B. 3M (Minnesota Mining Manufacturing)

C. Hilti

D. Specified Technologies, Inc.

E. Metacaulk

2.2 MATERIAL AND COMPONENTS

A. General: Except as otherwise indicated, provide firestop manufacturer's standard materials and components as indicated by published product information, designed and constructed as recommended by the manufacturer, and as required for installation.

2.3 FIRESTOP

A. Conduits: Provide a soft, permanently flexible sealant for 1-1/2 to 2 hour rated fireproofing for steel conduits (up to 4" diameter).

B. Low Voltage Cables, Fiber Optic Cable and Innerduct: Provide Specified Technologies, Inc. EZ-Path single, double, or triple pathways as required.

PART 3 - EXECUTION

3.1 INSTALLATION OF FIRESTOPS

A. General: Install firestops in accordance with the manufacturer's installation instructions and industry practices to ensure that the firestops comply with requirements. Comply with UL and NFPA standards for the installation of firestops.

END OF SECTION

SECTION 26 09 25 - ELECTRICAL CONTACTORS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Miscellaneous electrical contactors as shown, required, scheduled, and specified.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Provide products produced by one of the following:
Schneider Electric - Square D
ABB-General Electric
Siemens
Eaton

2.2 CONTACTORS

A. Provide contactors as shown, required, and specified. The number of poles, ampere-ratings, and pole arrangements shall be as required. Contactors shall conform to the following:
1. Rated for continuous duty at full rated current in an unventilated enclosure. Eight-hour duty ratings are not acceptable.
2. Contacts shall be readily replaceable, self-aligning, silver alloy.
3. Load contactors shall be rated for not less than 30A continuous rating. Auxiliary contacts shall be rated for not less than 10 amperes.
4. Contactors rated for lighting and mixed loads shall have an interrupting capacity of 150% of their continuous duty rating.
5. Contactors shall be capable of successfully handling inrush currents at 20 times rating.
6. Provide a minimum of two spare load contacts on each individual contactor rated 60A or less for future use.

B. Electrically-held Devices shall conform to the following:
1. AC operated units shall have laminated low loss electrical steel core pieces with machine ground pole faces and shading coils.
2. Units rated at 300A and above shall have DC operating coils and include the necessary rectifier for the AC/DC operation.
3. Normally open contactors shall be spring-loaded open and magnetically closed.
4. Contactors for emergency lighting or power shall be normally closed.

C. Controls: Individual contactors operated by automatic controls shall have 30.5mm HAND-OFF-AUTOMATIC switches, otherwise provide HAND-OFF switches. Contactor controls shall be mounted in the contactor enclosure cover. Contactors serving receptacle loads controlled by local switching shall not have Hand-Off-Auto nor Hand-Off switching.

D. Control Power. Provide dedicated 120-volt circuit for contactor control power and indicator pilot lights. Do not use same circuit feeding load.

E. Enclosure:
1. Contactors and control enclosures installed in indoor locations shall be NEMA 1 heavy-duty enclosures unless shown otherwise.
2. Contactors and control enclosures installed at kitchen and food preparation locations, hose down areas, cooling towers, exterior locations, in greenhouses, and in other corrosive areas shall be NEMA 4X, stainless steel.

F. Minimum interrupting rating shall be 35KAIC.

PART 3 - EXECUTION

3.1 INSTALLATION OF MISCELLANEOUS ELECTRICAL CONTROLS

A. Provide electrically held contactors, with line side wiring complete, in accordance with the National Electrical Code and manufacturer's recommendations.

B. Fuses: Install fuses where coil control power is fed from line side of contactor.

C. Adjustment: Adjust operating mechanisms for free mechanical movement.

D. Coordinate contactor control and operation requirements with the Building Management Control System.

E. Identify each contactor as specified in Section 26 05 00.

F. Contactors shall not be installed above ceiling and shall be readily accessible. Locate contactors in same room as panelboard serving the load unless otherwise indicated.

3.2 INTERIOR AND EXTERIOR LIGHTING CONTROL

A. Parking lot lighting, building mounted exterior lighting, and exterior signage shall be controlled by separate lighting contactors by the specified Building Management and Control System. Interior lighting as noted on the plans shall be controlled as noted on the plans and as specified by the Building Management and Control System. Contractor shall circuit all systems to be controlled by the Building Management and Control System through contactors compatible with system controls and shall ensure the control and operation of lighting control system is complete.

B. Provide mechanically held contactors where control is three-wire, momentary control signal.

C. Provide electrically held contactors where control is two-wire, constant control signal for open or close.

D. Provide normally closed contactors for emergency lighting and power circuits where contactors are indicated or required.

E. Provide normally closed contactors for circuits controlled by "emergency power off" or teacher control switches in science classrooms, computer labs, and vocational instructional areas.

F. Provide control contactors and cabling for bi-level or tri-level LED drivers. Bi / tri level control contactors for exterior lighting shall be controlled by the Building Management Control System, with local BMCS manual override for both "ON" and "HIGH" settings. Bi / tri level controls for interior lighting shall be controlled by occupancy sensors and local control switch.

END OF SECTION

SECTION 26 09 44 - LIGHTING CONTROLS

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Lighting control system and components:
   1. Touch panel controls
   2. Low and line voltage wall stations
   3. Power interfaces
   4. Sensors

1.2 SUMMARY

A. The lighting control system specified in this section shall provide manual lighting control, sensor-based (both occupancy and daylight control when indicated, specified, or required by AHJ.

B. The system shall be capable of turning lighting and plug loads on/off as well as dimming lights (if lighting load is capable and indicated to be dimmed). Dimmers shall be capable of smooth dimming lights to off.

C. All system devices within a group or controlled area shall be networked together, enabling wired or wireless digital communication between devices within that group.

D. The system architecture shall be stand-alone groups (areas) of devices.

E. The system shall not require any centrally hardwired switching equipment.

F. The system shall be capable of wireless, wired, or hybrid wireless/wired communication architectures. All powered devices shall be wired for power. Battery operation shall not be used unless specifically indicated on the drawings, typically due to existing conditions which prohibit wired power sources.

G. The term “occupancy sensor” shall be interchangeable with the term “vacancy sensor” as the control hardware shall be the same device and be capable of either function.

1.3 SUBMITTALS

A. Specification line-by-line compliance review consisting of a marked-up copy of these specifications with contractor comments. Refer to Submittals specification section for additional instructions.

B. Product Datasheets (general device descriptions, dimensions, electrical specifications, wiring details, nomenclature)

C. Riser Diagrams – typical per room type (detailed drawings showing device interconnectivity of devices)

D. Other Diagrams – as needed for special operation or interaction with other system(s)

E. Example Contractor Startup/Commissioning Worksheet – must be completed prior to factory start-up and commissioning.

F. Hardware Operation Manuals

G. Other operational descriptions as needed.

1.4 PROJECT CLOSEOUT DOCUMENTATION

A. Provide a factory published manual
   1. Warranty
   2. Technical support contact
   3. Electronic manual on manufacturer's website for free download

B. Completed Startup/Commissioning Worksheet with Owner's acceptance and date clearly noted.

1.5 QUALITY ASSURANCE

A. All components and the manufacturing facility where product was manufactured must be RoHS compliant.

B. In high humidity or cold environments, the sensors shall be conformably coated and rated for condensing humidity and -40 degrees Fahrenheit (and Celsius) operation.

C. All applicable products must be UL or ETL Listed or other acceptable national testing organization.

1.6 PROJECT CONDITIONS

A. Only install equipment after the following site conditions are maintained:
   1. Ambient Temperature 14 to 105 degrees F (-10 to 40 degrees C).
   2. Relative Humidity less than 90% non-condensing.

B. Standard electrical enclosures shall be permanently installed.

C. Equipment shall be protected from dust, debris and moisture.

1.7 WARRANTY

A. Five (5) year manufacturer's warranty parts replacement beginning upon completion of Factory Start-up and Commissioning date as noted on the Owner accepted Startup / Commissioning Worksheet.

1.8 MAINTENANCE & SUSTAINABILITY

A. Provide new parts, upgrades, and/or replacements available for a minimum of 5 years available to the end user.

B. Provide free telephone technical support.

C. Spare Parts: Provide minimum of 1 unit up to 5% of each hardware device product used, whichever is greater.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
   1. Acuity Brands Lighting, Inc.
   2. Legrand North America, LLC

3. Eaton Corporation, PLC
4. Douglas Lighting Controls
5. Lutron - Athena

2.2 SYSTEM REQUIREMENTS

A. System shall have an architecture that is based upon three main concepts; 1) intelligent lighting control devices 2) standalone lighting control zones. Intelligent lighting control devices shall consist of one or more basic lighting control components; occupancy sensors, photocell sensors, relays, UL 924 emergency lighting relays, dimming outputs, manual switch stations, manual dimming stations. Combining one or more of these components into a single device enclosure is be permissible so as to minimize overall device count of system.

B. Lighting control zones shall consist of one or more intelligent lighting control components and fully functional in stand-alone operation.

C. Low voltage devices within a lighting control zone shall be capable of being connected with low voltage cabling in any order.

D. Lighting control zone shall be capable of automatically configuring itself for default operation without any start-up labor required.

E. Power for devices within a lighting control zone shall come from either resident devices already present for that zone. Standalone power supplies are not acceptable.

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 remotely located devices such as panels) to facilitate system robustness and minimize wiring requirements.

G. Individual lighting zones requiring or indicated with intelligent room controllers shall be capable of being segmented into several local channels of occupancy, photocell, and switch functionality for more advanced configurations and sequences of operation.

H. Operating modes shall be utilized only in manners consistent with local energy codes. Where daylight controls are indicated or required the photocell functions noted below shall be incorporated.
   1. Auto-On / Auto-Off (via occupancy sensors)
      a. Zones with occupancy sensors automatically turn lights on when occupant is detected.
      b. Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
      c. Pressing a switch will turn lights off. The lights will remain off regardless of occupancy until switch is pressed again, restoring the sensor to Automatic On functionality.
   2. Manual-On / Auto-Off (also called Semi-Automatic or Vacancy)
      a. Pushing a switch will turn lights on.
      b. Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
   3. Auto On / Predictive Off
      a. Zones with occupancy sensors automatically turn lights on when occupant is detected.
      b. Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
      c. Pressing the switch will turn the lights off and a short “exit timer” begins. After the timer expires, sensor scans the room to detect whether occupant

is still present. If no occupancy is detected, zone returns to auto-on. If occupancy is detected, lights must be turned on via the switch.

4. Auto ON at 50% or less / Auto Off (Occupancy with dimming)
   a. Operating mode designed specifically IECC compliance using occupancy mode for specific areas.
   b. Zones with occupancy sensors automatically turn lights on to maximum 50-percent (adjustable and programmable to 50-perecent max) when occupant is detected.
   c. Pushing a switch will raise or lower light levels.
   d. Zones with occupancy and/or photocell sensors turn lights off when vacancy or dim accordingly when daylight is detected to maintain desired light level.
   e. Pushing a switch will turn lights off.
5. Manual-On to Auto-On/Auto-Off
   a. Pushing a switch will turn lights on.
   b. After initial lights on, zones with occupancy and/or photocell sensors turn lights on/off according to occupancy/vacancy and/or daylight conditions.

2.3 INDIVIDUAL DEVICE SPECIFICATIONS

A. Occupancy sensors:
   1. Occupancy sensors shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
   2. Only passive infrared (PIR) technology, which detects occupant motion, shall be used to initially turn lights on from an off state, thus preventing false on conditions.
   3. Dual technology sensors shall be used. Only where ultrasonic or microphonic technology might create a false occupied state, not allowing the lights to automatically turn off shall PIR only be used. Acceptable dual technology includes PIR/Microphonics technology (also known as Passive Dual Technology or PDT) which both looks for occupant motion and listens for sounds indicating occupants or PIR/Ultrasonic technology.
   4. Sensors shall include a minimum of one integrated dry contact switching relay, capable of switching 1 amp at 24 VAC/VDC (resistive only) for BAS/BMCS control.
   5. Sensors shall be available in multiple lens options which are customized for specific applications.
   6. Embedded luminaire sensors shall be capable of both PIR and Dual Technology occupancy detection. Embedded sensors shall have an optional photocell.
   7. Ceiling, fixture, recessed, & corner mounted sensors shall be available.
   8. Sensors shall have optional features for photocell/daylight override, dimming control, and low temperature/high humidity operation.

B. Daylight (photocell and/or dimming) sensors:
   1. Photocell shall provide for an on/off set-point, and a deadband to prevent the artificial light from cycling. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.
   2. Photocell and dimming sensor's set-point and deadband shall be automatically calibrated through the sensor's microprocessor by initiating an "Automatic Set-point Programming" procedure. Min and max dim settings as well as set-point may be manually entered.
   3. Deadband setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, luminaire depreciation, or luminaire outages).
   4. Combination units that have all features of on/off photocell and dimming sensors may be used
   5. Luminaire mounted dimming photocells shall be embedded into luminaire such that only the lens shows on luminaire face.

C. Power (Relay) Packs:
1. Power Packs shall incorporate one Class 1 relay, a 0-10 VDC dimming output, and contribute low voltage power to the rest of the system.
2. Power Packs shall accept 120 or 277 VAC, rated for a minimum 16 Amps for any type of lighting load or motor load rated to 1 HP, provide 0-10 VDC dimming control, be plenum rated, and provide Class 2 power to the system.
3. Every Power Pack parameter shall be available and configurable locally.
4. Power Pack shall securely mount to junction location through a threaded ½ inch chase nipple or be capable of being secured within a luminaire ballast channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.
5. When required by local code, Power Pack shall install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.
6. Secondary Packs shall be available that provide up to 5 Amps of switching and can line voltage dim 120 VAC incandescent/halogen lighting loads.
7. Secondary Packs shall be available that provide up to 5 Amps of switching and can dim line voltage 120/277 VAC magnetic low voltage transformers.
8. Secondary Packs shall be available that provide up to 4 Amps of switching and can dim 120 VAC electronic low voltage transformers.
9. Power/Secondary Packs shall be available that are UL924 listed for switching of Emergency Power circuits and control of 0-10 VDC dimming circuit.
10. Secondary Packs shall be available that control louver/damper motors for skylights.
11. Secondary Packs shall be available that provide a pulse on/pulse off signal for purposes of controlling shade systems via relay inputs.
12. Power (Secondary) Packs shall be available that provide up to 20 Amps switching of general purposed receptacle (plug-load) control.

D. Relay & Dimming Room Controller (Panel)
1. Panel shall incorporate up to 3 normally closed latching relays capable of switching 120/277 VAC or up to 2 Dual Phase relays capable of switching 208/240/480 VAC loads.
2. Relays shall be rated to switch up to a 30A ballast load at 277 VAC.
3. Panel shall provide one 0-10VDC dimming output paired with each relay.
4. Panel shall power itself from an integrated 120/277 VAC supply.
5. Panel shall supply current limited low voltage power to other devices in the same lighting zone.
6. Panel shall provide auxiliary low voltage device power connected wired directly to a dedicated terminal connection.

E. Auxiliary Input / Output (I/O) Devices for enhanced room controls:
1. Devices shall be plenum rated and be inline wired, screw mountable, or have an extended chase nipple for mounting to a ½" knockout.
2. Specific I/O devices shall have a dimming control output that can control 0-10 VDC LED drivers by sinking up to 20 mA of current.
3. Specific I/O devices shall have an input that reads a 0-10 VDC signal from an external device.
4. Specific I/O devices shall have a switch input that can interface with either a maintained or momentary switch and run a switch event (toggle the lighting load) or run a local/remote control profile.

5. Specific I/O devices shall sense state of low voltage outdoor photocells.
6. Specific I/O devices shall enable RS-232 communication between lighting control system and Touch Screen based A/V control systems.
7. Specific I/O devices shall sense momentary and maintained contact closures, and either toggle a connected load after a momentary contact or ramp the load high/low during a maintained contact (stopping when the contact releases).

F. Low Voltage Wall Switches & Dimmers:
1. Devices shall provide toggle on/off switch control.
2. Devices color shall match building standard line voltage wiring device color.
3. Devices with mechanical push-buttons shall provide tactile with LED user feedback.
4. Devices with mechanical push-buttons shall be made available with custom button labeling

G. Graphic Wall Station:
1. Minimum 3.5-inch full color touch screen for selecting up to 16 programmable lighting control preset scenes or acting as up to 16 on/off/dim control switches.
2. Color shall match building standard for line voltage switching.
3. Device shall enable configuration of all switches, dimmers, and lighting preset scenes via password protected setup screens.
4. Device shall enable user supplied .jpg screen saver image to be uploaded.
5. Surface mount to single-gang recessed switch box.
6. Micro-USB style connector for local computer connectivity.

H. Scene Controllers:
1. Two, three, four, or eight buttons for selecting programmable lighting control profiles or acting as on/off switches.
2. Color shall match building standard for line voltage switching.
3. Devices shall provide LED user feedback.
4. Device shall be capable of reprogramming other devices in its zone so as to implement user selected lighting scene.
5. Device shall have LEDs indicating current selection.

2.4 START-UP & SUPPORT FEATURES

A. To facilitate start-up, all devices daisy-chained together shall automatically be grouped together into a functional lighting control zone.

B. All lighting control zones shall be able to function according to default settings once adequate power is applied and before any field programming is performed.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide the quantity of sensors required for complete and proper coverage to completely cover the controlled areas. Contractor shall verify room coverage and ceiling heights with manufacturer and provide the quantity and type of occupancy sensors as required. Rooms shall have one hundred (100) percent coverage of small motion detection to completely cover the controlled areas to accommodate all occupancy habits of single or multiple occupants at any location within the room(s). The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only rooms that are to be provided with sensors. Proper judgment must be exercised in executing the work so as to ensure the best possible installation in the available space and to overcome local difficulties due

to space limitations or interference of structural components, architectural components, or Owner installed equipment which may cause obstructions to sensor coverage.

B. Provide ceiling mounted sensors. Wall mounted sensors shall only be used where ceiling mounted sensors are proven by the manufacturer to be impractical, or if specifically indicated on the drawings.

C. For ceilings up to 12-feet AFF, control equipment shall be mounted above an accessible ceiling. Control equipment shall be wall mounted on 24x24-inch fire resistive 0.75-inch thick plywood back board mounted to the wall above the ceiling. Do not paint fire resistive plywood or obliterate the fire resistive labeling. Locate the control equipment directly above the space/area main entry wall switch station, observing good installation practice and shall be consistent throughout the project. Where the ceiling is over 12-feet, the control equipment shall be located in an adjoining ancillary room/area where the ceiling is 12-feet AFF or lower, typically adjacent to the ancillary room/area above ceiling control equipment location, verify exact location with Owner.

D. Control units used for the security or fire systems shall be powered from the emergency power source as indicated on the drawings. Other control units shall be powered from the lighting circuit, which they control.

E. Refer to other specification sections for line voltage wiring device requirements, including momentary on/off toggle switches used with low voltage sensors.

3.2 INSTALLATION

A. Use lighting control wiring with jacket color that matches Owner’s cable color standards.

B. Install the work of this Section in accordance with manufacturer’s printed instructions unless otherwise indicated.

C. The installing electrical contractor shall complete, prior to request of factory start up and site commissioning, complete installation of all devices, their respective loads landed and confirmed operations, switches installed, and confirmed operational.

D. The installing contractor shall, prior to request of factory start up and site commissioning, request an on-site meeting by including the manufacture’s local authorized representative, the Owner and the general contractor, to assist in identification of any open-ended issues, thereby eliminating potential for delays and system commission interruptions.

E. Upon confirmation of progress by local factory representative, the installing electrical contractor shall complete the manufacture’s start up request form(s), including any field changes from the contract documents.

F. The installing electrical contractor shall provide a preliminary as-built drawing prior to commissioning to the manufacturer’s representative. Drawing shall include all wire routing, room by room device ID’s and locations of all lighting control devices.

G. Install sensors in accordance with manufacturer's written instructions, requirements of NEC, and in accordance with industry practices. Do not install devices until wall construction and wiring is completed.

H. Install sensors and switches only in electrical boxes that are clean, free from excess building materials, debris, and similar matter.

I. Install sensors plumb and aligned in the plane of the wall, or ceiling in where they are installed.

J. Install wall occupancy sensor switches in boxes on the strike side of doors as hung. Where more than one switch is in the same location, install switches in a multi gang box with a single cover plate.

K. Provide a cover plate for every switch. Refer to Architectural drawing, elevations, etc. for exact location of wall switches where indicated on the Architectural plans. Coordinate location of all wall switches with other specialty items and millwork and avoid conflicts. Coordinate with all trades to avoid conflicts during construction. Mounting heights of all switches shall comply with current Accessibility Standards and local codes.

L. Unless indicated otherwise, circuit relays/switchpacks ahead of local control switches. Source –> relay/switchpack –> local toggle switch(s).

M. Coordinate with BMCS/BAS Contractor for interface of BMCS/BAS System and wiring connections.

N. Low voltage cabling installed above ceiling shall be supported every 5 feet at a minimum height of 3 feet above grid/ceiling but no closer than six inches below deck. Support system shall be ceiling wire attached to structure and clipped to ceiling support grid using Caddy drop wire securing clip #EC311. Cabling shall hang plumb to devices.

3.3 SENSOR TESTING AND ADJUSTMENT

A. At the time of installation, the contractor shall test and adjust each sensor for proper detection of motion appropriate to room usage. The contractor shall follow the testing and adjustment procedures as written in the manufacturer's installation instructions for each sensor model. Relocate sensors as needed for proper coverage.

B. Prior to testing and adjusting, verify with Owner/Architect the initial settings for each type of area based on its intended function and use.

C. Verify with Owner all adjustable functions of each type of occupancy sensor prior to installation. Set all adjustable functions of each type of occupancy sensor as directed by Owner. Initial settings unless directed by Owner / Architect (some settings may not apply to all sensors):
1. Time delay = 10-miniutes
2. Zero Time Delay = OFF
3. Auto-On = OFF
4. Manual-On = ON
5. Self-Adjust = OFF
6. Disable Self-Adjust = OFF
7. Energy Saver (Dual Level) = ON
8. Manual Override = OFF

D. Bi-level occupancy wall switches shall be initially set with the energy saver feature enabled.

E. Before energizing, check for continuity of circuits, short circuits, and grounding connections. After energizing, check devices to demonstrate proper operation.

F. Operate each wall switch with circuit energized and verify proper operation

3.3 FACTORY COMMISSIONING

A. Upon completion of the installation, the system shall be commissioned by the manufacturer's factory authorized representative who will verify a complete fully functional system.

B. The factory commissioning shall include the following services. Programming of all button stations, configuration and of all occupancy sensors and photocells.

C. Provide written or computer-generated documentation on the commissioning of the system including room by room description including:
   1. Sensor parameters, time delays, sensitivities, and daylighting set points.
   2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
   3. Load Parameters

D. The electrical contractor shall provide in writing to the manufacturer, General Contractor, Architect, and the Owner with 21 Owner’s business days’ written notice of the requested system startup and adjustment date.

E. The electrical contractor shall provide at least (1) journeyman electrician familiar with the installation of the system dedicated to assisting the factory start-up technician for the entire duration of the commissioning process.

F. Upon completion of the system commissioning the factory-authorized technician shall provide the proper training to the Owner's personnel on the adjustment and maintenance of the system.

G. Re-commissioning – After 90 days from full certificate of occupancy, re-calibrate all sensor time delays and sensitivities to meet the Owner’s Project Requirements. Provide a detailed report to the Architect / Owner of re-commissioning activity.

END OF SECTION

SECTION 26 19 13 - COMBINATION MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Motor controller work as required, scheduled and specified.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Schneider Electric - Square D

B. ABB-General Electric Co.

C. Siemens

D. Eaton

2.2 MOTOR CONTROLLERS

A. General: Combination motor controllers shall consist of an integrally mounted, thermal magnetic or magnetic only circuit breaker disconnect or fused disconnect switch as specified in Section 26 24 25. Magnetic, full voltage non-reversing (FVNR) or two speed controller as required, in a heavy duty type, dead front enclosure, surface-mounted; size and number of poles as required. Controllers shall be constructed and tested in accordance with NEMA Standards. Refer to Division 23 for Variable Frequency Inverter furnished by Division 23, installed by Division 26. Minimum controller size shall be NEMA Size 1.

B. Contacts: Magnetic controller contacts shall be silver alloy, and not require any filing, dressing, or cleaning for the life of the controller.

C. Operating Coils: Operating coils shall be 120V, pressure molded and designed so that accidental exposure to excessive voltage up to 480V will not damage the coil. Design controller so that when a coil fails due to over voltage, the controller shall open, and not freeze in the closed position.

D. Overload Relays: Controllers shall have manual-reset, trip-free, solid state, overload relays in each phase conductor. Three phase FVNR controllers shall have three overload relays. Single-phase FVNR controllers shall have an overload relay in each ungrounded conductor. Two speed, full-voltage magnetic controllers shall have overload relays for all six ungrounded conductors. Overload relays shall not be field-convertible from manual to automatic reset. Provide reset button located in front cover to reset all overload relays.

E. LED Pilot Lights: Provide 30.5mm run and stop pilot lights for all motor controllers. Furnish additional pilot lights for motor controllers as shown. Provide FAST and SLOW pilot lights for two-speed controllers. Pilot lights shall be mounted in the controller enclosure cover. Pilot lights shall be operated from an interlock on the motor controllers, and not be wired across the operating coil.
   Green - Stop
   Red - Run
   Yellow - Slow
   Blue - Fast

F. Controls: Controllers shall have 30.5mm HAND-OFF-AUTOMATIC switches. Provide for

FAST-SLOW, REMOTE-LOCAL speed selection from HVAC control system for two-speed controllers. Two-speed controllers shall have deceleration relays between fast and slow speeds. Coordinate motor controller controls with the requirements of Division 23. Motor controller controls shall be mounted in the controller enclosure cover. Control switches shall be un-keyed rotary switches.

G. Control Power: A single phase control power transformer shall be included with each controller for 120V control power. The primary shall be connected to the line side of the motor controller through two fuses; the secondary shall have one leg fused and one leg grounded. Arrange transformer terminals so that wiring to terminals is not located above the transformer.

H. Auxiliary Contacts: Each controller shall have two normally open and two normally closed nonconvertible auxiliary contact in addition to the number of contacts required for the holding interlock and control wiring. One or more additional auxiliary contacts can be field installed without removing existing wiring, or removing the controller from its enclosure.

I. Phase Failure Monitors: Provide a 3-phase failure monitor for each motor controller. Monitor on any or all phases, for phase reversal from A-B-C sequence, under/over voltage, and phase failure. Provide adjustable relay for trip range. Provide automatic reset upon restoration of power to all phases. Where solid state overload relays provide this specified requirement, separate phase failure relays may be omitted.

J. Unit Wiring: Unit shall be completely pre-wired to terminals to eliminate any interior field wiring except for: connection of power supply conductors to switch line side terminals; motor leads to the controller load side terminals; and control conductors to holding coil terminals.

K. Enclosure:
1. Motor Controllers installed in indoor locations shall be NEMA 1 heavy duty enclosures unless shown otherwise.
2. Motor Controllers installed at kitchen and food preparation locations, hose down areas, cooling towers, exterior locations, and in other corrosive areas shall be NEMA 4X, Type 316 stainless steel.

L. Minimum interrupting rating shall be 35KAIC.

2.3 MANUAL MOTOR CONTROLLERS

A. General: Manual motor controllers shall consist of an integral controller and overload protection in a common enclosure, surface mounted. Size and number of poles shall be as shown and required with pilot light.

B. Manual Motor Controller: Manual motor controller with overload protection, 1 HP maximum, 115 or 230V.

C. Enclosures:
1. Manual motor controllers installed in indoor locations shall be NEMA 1 heavy duty enclosures unless shown otherwise.
2. Manual motor controllers installed at kitchen and food preparation locations, hose down areas, cooling towers, exterior locations, and in other corrosive areas shall be NEMA 4X, Type 316 stainless steel.

D. Disconnect Switch: For self-protected motors where one pole toggle motor control switch is allowed, the switch shall be horsepower rated and as specified for toggle switches in Section 26 27 73.

PART 3 - EXECUTION

3.1 INSTALLATION OF MOTOR CONTROLLERS

A. General: Install combination motor controllers where required or indicated and in accordance with the manufacturer's written instructions, requirements of the NEC and NECA Standard of Installation, and industry practices. Do not install motor controllers above ceilings. Do not install motor controllers on roofs.

B. Overloads: Install overload relays with manual reset in each phase of motor controller. Overload adjustable settings shall be based on actual motor nameplate full load amps. Field verify nameplate full load amps and adjust all relay settings accordingly.
   1. Set overcurrent at motor service factor x motor nameplate FLA
   2. Set high voltage trip to 8.3 percent above nominal voltage
   3. Set undercurrent trip to four automatic restarts
   4. Set all other trips to zero auto restarts
   5. Phase Failure Relay: Adjust phase failure relay to 10 percent over voltage and 10 percent under voltage.

C. Coordination: Motor controllers shall be provided to coordinate with motors furnished by Division 23. Motor controller controls shall be provided to coordinate with controls specified in Division 23.

D. Supports: Provide individual and combination motor controllers with galvanized angle or other suitable supports if mounting on wall or other rigid surface is impractical. Controllers shall not be supported by conduit alone. Where motor controllers are mounted on equipment served, the switch shall not inhibit removal of any service panels or interfere with any required access areas. Manual motor controllers shall be installed plumb and aligned in the plane of the wall where they are installed.

E. Identify each motor controller as specified in Section 26 05 00.

F. Where motor controllers are indicated to be installed as part of a Motor Control Center, refer to the Motor Control Center specification.

3.2 TESTING

A. Provide the field services of the manufacturer to provide initial programming of all variable functions, start-up and commissioning of each motor controller.

B. Pre-Energization Check: Check motor controllers for continuous circuits and short circuits.

C. Post Hook-Up Test: After wire and cable hook-ups, energize motor controller to show it functions as specified.

D. Provide thermal infrared scan of the combination motor controllers rated 200 Amps or larger under full load prior to testing / maintenance and modifications and of the modified and new switchboard sections after construction as directed and witnessed by Owner. Make corrections as needed as soon as possible as directed by the Owner. Repeat the scan at the 11-month prior to closeout, and make corrections prior to closeout. Provide digital video documentation with test results for comparison between prior condition and post construction modifications and future tests.

END OF SECTION

SECTION 26 24 25 - ENCLOSED SWITCHES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Safety and disconnect switch work where required, scheduled, indicated, specified, and required. For switches indicated or rated above 1,200 Amps, provide switchboard construction as specified for switchboards.

B. UL Approved: Safety and disconnect switches shall have UL approval and the UL label.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Schneider Electric - Square D

B. ABB-General Electric Co.

C. Siemens

D. Eaton

2.2 ENCLOSED SWITCHES

A. General: Provide heavy duty type, dead-front, sheet steel enclosed, surface-mounted safety switches of the type and size indicated. Safety switches shall be rated for the voltage of the circuit where they are installed. Safety switches used as motor disconnects shall be rated for the motor horse power served.

B. The overcurrent protective device short circuit, coordination and arch flash studies performed by the overcurrent protective device manufacturer shall be used by the respective switchgear vendor(s) to select appropriate equipment, switchgear, and overcurrent protective device characteristics such as but not limited to: equipment bracing, AIC rating, circuit breaker frame size and trip settings, and fuse type/class. The appropriate equipment suitable and required by the studies for code compliance shall be included with the submittal data for review and provided at no additional cost to the Owner. The appropriate equipment recommended by the studies for enhanced selective coordination or enhanced arc flash energy reduction beyond code compliance shall be included with the submittal data for review and consideration purposes by the engineer.

C. Switch Mechanism:
1. Safety switches shall be quick-make, quick-break type with permanently attached arc suppressor. Constructed so that switch blades are visible in the OFF position with the door open. The operating handle shall be an integral part of the box, not the cover. Switch shall have provision to padlock in the OFF position. Safety switches shall have a cover interlock to prevent unauthorized opening of the switch door when the switch mechanism is in the ON position, or closing of the switch mechanism when the switch door is open.
2. Cover interlock shall have an override mechanism to permit switch inspection by authorized personnel. Current-carrying parts shall be constructed of high conductivity copper with silver-plated switch contacts. Lugs shall be suitable for copper conductors and front removable.

D. Neutral: Provide safety switches with number of switched poles indicated. Where a

neutral is present in the circuit, provide a solid neutral with the safety switch. Where a ground conductor is present in the circuit, provide a separate solid ground with the safety switch.

E. Auxiliary Contacts: Disconnect switches related to all smoke control fans shall have auxiliary contacts for fire alarm system monitoring of the position of the disconnect switch.

2.3 ENCLOSED SWITCHES WITH OVERCURRENT AND/OR GROUND FAULT PROTECTION

A. Overcurrent protective devices 1,200 Amps and below:
   1. Where switch is intended as a building service disconnect provide solid neutral and ground bus and service entrance SE rating.
   2. Molded case circuit breakers:
      a. Greater than 800 Amp: Solid state true RMS sensing with adjustable: current, I^2t settings, ground fault (where required), instantaneous trip, and short time trip; 80-percent continuous current rating.
      b. 800 Amp and smaller: Solid state true RMS sensing with fixed current setting by rating plug or dial. Breaker shall have adjustable instantaneous trip function with short time tracking.
      c. 1,200 Amp and larger frame circuit breakers regardless of trip shall have Energy Reducing Maintenance System switch with local status indicator (ERMS).
   3. Fusible switches:
      a. Quick-make, quick-break units utilizing the double-break principle of circuit interrupting to minimize arcing and pitting and shall conform to the ratings shown.
      b. Individual door over the front, equipped with a voidable interlock that prevents the door from being opened when the switch is in the ON position unless the interlock is purposely defeated by activation of the voiding mechanism. All switches shall have externally operated handles.
      c. 600 Amps and below equipped for Class J fuses.
      d. 601 Amps and above shall be equipped for Class R or L fuses.
      e. When required by the latest edition of the NEC or the AHJ, 1,200 Amp fused switches regardless of fuse size installed shall have Energy Reducing Maintenance System switch with local status indicator (ERMS).

B. Ground Fault Interrupter (GFI) protection: Where shown or required, ground fault protection shall be achieved with adjustable pickup for ground fault currents, field-adjustable from 200 amperes and instantaneous to 60 cycle time delay. The ground fault protection system shall include necessary current sensors, internal wiring, and relays to coordinate opening the monitored faulted circuits.
   1. Ground fault protection shall be set at minimum setting for both current and time during construction. The manufacturer shall include in the submittal data the minimum setting of the device and the recommended setting for normal building operation.
   2. The ground fault system shall be factory-tested before shipment as specified:
      a. The manufacturer shall provide a factory ground fault protection system test for circuit testing and verification of tripping characteristics. The manufacturer shall pass predetermined values of current through the sensors and measure the tripping time for each phase and neutral. The measured time-current relationships shall be compared to the trip-characteristic curves. If the ground fault device trips outside the range of values indicated on the curve, the ground fault device shall be replaced or recalibrated.

b. Relays, electrically operated switches, shunt-trip switches, circuit breakers, and similar items shall have proper voltages applied to their circuits and satisfactory operation demonstrated.
c. Upon completion of the factory ground fault protection system test, the current and time on each ground fault device shall be set to minimum values.

2.4 ENCLOSURES

A. Enclosures in indoor locations shall be NEMA 1 unless shown otherwise.

B. Enclosures in exterior locations shall be NEMA 4X stainless steel.

C. Enclosures at kitchen and food preparation locations, exterior kitchen supply and exhaust fans, hose down areas, cooling towers, in greenhouses, and in other corrosive areas shall be NEMA 4X, stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install safety and disconnect switches where required or indicated, in accordance with the manufacturer's written instructions, requirements of the NEC, NECA Standard of Installation, and industry practices. Provide fuse identification label when fused switches are required showing type and size inside door of each switch. Include devices in coordination study to indicate overcurrent devices will selectively coordinate.

B. Location: Provide safety switches within 50’ and in sight of motor served. There shall be minimum code required clearance in front of safety switch and a clear path in which to access the switch. (i.e.: not having to walk and/or stand on obstacles such as drain pans on floor to service).

C. Supports: Provide all safety and disconnect switches with galvanized angle or other supports where mounting on wall or other rigid surface is impractical. Switches shall not be supported by conduit alone. Where safety and disconnect switches are mounted on equipment served, the switch shall not inhibit removal of service panels or interfere with access areas, not void the warranty of the equipment served. Provide mounting hardware that will allow removal of safety and disconnect switches with common work tools. Do not utilize drive pin anchors through enclosure.

D. Ground Fault Interrupter (GFI) test and settings: Where adjustable ground fault interrupter settings are provided or required, after completion of construction and before final acceptance testing, the ground fault protection system shall be field-tested and reset to the manufacturer's settings for both current and time by a representative of the manufacturer's engineering service department. After the test, set ground fault to 50-percent of the overcurrent device rating.

E. Safety and Disconnect Switches: Install disconnect switches for motor-driven equipment, appliances, motors, and motor controllers within sight of the controller position unless indicated otherwise.

F. Variable Frequency Drive (VFD) Warning Plaque: Provide VFD warning plaque at safety disconnect switches which are located down-stream of VFDs. Secure plaque to disconnect switch or immediately adjacent to disconnect switch with fasteners. Plaque shall be Yellow-White-Yellow 3-layer plastic laminated engraved with: “WARNING” (1/2 Inch Letters). “TURN OFF VFD BEFORE OPENING THIS SWITCH FOR

MAINTENANCE." (1/4 inch letters).

G. Provide disconnect switch for electric duct heaters.

H. Where disconnect switch is used or indicated as the utility service building disconnect, provide main bonding jumper and neutral to ground bond connected to the building's grounding system. Do not bond neutral to ground when there is a neutral to ground bond upstream from the same derived neutral system serving the disconnect switch.

I. Disconnect switches related to all smoke control fans shall have auxiliary contacts for fire alarm system monitoring of the position of the disconnect switch, coordinate with Division 28. Coordinate with fire detection and alarm contractor for the fire alarm and detection system to monitor all disconnect switches open/closed position that serve the smoke control system. All fire alarm and control wiring directly related to the monitoring of the supply power disconnect switches and control of the smoke control fans shall be installed in conduit.

3.2 TESTING

A. General: Before energizing, check for continuity of circuits and short circuits.

B. Provide thermal infrared scan of the enclosed switches rated 200 Amps or larger under full load prior to testing / maintenance and modifications and of the modified and new switchboard sections after construction as directed and witnessed by Owner. Make corrections as needed as soon as possible as directed by the Owner. Repeat the scan at the 11-month prior to closeout, and make corrections prior to closeout. Provide digital video documentation with test results for comparison between prior condition and post construction modifications and future tests.

END OF SECTION

SECTION 26 24 30 - FUSES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Fuse work as shown and scheduled, and as specified.

B. Types: Fuses required for the project include the following:
1. 250 volt current limiting fuses
2. 600 volt current limiting fuses

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Provide products produced by Bussman or Littlefuse.

2.2 CURRENT LIMITING FUSES - 600 VOLTS AND LESS

A. General: Provide 200,000 amperes interrupting capacity (AIC) current-limiting fuses of the current ratings shown and voltage rating equal to or greater than the voltage at the point of application.

B. Types:
1. Fuses in circuits supplying individual motors, groups of motors, or loads including motors, 600 amperes or less, shall be UL Class RK1 or Class J, time delay fuses, Bussman LPS-RK (600V) LPJ-SP (600V), LPN-RK (250V).
2. Fuses in circuits supplying individual motors, groups of motors, or loads including motors, 601 to 4000 amperes, shall be UL Class L time delay fuses, Bussman KRPC "HI-CAP".
3. Fuses in circuits supplying other than motor loads, 600 amperes or less, shall be UL Class RK1, time delay fuses, Bussman LPS-RK (600V), LPN-RK (250V).
4. Fuses supplying surge protection devices (SPD) shall be surge rated for use with SPD devices.

2.3 SPARE FUSES

A. General: Provide spare fuses in the amount of 10% of each type and size installed, but not less than 3 spares of a specific size and type. Deliver to the Owner at the time of project acceptance. Fuses shall be encased in a labeled steel enclosure with padlock provision, to be wall mounted where directed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install fuses in fuse holders immediately before energizing of the circuit where the fuses are installed. Fuses shall not be installed and shipped with equipment.

B. Labels: Place fuse identification labels, showing fuse size and type installed, inside the cover of each switch.

END OF SECTION

SECTION 26 27 73 - LINE VOLTAGE WIRING DEVICES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide wiring device work as shown, scheduled, indicated, and specified. Low voltage and/or digital control switches required for lighting controls and lighting control systems shall be as specified and required for the low voltage and / or digital control lighting system. Refer to drawings or other specification sections for low voltage / digital lighting control systems. Cover plates for lighting control systems shall be as specified in this section unless specifically required otherwise by the low voltage / digital control device bulkhead or form factor.

1.2 QUALITY ASSURANCE

A. UL Label: Wiring devices shall be UL labeled.

B. NEMA Standard WD1 and WD6.

C. Fed. Spec. WC596, W-S-896

1.3 SUBMITTALS

A. Mark up a complete copy of the specification section for the product to indicate a) acknowledgement of the specification requirement (Comply), or b) acknowledgement that the particular specification requirement does not apply to this specific project (Not Applicable) or, c) acknowledgement that the specification requirement cannot be made or that a variance is being submitted for review to the Architect/Engineer/Owner (Does Not Comply, Explanation:) Do not submit an outline form of compliance, submit a complete copy of the specification section with the product data.

B. Submit a sample of each style and color of 120-Volt duplex receptacle and each 120/277-Volt switch with related cover plate. Attach plate to wiring device and label back side of plate with job description with permanent black marker.

C. Submit manufacturer's product data sheet for each style of device and plate on the project.

D. Submit drawings of plans, elevation and sections of receptacles and outlets in casework, cabinetwork and built-in place furniture. Coordinate dimensions with millwork shop drawings and related architectural drawing series.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Toggle switches, straight blade and twist lock devices, interior cover plates:
1. Leviton
2. Hubbell
3. Pass and Seymour
4. Eaton

B. Dimming
1. Leviton
2. Lutron

2.2 WIRING DEVICE COLOR

A. Device color shall be gray except 20A, 125V receptacles and toggle wall switches which are directly supplied from an emergency source shall be red, and heavy duty 30 Amp and larger simplex devices which shall be black in color where the building standard color is not available. Provide equivalent hospital grade devices where red is not available in grade specified. Verify with Owner / Architect prior to submitting for approval. Color change kits as required for dimming switches. Low voltage lighting control devices specified elsewhere shall match the line voltage wiring device color specified in this section.

2.3 RECEPTACLES

A. Industrial or hospital grade tamper resistant smooth face duplex receptacles, 2 pole, 3 wire grounding, with ground connection and poles internally connected to mounting yoke, with metal mounting straps, locking plug-tail or back and side wired with screw type terminals, NEMA indicated, (X=color designation).
   1. 20A, 125V duplex NEMA #5-20R: Leviton #5362-SGX
   2. 20A, 125V isolated ground duplex NEMA #5-20R: Leviton #5362-IGX
   3. 20A, 125V ground fault circuit interruption (GFCI) NEMA #5-20R weather and tamper resistant: Leviton #G5362-WTX
   4. 20A, 125V weather resistant (WR), tamper resistant: Leviton #TWR20-GY
   5. 20A, 125V plug load control, split circuit marked for “controlled”, tamper resistant: Leviton #TDR20-S1G
   6. 15A, with 20A feed-through, NEMA #5-15R, 125V duplex, arc fault (AFCI), tamper resistant: Leviton #AFTR1-HGX

B. Heavy-Duty Simplex: Single heavy-duty type receptacles, with green hexagonal equipment ground screw, with metal mounting straps, back or side wiring, black molded phenolic compound.
   1. 15-60A, 125-250V, straight blade, NEMA configuration as indicated or as required by Owner.
   2. 15-50A, 125-480V, twist lock, NEMA configuration as indicated or as required by Owner.

C. Hospital grade receptacles, 2 pole, 3 wire grounding, with ground connection and poles internally connected to mounting yoke, with metal mount straps, locking plug-tail or back and side wired with screw type terminals, molded phenolic compound, NEMA configuration indicated.
   1. 20A, 125V grounded duplex NEMA #5-20R: Leviton #8300-X
   2. 20A, 125V isolated ground duplex NEMA #5-20R: Leviton #8300-LIG (orange)
   3. 20A, 125V ground fault circuit interruption (GFCI) with indicator light: Leviton NEMA 5-20R-8898-HGX
   4. 20A/125V Tamper Resistant Duplex NEMA 5-20R: Leviton 8300-SGX

D. USB 2-port charger / tamper-resistant with 125-Volt receptacles:
   1. USB type A/C, 1 type A and 1 type C port, 5.1A 5.0VDC charging. 20A, 125V, NEMA 5-20R: Leviton #T5833-HGX
   2. USB A, 2 type A ports, 5.1A 5.0VDC charging. 20A, 125V, NEMA 5-20R: Leviton #T5832-HGX

E. USB 4-port charger:
   1. USB type A+C, 2 type A ports and 2 type C ports. 5.0A 5.0VDC charging. Hubbell #USB4ACX.
   2. USB type A, 4 type A ports. 5.0A 5.0VDC charging. Hubbell #USB4X.

2.4 WALL SWITCHES

A. Toggle: Industrial grade flush toggle switches, with mounting yoke insulated from mechanism, equipped with plaster ears, switch handle, back and side-wired screw terminals.
   1. Single-pole, 120/277V, 20A switch: Leviton #1221-2X
   2. Double pole 120/277V, 20A switch: Leviton #1222-2X
   3. Three-way, 120/277V, 20A switch: Leviton #1223-2X
   4. Four-way, 120/277V, 20A switch: Leviton #1224-2G
   5. Pilot light single-pole, 120/277V, 20A switch: Leviton #1221-PL
   6. Momentary, 120/277V, 20A, single-pole double throw, center off: Hubbell only, #HBL 1557G

B. Toggle key operated switch (verify manufacture and key type with Owner prior to construction).
   1. Single-pole, 120/277V, 20A key operated switch: Hubbell HBL #1221GY
   2. Two-pole, 120/277, 20A key operated, Hubbell HBL #1222GY
   3. Three-way, 120/277V, 20A key operated switch: Hubbell HBL #1223GY
   4. Four-way, 120/277V, 20A key operated switch: Hubbell HBL #1224GY
   5. Momentary, single pole double throw, center off, 20A key switch: Hubbell #HBL 1557LG.
   6. Key: Hubbell #HBL 1209. Key switches shall be keyed alike to match the Owner's standard key system. Coordinate with Owner.

B. Rotary key operated switch (verify manufacturer and keying with Owner prior to construction).
   1. Single-pole, 120/277V, 20A key operated switch: Leviton #1221-KL
   2. Two-pole, 120/277, 20A key operated, Leviton #1222-2KL.
   3. Three-way, 120/277V, 20A key operated switch: Leviton #1223-3KL
   4. Four-way, 120/277V, 20A key operated switch: Leviton #1224-4KL
   5. Key switches shall be all keyed alike to match the Owner's standard key system. Leviton #WS-35 or as otherwise directed by Owner.

2.5 WALL DIMMERS

A. Wall Box Dimmers: Self-contained, wall box mounted, linear slide square law dimmers with ON/OFF switch. Dimmers shall operate continuously at rated load in an ambient temperature up to 40°C and an input of 100 to 277V. Heat sink fins may be removed only as approved by Owner / Engineer for narrow ganging after applying de-rating.
   1. Single-pole, 120/277V, 1000/2308 Watt incandescent / magnetic low voltage: Leviton #AWSMT-MBW.
   2. Single-pole, 120/277V, 1500/3463 Watt incandescent / magnetic low voltage, 2-gang heat sink: Leviton #AWSMT-MCW.
   3. Single-pole, 120/277V, 1920/4432-Watt LED / fluorescent 0-10V dc, 75 mA current sink: Leviton #AWSMT-7DW.
   4. Three, four- or five-way remote switch: Leviton #AWSRT-00W.
   5. Color change kit as required.

2.6 GFCI – GROUND FAULT CIRCUIT INTERRUPTER, BLANK FACE

A. 20A, 125V, GFCI, switch rated, blank face feed through, Hubbell #GFBF20GYL, gray finish, stainless steel cover plate black laser engraved with device protected, (example: DRINKING FOUNTAIN GFCI).

2.7 INTERIOR WALL COVER PLATES AND FASTENERS

A. Type 302 non-magnetic stainless-steel with satin finish (also required for wall box device cover plates for low voltage and digital lighting controls specified elsewhere).

B. Cover plate laser plate engraving for device identification (other than low voltage lighting controls).
   1. Provide laser cover plate engraving with black filling for all wiring devices indicating panelboard name, circuit, and voltage.
   2. Wiring devices connected to emergency/stand-by generator or inverter shall include the word “EMERGENCY”.
   3. Text orientation shall be upright, readable from left to right when cover plate is installed.
   4. Remotely located lighting switches shall also indicate the room or area and zone controlled by each switch. Coordinate specific wording with Owner/Architect.
   5. Blank face GFCI cover plates shall also intuitively indicate the load or equipment served, device, or area protected downstream (“EDF” for drinking fountains, “RM RECEPTS”, “HOOD RECEPTS”, “VENDING”, “REFRIG”, etc.) For other loads, Owner/Architect shall determine name plate wording.

2.8 EXTERIOR COVER PLATES

A. Thomas & Betts CK Series, cast aluminum standard depth, locking mount, while-in-use, wet location, universal configuration.
   1. Vertical mount receptacle: #CKSUV
   2. Horizontal mount receptacle: #CKMU
   3. Two-gang: #2CKU
   4. 30-60 Amp Devices: #CKLSUV

2.9 CORD REELS AND DROP CORDS

A. Cord Reels:
   1. Lighted cord reels: Industrial grade, LED hand Lamp only, 125V, 45-foot 16/3 SJEO cord, white finish, LED hand lamp. Hubbell #HBLI45163LED with #HBL340PB pivot base.
   2. 20 Amp (2) duplex receptacle cord reels: Industrial grade, 125V, (2) 20A duplex receptacles, GFCI protection, 45-foot 12/3 SJO cord, white finish, yellow outlet box. Hubbell #HBLI45123GF220 with #HBLI340PB pivot base.
   3. 30 Amp receptacle cord reels: Industrial grade, 125/250V, 30A, 45-foot 10/4 SJO cord, white finish, yellow outlet box. Hubbell #HBLI45104 with #HBLI340PB pivot base. 30 Amp NEMA receptacle termination as required by Owner.
   4. 50 Amp receptacle cord reels: Industrial grade, NEMA 4 wet location, 600V, 55A, 50-foot 6/4 SOOW cord, yellow finish, self-retracting, with NEMA 50-Amp maximum receptacle termination as required by Owner. KH-Industries RTMH4L-WW-K6K.
   5. Recessed enclosure for 20 and 30-Amp cord reels recessed above T-grid drop ceilings: Hubbell #HBLIPRBOX recessed cord reel enclosure, white finish, plenum rated.

B. Drop cord receptacles:
   1. 20A, 125V, 25-feet 600 VAC, 3-conductor 12 AWG SOOW cable, twist lock plug, two 125V, 20A duplex WR GFCI outlets, safety yellow rubber outlet box, mesh strain relief cord grips. KH Industries #PP4DD-520-B12F-520.
   2. 20A, 125/250V, 25-feet 600 VAC, 4-conductor 12AWG SOOW cable, twist lock plug, four 125/250V NEMA L1420P outlets, safety yellow rubber outlet box, mesh strain relief cord grips. KH Industries #PP7DD-520-B12F-L1420.
   3. 30-60 Amp, voltage, NEMA plug/receptacle as required by Owner, SOOW cable, number of conductors and length as required, mesh strain relief cord grips.

2.10 FIRST RESPONDER EMERGENCY REMOTE POWER OFF (FREPO) STATION

A. Knox Company Remote Power Rapid Access 4500 Series Shutdown Station
   1. Recessed mount for public spaces and new construction, surface mount for when mounted to equipment or existing construction.

2. Single lock keyed for local Fire Department/AHJ, verify configuration and keying with Knox Company.
3. Red Finish
4. Tamper alert for integration with building security system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Cover plates for receptacles and toggle switches shall be of the same manufacturer throughout unless otherwise noted.
   1. Key switches and keys shall be as specified and also as approved by Owner.
   2. Submit samples for each specified toggle switch and duplex receptacle color to Architect.

B. Install wiring devices where shown and as required, in accordance with manufacturer's written instructions, requirements of NEC, and in accordance with industry practices. Do not install devices until wall construction and wiring is completed.

C. Install receptacles and switches only in electrical boxes that are clean, free from building materials, debris, and similar matter.

D. Install wiring devices plumb and aligned in the plane of the wall, floor, ceiling or equipment rack.

E. Install switches in boxes on the strike side of doors as hung. Install so the up position will close the circuit or will be the highest level of illumination. Where more than one switch is in the same location, install switches in a multi-gang box with a single cover plate.

F. Provide a cover plate for every wiring device and blank cover plates for unused rough-in-only boxes that matches the building standard. Fasten all plates outdoors with type 302 Allen Head "tamper-proof" screws.

G. Mounting heights of all wiring devices shall comply with local accessibility standards and local codes, except where wiring devices are indicated for special purpose and access is only required by maintenance or service personnel.

H. Refer to Architectural drawing and elevations, etc. for exact location of wiring devices. Coordinate location of all wiring devices with other trades, specialty items, and millwork and resolve all conflicts prior to rough-in. Field coordinate exact mounting location with all trades to avoid and resolve conflicts during construction.

I. Locate receptacles for electric drinking fountains/coolers and bottle fill stations below equipment so that the receptacle is accessible and concealed as much as practical from public view by the equipment open cowling so that the receptacle remain readily accessible. For dual level basin equipment, locate receptacle under the upper basin.

J. Provide convenience outlet receptacle within 25-feet of all new electrically operated mechanical equipment.

K. Where exterior receptacles are intended for continuous use, mount in horizontal position with while in use cover plate. (Exterior electric drinking fountains, ice makers, ice storage bins, landscape lighting low voltage transformers, seasonal decorative lighting, etc.)

L. Install wall box dimmers to achieve full rating specified after de-rating for ganging as recommended by manufacturer.

M. Do not share neutral conductor on load side of dimming switches.

N. Install receptacles with grounding pole down, except in any of the following conditions where the grounding pole shall be installed in the up position: healthcare occupancies, if required by local AHJ, if required by Owner's construction standards or if directed by Owner or Architect. If installed horizontally, install with neutral pole on top.

O. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.

P. Provide pigtail to each receptacle and each switch. Neutral and phase conductors shall be installed using side or rear entry lugs only. Do not wrap conductors around screw terminals. Tighten all screws and lugs as recommended by manufacturer.

Q. All receptacles and switches shall have a minimum of two wraps of Scotch 33 or equivalent tape around terminal screws.

R. Provide toggle switch within sight of all trap primers, circulation pumps, 120-Volt motors and motorized equipment to serve as the equipment disconnect switch.

S. Mount cord reels and cord reel recessed enclosures to structure with galvanized steel struts and as recommended by manufacturer. Field verify exact location of cord reels with Owner/Architect. Mounting location shall avoid conflicts with piping, light fixtures and ductwork, etc. when cord reel is extended and retracted. Set ball stop as directed by Owner / Architect. Provide hand lamp only type cord reels in commercial / educational automotive garages with classified (hazardous) locations. Provide local toggle switch at standard switch height for hand lamp only cord reels.

T. Mount drop cord suspension hook or j-box to structure to support the cord's weight and additional normal use pulling tension and as recommended by manufacturer. Use cable grips, either with cord grip hanging hook at open ceilings or with chrome plated escutcheon cover plate mounted to recessed j-box at finished ceilings. Field verify exact location, drop height, and NEMA outlet configuration of drop cords with Owner/Architect. Provide weatherproof receptacle cap or covers if located in wet location. Mounting location shall avoid conflicts with piping, light fixtures and ductwork, etc.

3.2 GROUND FAULT PROTECTION FOR PERSONELL

A. When GFCI personnel protection receptacles are not commercially available or cannot be installed at a readily accessible location or indicated otherwise on the drawings, GFCI personnel protection shall be provided by a remote blank face GFCI wiring device or by an up-stream GFCI receptacle that also provides downstream GFCI protection and located in a readily accessible location. When branch circuit breaker device with integral GFCI protection is required or specified, it shall be within the manufacture's recommended distance limitations of the connected receptacle(s) or load(s) for proper GFCI personnel protection at the farthest outlet.

B. GFCI personal protection locations include but are not limited to the following:
   1. For other than dwelling units: All single phase 125-250-Volt (150-Volts to ground or less) receptacles 50-Amperes or less, and all three phase 125-250-Volt (150-Volts to ground or less) receptacles 100-Ampres or less in the locations indicated below.
   2. Dwelling units: All single phase 125-250-Volt receptacles installed in the following locations indicated below.
   3. Provide personnel GFCI protection as indicated above in the following locations and all additional locations as required by the NEC.
      a. Outdoors (with exceptions for not readily accessible receptacles with dedicated branch circuits for snow melting, deicing, pipeline/vessel heat

receptacles. Provide these loads with 30mA EGFI circuit breaker protection).

b. Bathrooms/toilets/restrooms
c. Janitors/custodial closets and mop sinks.
d. Laundry areas
e. Parking structures, service garages, garages and accessory buildings
f. Basements, crawl spaces (including 120-Volt lighting)
g. Within 6-feet of all water sources including sinks, mop-sinks, lavatories, bathtubs, shower stalls, faucets, eye wash stations, emergency shower stations
h. Indoor damp and wet locations
i. Locker rooms
j. Indoor swimming pools and natatoriums areas and adjacent corridor/hall convenience receptacle outlets located within 25-feet of all access doors.
k. Non-dwelling unit therapeutic tubs/pools/whirlpool areas and adjacent corridor/hall convenience receptacle outlets located within 25-feet of all access doors.
l. Receptacles serving dwelling unit kitchen counter tops
m. Vending machines
n. Elevators, dumb waiters, escalators, moving sidewalks: receptacles in pits, hoist ways, well ways or those mounted on the cars of elevators and dumb waiters.
o. Electric vehicle charging equipment.
p. All receptacles serving kitchen or food preparation counter tops.
q. Automotive vacuum machines
r. Drinking water fountains/coolers and bottle fill stations
s. Corded high-pressure spray washing machines
t. Tire inflation machines
u. Dish washers
v. Receptacles at end of cord reels or drop cords.
w. Boat houses, boat hoist, and all pier/dock receptacles and lighting (excludes shore power that requires GFPE).
x. Central plant, mechanical rooms and electrical rooms
y. Wood, metal, or other material fabrication or vocational training shops.
z. Receptacles that serve educational science and science prep room counter tops.

C. Where a GFCI protected receptacle outlet is required or indicated behind vending machine, refrigerators or other equipment, provide remote GFCI blank face in same room as protected receptacle and at a readily accessible location with standard receptacle outlet behind equipment. Refrigerators shall be GFCI protected only where located within 6-feet of power cord distance from the edge of a sink to the surface of the refrigerator.

D. Unless indicated otherwise, locate blank face GFCI device near light switches at same height as light switches or ganged with the light switch. Provide GFCI protection for all receptacle outlets located below 42-inches in all infant through 2-year old day care and similar areas designated for occupancy by infant through 2-year old day care occupants so the GFCI device can easily be intentionally tripped or tested and reset.

E. Provide branch circuit breaker 30mA (EDP) or 100mA (EPE) equipment protection for utilization equipment as required by the NEC and where indicated on the drawings.

3.3 FIRST RESPONDER REMOTE EMERGENCY POWER OFF (FREPO) STATION

A. Provide Knox Company first responder remote emergency power off (FREPO) stations as indicated and/or where required by local AHJ. Mounting locations shall be as directed by the local AHJ and exact locations coordinated with the Architect. FREPOs shall be circuited only to shunt trip or shut-down control circuiting. FREPOs shall be recessed

mounted in public locations and in all new construction when attached to building construction. Provide surface mount FREPOs when mounted to equipment or existing construction.

B. Integrate the FREPOs to shut-down the building non-emergency and non-legally required power sources which include the main electrical utility service disconnect circuit breaker(s), other than non-life safety or non-legally required distribution scale UPS equipment, and non-life safety or non-legally required local power generation equipment.

C. Provide FREPOs for fire pump, life safety, and legally required electrical generation equipment only when required by the AHJ. When required by the AHJ, fire pump, life safety, and legally required power generation and/or stored energy power supply equipment shall each have separate dedicated FREPOs that shut down only their associated power generation/stored energy equipment. FREPOs for emergency, and legally required systems shall have minimal 25-foot physical separation from the building main utility service FREPOs and clearly labeled with the equipment that they will shut down. FREPOs for fire pumps shall have minimal 25-foot physical separation from the any other FREPOs and from the building main utility service disconnect and clearly labeled with the equipment that it will shut down.

D. Integrate the FREPOs tamper switch with the building security or building management control system (BMCS) as directed by Owner.

3.4 TESTING

A. Before energizing, check for continuity of circuits, short circuits, and grounding connections.

B. After energizing, check wiring devices to demonstrate proper operation and receptacles for correct polarization, voltage and phase orientation if intended 3-phase equipment is phase orientation dependent for proper motor rotation or operation.

C. Test each individual GFCI receptacle and all downstream receptacles protected by an upstream GFCI device with simulated ground fault tester, make corrections as necessary.

D. Operate each wall switch with circuit energized and verify proper operation.

END OF SECTION