West Brook High School
Auxiliary Field House

8750 Phelan Boulevard
Beaumont, Texas 77706



BISD

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West Brook Auxiliary Field House

8750 Phelan Boulevard
Beaumont , Texas 77706

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28 31 02 EXPANSION OF EXISTING FIRE DETECTION AND ALARM SYSTEM



04/18/2022

DOCUMENT 000101 - PROJECT TITLE PAGE

1.1 PROJECT MANUAL VOLUME 1

A. West Brook Auxiliary Field House .

B. Architect Project No. 21021 .

C. Architectural Alliance Incorporated .

D. 350 Pine Street, Suite 720 .

E. Beaumont, Texas 77701 .

F. Phone: 409 866-7196 .

G. Website: www.architectall.com .

H. Issued: April 18, 2022 .

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END OF DOCUMENT 000101

DOCUMENT 000107 - SEALS PAGE

1.1 DESIGN PROFESSIONALS OF RECORD

A. Architect:

1. James Rob Clark, AIA .
2. 8212 .



04/18/2022

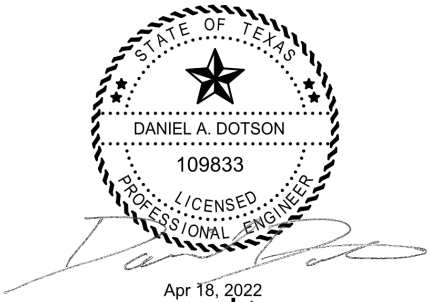
B. Civil Engineer:

1. Bernardino Tristan .
2. 117017 .



C. Structural Engineer:

1. Daniel A. Dotson .
2. 109833 .



D. Plumbing Engineer:

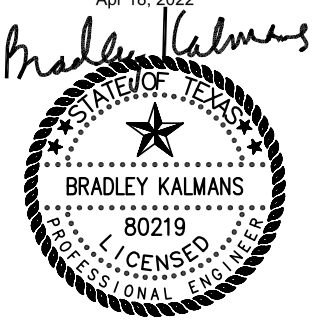
1. Bradley Kalmans .
2. 80219 .

E. HVAC Engineer:

1. Bradley Kalmans .
2. 80219 .

F. Electrical Engineer:

1. Bradley Kalmans .
2. 80219 .



04/18/2022

END OF DOCUMENT 000107

SECTION 003132 - GEOTECHNICAL DATA

1.1 GEOTECHNICAL DATA

A. This Document with its referenced attachments is part of the Procurement and Contracting Requirements for Project. They provide Owner's information for Bidders' convenience and are intended to supplement rather than serve in lieu of Bidders' own investigations. They are made available for Bidders' convenience and information. This Document and its attachments are not part of the Contract Documents.

B. Because subsurface conditions indicated by the soil borings are a sampling in relation to the entire construction area, and for other reasons, the Owner, the Architect, the Architect's consultants, and the firm reporting the subsurface conditions do not warranty the conditions below the depths of the borings or that the strata logged from the borings are necessarily typical of the entire site. Any party using the information described in the soil borings and geotechnical report shall accept full responsibility for its use.

C. A geotechnical investigation report for Project, prepared by Science Engineering , is attached herewith .

1. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from the data.
2. Any party using information described in the geotechnical report shall make additional test borings and conduct other exploratory operations that may be required to determine the character of subsurface materials that may be encountered.

D. Related Requirements:

1. Document 002113 "Instructions to Bidders" for the Bidder's responsibilities for examination of Project site and existing conditions.
2. Document 003119 "Existing Condition Information" for information about existing conditions that is made available to bidders.

END OF DOCUMENT 003132

SEL GEOTECHNICAL ENVIRONMENTAL MATERIALS TESTING

GEOTECHNICAL INVESTIGATION

FOR

PROPOSED FIELD HOUSE AT WESTBROOK HIGH SCHOOL

IN

BEAUMONT, TEXAS

REPORT NUMBER 21243

REPORTED TO:

FITTZ & SHIPMAN, INC.
1405 CORNERSTONE COURT
BEAUMONT, TEXAS 77706

DECEMBER 2021

PREPARED BY:
SCIENCE ENGINEERING, LTD.

P.O.Box 2048 Nederland, Texas 77627 Ph: (409) 982-0686 Fax: (409) 982-0619
Email: yousef@science-engineer.com

GEOTECHNICAL INVESTIGATION
Proposed Field House
Beaumont, Texas

INTRODUCTION

The study reported herein is an investigation of subsurface conditions for a proposed field house at Westbrook High School in Beaumont, Texas.

AUTHORIZATION

This investigation was authorized by Mr. Ben Tristan by telephone on November 16, 2021.

SUBSURFACE EXPLORATION

The subsurface exploration at the site was accomplished by means of one (1) undisturbed sample core boring drilled to a depth of approximately twenty (20) feet below existing ground surface. Approximate location of the boring is shown on attached boring plan.

SUBSURFACE INVESTIGATION

The subsurface investigation consisted of drilling three-inch nominal diameter core boring. Undisturbed samples of the cohesive soils were obtained from the boring by means of thin-wall, seamless steel Shelby tube samplers, in accordance with the ASTM D–1587 method. The shear strength of the cohesive soil samples was estimated by hand pentrometer in the field.

All undisturbed samples were extracted mechanically from the core barrels in the field, classified, wrapped in aluminum foil, and sealed in airtight plastic bags to prevent moisture loss and disturbance. The samples were transported to our laboratory for testing and further study.

LABORATORY INVESTIGATIONS

All samples from boring were examined and classified in the laboratory by a soil engineer, according to procedures outlined in ASTM D-2488. Laboratory tests were performed on selected soil samples in order to evaluate the engineering properties of the soil in accordance with the indicated standard procedures.

Laboratory Tests	ASTM Standard
Atterberg Limits [Liquid Limit (LL), Plastic Limit (PL), Plasticity Index (PI)]	D-4318
Soil Moisture Content	D-2216
Unconfined Compressive Strength	D-2166
Soils Classification	D-2487

Undrained shear strength of selective cohesive soils was determined by unconfined compression tests. Water content and dry unit weight of the foundation soils were determined as routine parts of the unconfined compression tests. Atterberg limits tests were performed on appropriate cohesive samples. The results of these tests are shown on attached boring log.

SUBSURFACE CONDITIONS

Specific types and depths of subsurface strata encountered on the site are shown on the attached boring logs. Review of the boring log indicates that generalized stratography is approximately as follows:

Stratum No.	Average Depth, feet	Soil Description
I	0.00 - 1.00	Dark Gray SILTY CLAY (CL)
II	1.00 - 6.00	Dark Gray CLAY (CH) with ferrous nodules
III	6.00 -20.00	Tan and Gray CLAY (CH) with ferrous nodules and slickensides

The near surface soils are "CH" type soils when classified by the unified soils classification system. This type soil normally exhibits high swell potential during seasonal moisture variations.

Hydrostatic water was encountered at the time of drilling, as shown on attached boring log.

CONSTRUCTION VARIATIONS

The information contained in this report summarizes conditions found on the date that the boring was drilled. The depth to the static water table may be expected to vary with the

environmental variations, such as frequency and magnitude of precipitation and the time of year that construction begins.

DESIGN ANALYSIS AND RECOMMENDATIONS

Information available to this office indicates that the proposed construction at the site will consist of a field house.

FOUNDATION RECOMMENDATIONS (BELL BOTTOM PIERS)

From analysis of the boring log and laboratory test results, structural loads can be transmitted to the foundation soils by use of drilled and underreamed type footings. Footings should extend to a depth of ten (10) feet below existing ground surface to be located in Tan and Gray Clay. Utilizing a minimum factor of safety of three for dead load, or a minimum factor of two for total load, the allowable bearing capacity of the foundation soils for circular type footings is as follows: **2,800** PSF for dead load, plus long-term live loads, and **4,200** PSF for total load. Whichever is critical should be used. The allowable loads given can be increased by thirty (30) percent for wind or temporary lateral loading.

Due to the presence of slickensides at the recommended depth, we suggest that the bell to shaft ratio for the footings be limited to two to one (2:1).

There is a potential for upward movement of the plastic clays in contact with the sides of the piers; the pier shafts should be well reinforced throughout their length resist tensional force.

FLOOR SLABS AND GRADE BEAMS

Review of the Atterberg Limits determinations indicates that the surface soils are "CH" type soils, with high plasticity, which may exhibit expansion during seasonal wetting and drying cycles. We believe that conventional "slab-on-fill" construction may be used for the interior portion of the structures built at the site. Select fill, a minimum of thirty-six (36) inch thickness should be used to bring the structure to grade.

Prior to placement of select fill, strip site sufficiently to remove all topsoil, existing vegetation, and roots larger than ½" in diameter to an approximate depth of thirty-six (36) inches. Then scarify the subgrade, add moisture, if necessary, and re-compact to 95% of the maximum dry density as determined by ASTM D-698 (Standard Proctor). The moisture content at the time of compaction of subgrade soils should be within +3% of the proctor optimum value.

Select fill should then be placed, under laboratory control, in no greater than eight-inch (8") loose layers and compacted to a minimum of 95% of the maximum dry unit weight, as obtained in the laboratory by means ASTM D-698 procedure. Moisture content of ±2% optimum should be maintained during placement of the select fill material. A vapor barrier consisting of six (6) mil Polyethylene shall be placed between the select fill and concrete slab.

The material used as select fill should consist of a non-active sandy clay or clayey sand type substance, having a Liquid Limit of 36 or less and Plasticity Index (P.I.) varying from 10 to 20.

STRUCTURE FOUNDATION

Each footing excavation should be inspected by the project's Engineer, Architect or Owner's representative prior to placing concrete to insure that (a) the footing has been constructed at the correct depth and the correct formation established by previously mentioned criteria, (b) the footing is concentric with the pier shaft or column, and (c) excessive cuttings, build-up or any soft-compressible material(s) have been removed from the bottom of the excavation.

Placement of concrete should be accomplished as soon as possible to prevent changes in the state of stress and the caving of the foundation soils. No footings should be poured without the prior approval of the projects' Engineer, Architect or Owner's representative.

FOUNDATION SETTLEMENT

A detailed settlement analysis was not within the scope of this study. It is anticipated that the footings designed, using the recommended allowable bearing pressures, will experience small settlements that will be well within the tolerable limit for the proposed structure.

SITE PREPARATION

In order to remedy construction problems, which may develop if attempts are made to work the surface materials following prolonged periods of rainfall which are common to this area, it is recommended that prior to starting any work at the site that proper construction drainage is to be provided to maintain a relatively dry construction site. (Use a minimum slope of 5% within 10 feet of the foundation).

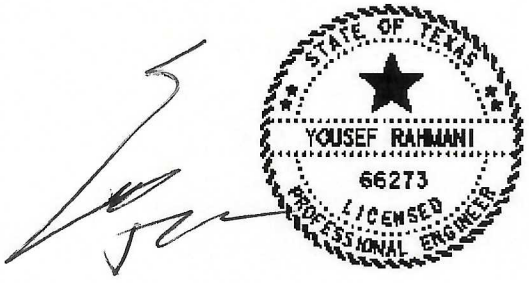
LIMITATIONS

The conclusions and recommendations given in this report are based on the analysis of the data collected for this project. Additive conclusions or recommendations made from this data by others are their responsibility.

Our study is based on the data obtained from soil borings made at the locations shown on borings plan. The nature and extent of variations between borings may become evident during construction. We should be requested to observe exposed conditions. After making these observations, and noting the engineering significance of variations, we will advise you of any changes in recommendations believed appropriate.

We appreciate this opportunity to provide our services to this project. Please let us know if you require additional information. Thank you.

Respectfully submitted for the firm,
TBPE Registration No. 4060



Yousef Rahmani, P.E.
President

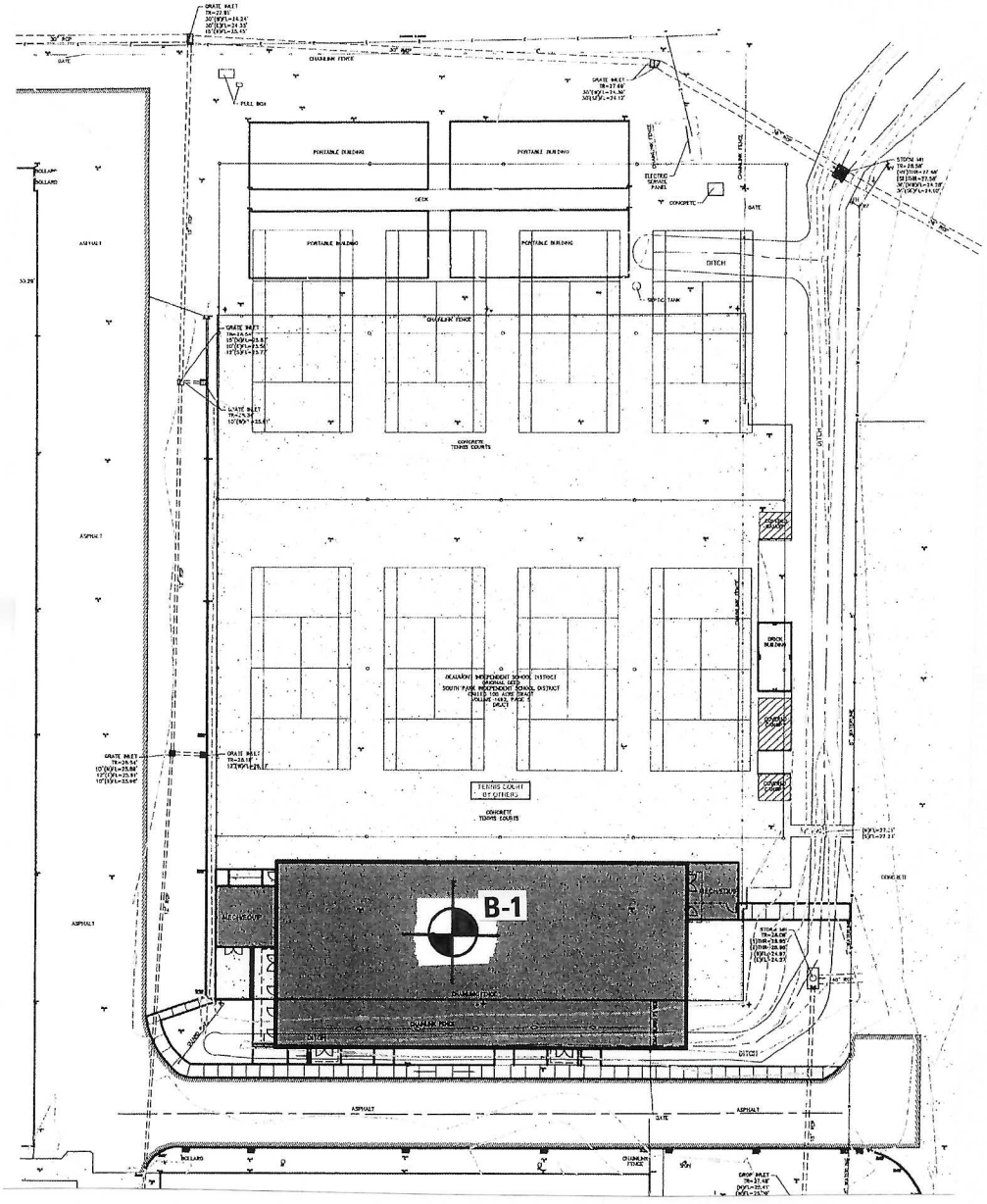
Encl.: Boring Plan
Boring Log 1
Geotechnical Chart/Symbols

Copies: 2 – Client
1 – SEL File 21243

YR/nb

SEL GEOTECHNICAL ENVIRONMENTAL MATERIALS TESTING

Report Number 21243



PROPOSED FIELD HOUSE AT WESTBROOK HIGH SCHOOL
BEAUMONT, TEXAS

BORING PLAN

DECEMBER 2021

NOT TO SCALE

P.O.Box 2048 Nederland, Texas 77627 Ph: (409) 982-0686 Fax: (409) 982-0619
Email: yousef@science-engineer.com

SEL GEOTECHNICAL ENVIRONMENTAL MATERIALS TESTING

LOG OF BORING

Project: Proposed Field House at Westbrook High School
Beaumont, Texas

Project No: 21243
Boring Number: B-1
Date of Report: 12/13/2021
Location: See boring plan
Date of Boring: 12/08/2021
Dry Auger: 0 to 20 Feet
Authorization: Mr. Ben Tristan

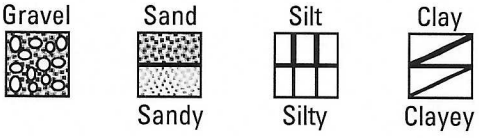
DEPTH, FEET	SYMBOL	SAMPLE	BLOWS PER FOOT	STRATUM DESCRIPTION	WATER CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)	PERCENT PASSING NO. 200 SIEVE	SHEAR STRENGTH: POCKET PENETROMETER (TSF)	SHEAR STRENGTH: UNCONFINED COMPRESSIVE STRENGTH (TSF)
				Dark Gray SILTY CLAY CL								
				Dark Gray CLAY with ferrous nodules			56	23	33		0.25	
					23	96	58	22	36		0.25	0.40
5				_ gray and tan	27	89					0.12	0.25
				_ tan and gray with slickensides	25	98	67	24	43		1.00	0.70
					27	94	71	25	46		0.75	0.60
10					33	89	74	25	49		0.75	0.60
				_ sand seams	27	92	55	21	34		0.65	0.50
15												
				CH	27	96	81	27	54		0.65	0.50
20				Bottom at 20 feet								
				1. Water was encountered at 13 feet during drilling.								
				2. Water level was at 11' - 5" after 5 minutes.								

P.O.Box 2048 Nederland, Texas 77627 Ph: (409) 982-0686 Fax: (409) 982-0619
Email: yousef@science-engineer.com

SEL GEOTECHNICAL ENVIRONMENTAL MATERIALS TESTING

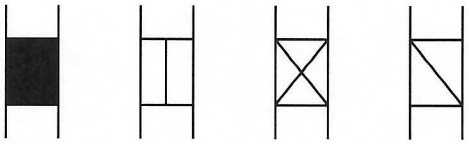
KEY TO SOIL CLASSIFICATION AND SYMBOLS

SOIL TYPE



Predominant type shown heavy

SAMPLE TYPE



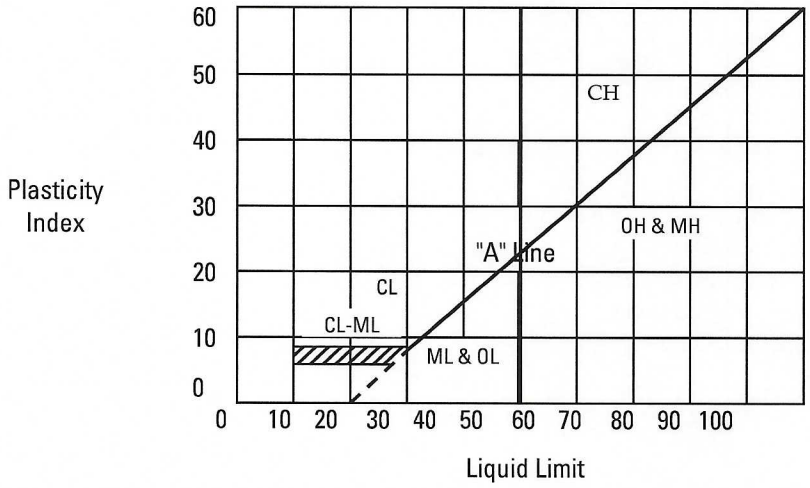
Un-Disturbed | Rock Core | Split Spoon | No Recovery

SOIL GRAIN SIZE

U.S. Standard Sieve

6"	3"	3/4"	4	10	40	200		
Boulders	Cobbles	Gravel		Sand			Silt	Clay
		Coarse	Fine	Coarse	Medium	Fine		
152	76.2	19.1	4.76	2.00	0.420	0.074	0.002	(mm)

PLASTICITY CHART



CONSISTENCY OF COHESIVE SOILS

Penetration Resistance, blows per foot	Consistency	Cohesion TSF	Plasticity Index	Degree of Plasticity
0 - 2	Very Soft	0 - 0.125	0 - 5	None
2 - 4	Soft	0.125 - 0.25	5 - 10	Low
4 - 8	Firm	0.25 - 0.5	10 - 20	Moderate
8 - 15	Stiff	0.5 - 1.0	20 - 40	Plastic
15 -30	Very Stiff	1.0 - 2.0	> 40	Highly Plastic
> 30	Hard	> 2.0		

RELATIVE DENSITY OF COHESIONLESS SOILS

Penetration Resistance, blows per foot	Relative Density
0 - 4	Very Loose
4 - 10	Loose
10 - 30	Medium Dense
30 - 50	Dense
> 50	Very Dense

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Email: yousef@science-engineer.com

SECTION 024119 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Demolition and removal of selected portions of building or structure.
2. Demolition and removal of selected site elements.
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.

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 040110 - MASONRY CLEANING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes cleaning the following:

1. Unit masonry surfaces.
2. Stone surfaces.

1.2 DEFINITIONS

A. Low-Pressure Spray: **100 to 400 psi**

B. Medium-Pressure Spray: **400 to 800 psi** .

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.5 QUALITY ASSURANCE

A. Mockups: Prepare mockups of cleaning on existing surfaces to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Cleaning: Clean an area **approximately 25 sq. ft.** for each type of masonry and surface condition.
   a. Test cleaners and methods on samples of adjacent materials for possible adverse reactions. Do not test cleaners and methods known to have deleterious effect.
   b. Allow a waiting period of not less than seven days after completion of sample cleaning to permit a study of sample panels for negative reactions.

PART 2 - PRODUCTS

2.1 CLEANING MATERIALS

A. Water: Potable.

B. Hot Water: Water heated to a temperature of 140 to 160 deg F.

C. Detergent Solution, Job Mixed: Solution prepared by mixing 2 cups of tetrasodium pyrophosphate (TSPP), 1/2 cup of laundry detergent, and 20 quarts of hot water for every 5 gal. of solution required.

2.2 CHEMICAL CLEANING SOLUTIONS

A. All chemical cleaners shall be submitted for approval and a test area performed for acceptance prior to any cleaning work being performed. Submit all data sheets for shop drawing review prior to start of any masonry work.

PART 3 - EXECUTION

3.1 PROTECTION

A. Comply with each manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products. Prevent paint removers and chemical cleaning solutions from coming into contact with people, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

1. Cover adjacent surfaces with materials that are proven to resist paint removers and chemical cleaners used unless products being used will not damage adjacent surfaces. Use protective materials that are waterproof and UV resistant. Apply masking agents according to manufacturer's written instructions. Do not apply liquid strippable masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.

3.2 CLEANING MASONRY, GENERAL

A. Cleaning Appearance Standard: Cleaned surfaces are to have a uniform appearance as viewed from 25 feet away by Architect.

B. Proceed with cleaning in an orderly manner; work from [**bottom to top**] [**top to bottom**] of each scaffold width and from one end of each elevation to the other. Ensure that dirty residues and rinse water do not wash over dry, cleaned surfaces.

C. Use only those cleaning methods indicated for each masonry material and location.

1. Brushes: Do not use wire brushes or brushes that are not resistant to chemical cleaner being used.
2. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that cleaning methods do not damage surfaces, including joints.
   a. Equip units with pressure gages.

b. For chemical-cleaner spray application, use low-pressure tank or chemical pump suitable for chemical cleaner indicated, equipped with nozzle having a cone-shaped spray.
c. For water-spray application, use fan-shaped spray that disperses water at an angle of 25 to 50 degrees.
d. For heated water-spray application, use equipment capable of maintaining temperature between 140 and 160 deg F at flow rates indicated.

D. Perform each cleaning method indicated in a manner that results in uniform coverage of all surfaces, including corners, moldings, and interstices, and that produces an even effect without streaking or damaging masonry surfaces. Keep wall wet below area being cleaned to prevent streaking from runoff.

E. Perform additional general cleaning, paint and stain removal, and spot cleaning of small areas that are noticeably different when viewed according to the "Cleaning Appearance Standard" Paragraph, so that cleaned surfaces blend smoothly into surrounding areas.

F. Water-Spray Application Method: Unless otherwise indicated, hold spray nozzle at least 6 inches from masonry surface and apply water in horizontal back-and-forth sweeping motion, overlapping previous strokes to produce uniform coverage.

G. Chemical-Cleaner Application Methods: Apply chemical cleaners to masonry surfaces according to chemical-cleaner manufacturer's written instructions; use brush near adjacent sensitive surfaces and spray application otherwise. **Do not spray apply at pressures exceeding 50 psi .** Do not allow chemicals to remain on surface for periods longer than those indicated or recommended in writing by manufacturer.

H. Tape off adjacent glass and aluminum or steel frame items to avoid chemical or spray damage throughout the duration of the cleaning process.

I. Rinse off chemical residue and soil by working upward from bottom to top of each treated area at each stage or scaffold setting. Periodically during each rinse, test pH of rinse water running off of cleaned area to determine that chemical cleaner is completely removed.

1. Apply neutralizing agent and repeat rinse if necessary to produce tested pH of between 6.7 and 7.5 as recommended or required by the manufacturer and good practices.

3.3 PRELIMINARY CLEANING

A. Removing Plant Growth: Completely remove visible plant, moss, and shrub growth from masonry surfaces. Carefully remove plants, creepers, and vegetation by cutting at roots and allowing remaining growth to dry as long as possible before removal. Remove loose soil and plant debris from open joints to whatever depth they occur.

B. Preliminary Cleaning: Before beginning general cleaning, remove extraneous substances that are resistant to planned cleaning methods. Extraneous substances include paint, calking, asphalt, and tar.

1. Carefully remove heavy accumulations of rigid materials from masonry surface with sharp chisel. Do not scratch or chip masonry surface.

3.4 PAINT REMOVAL

A. Paint-Remover Application, General: Apply paint removers according to paint-remover manufacturer's written instructions. Do not allow paint removers to remain on surface for periods longer than those indicated or recommended in writing by manufacturer.

B. Paint Removal with Covered or Skin-Forming Alkaline Paint Remover:

3.5 CLEANING MASONRY

A. Detergent Cleaning:

1. Wet surface with **hot** water applied by low-pressure spray.
2. Scrub surface with detergent solution using medium-soft brushes until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from mortar joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that surface remains wet.
3. Rinse with **hot** water applied by **medium**-pressure spray to remove detergent solution and soil.
4. Repeat cleaning procedure above where required to produce cleaning effect established by mockup.

B. Mild-Acid Chemical Cleaning:

1. Wet surface with cold water applied by low-pressure spray.
2. Apply cleaner to surface **in two applications** by brush where adjacent to sensitive materials such as glass, aluminum or steel components.
3. Let cleaner remain on surface for period **recommended in writing by chemical-cleaner manufacturer and tested on mockup at site.**
4. Rinse with cold water applied by **medium**-pressure spray to remove chemicals and soil.
5. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.

C. Acidic Chemical Cleaning:

1. Wet surface with cold water applied by low-pressure spray.
2. Apply cleaner to surface **in two applications** by brush where adjacent to sensitive areas such as aluminum, glass or steel taping off sensitive areas to avoid potential etching.
3. Let cleaner remain on surface for period **recommended in writing by chemical-cleaner manufacturer and tested on mockup area.**
4. Rinse with cold water applied by **medium-p**ressure spray to remove chemicals and soil. Rinse until all foaming, if any, stops and suds disappear.
5. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.

END OF SECTION 040110

SECTION 040513 - MASONRY MORTARING

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.

1.2 SUMMARY

A. Section includes mortar and grout used at all masonry work

B. It is the intent that work of the Section be performed by Contractor performing work of Section 042000 " Unit Masonry"

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 SUBMITTALS

A. Product Data: For each type of product indicated

B. Samples for Initial Selection: For the following:

1. Colored mortar (not required this project).

C. Samples for Verification: For each type and color of the following:

1. Pigmented mortar. Make Samples using same sand and mortar ingredients to be used on Project. (not required this project).

D. Qualification Data: For testing agency

E. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturer's product names, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.

1. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of the Architect and approved in writing.

F. Materials Certificates: Include statements of materials properties indicating compliance with requirements including compliance with standards and type designations within standards. Provide for each type and size of the following:

1. Cementituous materials. Include brand, type, and name of manufacturer.
2. Pre-blended, dry mortar mixes. Include description of type and proportions of ingredients.
3. Grout mixes. Include description of type and proportions of ingredients.

G. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports, per ASTM C 780, for mortar mixes required to comply with property specifications
2. Include test reports, per ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

H. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide a statement of net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602

I. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold0weather requirements.

1.5 QUALITY ASSURANCE

A. This section outlines only minimum standards and requirements. Refer to the Drawings, and other sections of the specifications for additional requirements. Bring all conflicts and discrepancies to the attention of the Architect and do not start work until such conflicts and discrepancies and clarified and corrected. Failure to do so will not relieve the Contractor from performing the Work correctly at no additional expense to the Owner.

B. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1093 for testing indicated, as documented according to ASTM E 548

C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from a single manufacturer for each cementituous component and from one source or producer for each aggregate.

D. Contractor to provide a sample brick panel of at least 100 face brick to be laid up with specified jointing for approval by Owner. A sample panel must be provided for each pattern. Condition.

E. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Section 013100 “ Project Management Coordination”

F. Store cementituous materials on elevated platforms, under cover, and in dry location. Do not use cementituous materials that have become damp

G. Store aggregates where grading and other required characteristics can be maintained and contamination be avoided.

H. Deliver pre-blended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store pre-blended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.

I. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

J. Cold-Weather Requirements: Do no use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damage by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602

K. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602

PART 2 - Part II - PRODUCTS

2.1 MATERIALS AND PRODUCTS

A. Cements:

1. Masonry Cement: Shall not be used.
2. Portland Cement: ASTM C150 Type I, gray or white color as required to produce mortar colored indicated.

B. Admixture: Setting accelerators or antifreeze compounds are not permitted.

C. Masonry Aggregate: ASTM 144, standard masonry type.

D. Grout Aggregate: ASTM C404, fine and coarse.

E. Water: Fresh, clean, and free from acid, alkalis, sewage, or organic matter.

F. Hydrated Lime: ASTM C206, Type S

G. Mortar Color: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortars.

1. Approved Manufacturers: One (1) of the following or Architect approved equal. (Not required this project).
   a. “SGS Mortar Color”: Solomon Grind-Chem Service, Inc.
   b. “True Tone Mortar Colors”: Davis Colors
2. Color shall be as selected by the Owner and Architect from manufacturer’s full range. (Not required this project).

H. Integral Water Repellant Agent: One (1) of the following or Architect approved equal.

1. “Dry-Block Mortar Admixture”: W.R. Grace & Co.

2. "RainBloc for Mortar" ACM Chemistries, Inc.
3. "Krete Gard Mortar Mix";Krete Industries, Inc.
4. "Rheopel Mortar Admixture." BASF Master Builders.

I. Mortar Mixes for CMU Walls: ASTM C270, Type S using proportion specification.

J. Mortar for Face Brick: Type N using proportion specification

2.2 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Limit cementituous materials in mortar, including that for exterior and reinforced masonry, to Portland cement, aggregate, and lime.

B. Grout for Unit Masonry: Comply with ASTM 476

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimension of grout spaces and pour height.
2. Provide grout with a slump of 8" to 11" as measured according to ASTM C143

PART 3 - Part III – EXECUTION

3.1 MIXING

A. Thoroughly mix mortar ingredients in strict accordance with admixture manufacturer's specifications and in accordance with ASTM C270

B. Mix only sufficient mortar to supply immediate requirements.

C. Mix by mechanical means, if possible

D. Keep proportion constant

E. Achieve uniformly damp sand immediately before mixing process.

F. Add mortar color to achieve uniformity of mix and colorant. Limit mineral-oxide pigments to no more than 10% of cement content by weight (Not required this project).

G. Add water repellent admixture to mortar used for bedding decorative concrete masonry units containing integral water repellent.

H. Re-temper only within 2 hours of mixing

I. Install mortar and grout in accordance with Section 042000 "Unit Masonry"

J. Lay hollow concrete masonry units (CMU) as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
2. With webs fully bedded in mortar in all courses of piers, columns and pilasters.
3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

K. Lay solid masonry units with completely filled bed and head joints butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints

L. Low-Lift Grouting:

1. Use Low-Lift grouting techniques for all walls and bond beams.
2. Provide minimum clear dimension of 2” and clear area of 8 in2 in vertical cores to be grouted.
3. Place vertical reinforcement prior to laying CMU. Extend above elevation of maximum pour height as required for splicing. Support in position at vertical intervals not exceeding 192 bar diameters nor 10’-0”.
4. Place horizontal beam reinforcement as the masonry units are laid.
5. Lay CMU to maximum pour height. Do not exceed 5’ height, or if bond beam occurs below 5’ height stop pour at course below bond beam.
6. Pour grout using chute or container with spout. Rod or vibrate grout during placing. Place grout continuously; do not interrupt pouring of grout for more than 1 hour. Terminate grout pours 1½” below top course of pour/
7. Bond Beams: Stop grout in vertical cells 1½” below bond beam course. Place horizontal reinforcing in bond beams; lap at corners and intersections as shown. Place grout in bond beam course before filling vertical cores above bond beam.

M. Comply with Section 014000 “Quality Requirements” for field inspecting and testing.

N. Testing Frequency:

1. 1 set of prism tests for every 5,000 ft2 of completed wall area.
2. 1 set of mortar tests in accordance with ASTM C780 for aggregate ratio and water content, consistency, and compressive strength, for every 25 cu. yds. Mortar
3. 1 set of grout tests in accordance with ASTM C780 for compressive strength and slump, for every 25 cu. yds grout.

O. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

END OF SECTION 040513

SECTION 040523 - MASONRY ACCESSORIES

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.

B. Reference structural drawings for specific masonry anchoring requirements and application requirements for Windstorm Requirements.

1.2 SUMMARY

A. Section includes masonry accessories required to complete work.

B. It is the intent that work of this Section be performed by Contractor performing work of Section 042000 “Unit Masonry”

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 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples for Initial Selection: For the following:

1. Joint reinforcement
2. Anchors, ties, and metal accessories.
3. Weep holes/vent.

C. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturer’s product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.

D. Material Certificates: Include statements of material properties indicating compliance with requirements including compliance with standards and type designations within standards. Provide for each type and size of the following :

1. Joint reinforcement
2. Anchors, ties, and metal accessories.

1.5 QUALITY ASSURANCE

A. This section only outlines the minimum standards and requirements. Refer to the Drawings, and other sections of the specifications for additional requirements. Bring all conflicts and discrepancies to the attention of the Architect and do not start work until such conflicts and discrepancies are clarified and corrected. Failure to do so will not relieve the Contractor from performing the Work correctly at no additional expense to the Owner.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

PART 2 - Part II - PRODUCTS

2.1 JOINT REINFORCEMENT

A. Wall Ties: Specifications are based on “Wire-Bond” manufactured by Masonry Reinforcing Corporation of America, or Architect approved equal by 1 of the following:

1. “Dur-O-Wall Products”; Dayton Superior Corporation
2. Heckmann Building Products, Inc.
3. Hohmann & Barnard, Inc.

B. At all single wythe masonry walls, provide “Wire-Bond” Truss-type Series 300 2-wire masonry wall reinforcing, or Architect approved equal by approved manufacturer. Out-to-out spacing of longitudinal wires shall be approximately 2” less than the nominal thickness of the block. Mill galvanized finish.

C. At all masonry walls with structural steel backup, provide “Wire-Bond” 1001, Type II anchors, or Architect approved equal by approved manufacturer.

D. Corners and tees shall be used at all corners and wall intersections.

2.2 CAVITY DRAINAGE MATERIAL

A. Mortar Netting: Specifications are based on “Mortar Net” manufactured by Masonry Reinforcing Corporation of America, or Architect approved equal by 1 of the following:

1. Dur-O-Wall Products”; Dayton Superior Corporation; “Mortar Net DA 1008”
2. Heckmann Building Products, Inc.; #84-2, Weep-Thru Mortar Deflector”
3. Hohmann & Barnard, Inc; “Mortar Net”

B. Install 2” wide, 10” high free-draining mesh, made from polymer strands that will not degrade within the wall cavity, on top of the flashing inside the wall cavity.

C. All proposed substitutions must be submitted to the Architect for review and possible approval of both the manufacturer and the specified product.

2.3 WEEP HOLES/VENTS

A. Louvered vents extrusions not required if masonry contractor maintains clean weep holes clean drain cavities.

PART 3 - Part III – EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.

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

3.2 INSTALLATION

A. Attached veneer anchors in accordance with manufacturer's instructions to studs at 15" o.c. vertically and 16" o.c. horizontally for face brick and 16" o.c. vertically.

B. Corners and tees shall be used at all corners and wall intersections.

C. Interrupt joint reinforcement at control and expansion joints.

D. Place wire into a bed of mortar and seat in the mortar bed by frequent lifting of the cross rod.

E. Install mortar netting in accordance with manufacturer's instructions at all exterior double wythe masonry walls, all exterior masonry walls with stud backup wall, all exterior masonry walls with metal panel backup wall, and all other exterior masonry walls with a cavity behind exterior wythe.

F. Weep Holes/ Vents: Install stamped aluminum louvered vents of size to fit head joints in brickwork or blockwork in accordance with manufacturer's instructions. Plug anchorage by use of wood or plastic is prohibited.

3.3 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form expansion joints in bricks made from clay or shale by forming open joint full depth of brick wythe and of width indicated, but not less than 1/2" for the installation of sealant and backer rod specified in Section 079200 "Joint Sealants"

C. Provide horizontal, pressure-relieving joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified in Section 079200 “Joint Sealants”, but no less than 3/8”.

END OF SECTION 040523

SECTION 042000 – CONCRETE UNIT MASONRY (INTERIOR APPLICATION ONLY)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Face Brick

1.2 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For reinforcing steel. Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315.

C. Samples for Verification: For each type and color of exposed masonry unit and colored mortar.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each type and size of product. For masonry units, include material test reports substantiating compliance with requirements.

B. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
2. Include test reports, according to ASTM C1019, for grout mixes required to comply with compressive strength requirement.

1.5 QUALITY ASSURANCE

A. Sample Panels: Build sample panels to verify selections made under Sample submittals and to demonstrate aesthetic effects. Comply with requirements in Section 014000 "Quality Requirements" for mockups.

1. Build mock-up of typical wall area as shown on drawings.
   a. Include a sealant-filled joint at least 16" long in each exterior wall mock-up.
   b. Include a through-wall flashing installed for a 24" length in corner of exterior wall mock-up approximately 16" down from top of mark-up, with a 12" length of flashing left exposed to view. Omit masonry above half of flashing.
   c. Include steel girts, sheathing, weather barrier membrane, wall panels and base trim/ flashing.
2. Protect accepted mockups from the elements with weather-resistant membrane.
3. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints and aesthetic qualities of workmanship.
4. Approval of mockups is also for the assembly of different wall components of the exterior wall to demonstrate weather-tightness, aesthetic and quality of workmanship specifically approved by Architect-in writing.
5. Approval of mockups does not constitute appoval of deviations from the Contract Documents contained in mockups unless deviations are specifically approved by Architect in writing.

1.6 FIELD CONDITIONS

A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

B. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

PART 2 - PRODUCTS

2.1 UNIT MASONRY, GENERAL

A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6, except as modified by requirements in the Contract Documents.

B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed work, and will be within 15 feet vertically and horizontally of a walking surface.

C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.

1. Where fire-resistance-rated construction is indicated, units shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

2.2 CONCRETE MASONRY UNITS

A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.

B. CMUs: ASTM C90.

1. Density Classification: Normal weight unless otherwise indicated.

C. Concrete Building Brick: ASTM C55.

1. Density Classification: Normal weight.

2.3 CONCRETE LINTELS

A. Concrete Lintels: ASTM C1623, matching CMUs in color, texture, and density classification; and with reinforcing bars indicated. Provide lintels with net-area compressive strength not less than that of CMUs.

2.4 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

B. Hydrated Lime: ASTM C207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Masonry Cement: ASTM C91/C91M. - Shall not be used.

E. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar.

1. Not required in this project.

F. Aggregate for Mortar: ASTM C144.

1. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
2. White-Mortar Aggregates: Natural white sand or crushed white stone.
3. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

G. Aggregate for Grout: ASTM C404.

H. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C494/C494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

1. Admixture: Setting accelerators or antifreeze compounds are not permitted.

I. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent from same manufacturer.

J. Water: Potable.

2.5 REINFORCEMENT

A. Uncoated-Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, Grade 60.

B. Masonry-Joint Reinforcement, General: ASTM A951/A951M.

1. Interior Walls: Hot-dip galvanized carbon steel.
2. Exterior Walls: Hot-dip galvanized carbon steel.
3. Wire Size for Side Rods: 0.187-inch diameter.
4. Wire Size for Cross Rods: 0.187-inch diameter.
5. Wire Size for Veneer Ties: 0.187-inch diameter.
6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
7. Provide in lengths of not less than 10 feet , with prefabricated corner and tee units.

C. Masonry-Joint Reinforcement for Single-Wythe Masonry: Ladder type with single pair of side rods.

D. Masonry-Joint Reinforcement for Multiwythe Masonry:

1. Ladder type with one side rod at each face shell of hollow masonry units more than 4 inches wide, plus one side rod two side rods at each wythe of masonry 4 inches wide or less.
2. Tab type, either ladder or truss design, with one side rod at each face shell of backing wythe and with rectangular tabs sized to extend at least halfway through facing wythe, but with at least 5/8-inch cover on outside face.
3. Adjustable (two-piece) type, either ladder or truss design, with one side rod at each face shell of backing wythe and with separate adjustable ties with pintle-and-eye connections having a maximum horizontal play of 1/16 inch and maximum vertical adjustment of 1-1/4 inches. Size ties to extend at least halfway through facing wythe but with at least 5/8-inch cover on outside face. Ties have hooks or clips to engage a continuous horizontal wire in the facing wythe.

E. Masonry-Joint Reinforcement for Veneers Anchored with Seismic Masonry-Veneer Anchors: Single 0.187-inch- diameter, hot-dip galvanized carbon steel continuous wire.

2.6 TIES AND ANCHORS

A. General: Ties and anchors shall extend at least 1-1/2 inches into veneer but with at least a 5/8-inch cover on outside face.

B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:

1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A82/A82M, with ASTM A153/A153M, Class B-2 coating.
2. Steel Sheet, Galvanized after Fabrication: ASTM A1008/A1008M, Commercial Steel, with ASTM A153/A153M, Class B coating.
3. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

C. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches wide.

1. Wire: Fabricate from 1/4-inch- diameter, hot-dip galvanized-steel wire.

D. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- diameter, hot-dip galvanized-steel wire.
2. Tie Section: Triangular-shaped wire tie made from 0.25-inch- diameter, hot-dip galvanized-steel wire.

E. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Connector Section: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.105-inch- thick steel sheet, galvanized after fabrication
2. Tie Section: Triangular-shaped wire tie made from 0.25-inch- diameter, hot-dip galvanized-steel wire.

F. Partition Top Anchors: 0.105-inch- thick metal plate with a 3/8-inch- diameter metal rod 6 inches long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.

G. Rigid Anchors: Fabricate from steel bars 1-1/2 inches wide by 1/4 inch thick by 24 inches long, with ends turned up 2 inches or with cross pins unless otherwise indicated.

1. Corrosion Protection: Hot-dip galvanized to comply with ASTM A153/A153M .

H. Adjustable Masonry-Veneer Anchors:

1. General: Provide anchors that allow vertical adjustment but resist a 100-lbf load in both tension and compression perpendicular to plane of wall without deforming or developing play in excess of 1/16 inch.
2. Fabricate sheet metal anchor sections and other sheet metal parts from 0.105-inch- thick steel sheet, galvanized after fabrication.
3. Fabricate wire ties from 0.25-inch- diameter, hot-dip galvanized-steel wire unless otherwise indicated.
4. Screw-Attached, Masonry-Veneer Anchors: Wire tie and a rib-stiffened, sheet metal anchor section.

a. Manufacturer and Type: Hohmann and Barnard, inc. - DW-10Material: 14 gauge plate with 1/4" Vee Byna-Tie, corrosion resistant 10-16x 1 1/2" HWH T/3 veneer screws with bond seal aluminum washers and X-Seal tape. Fabrication: Allow for maximum joint misalignment of 1 1/2".Finish: Hot dipped galvanized ASTM A 153 (1.5 oz psf)

5. Screw-Attached, Masonry-Veneer Anchors: Wire tie and a gasketed sheet metal anchor section, with pronged legs of length to match thickness of insulation or sheathing and raised rib-stiffened strap to provide a slot for inserting wire tie.
6. Coated, Steel Drill Screws for Steel Studs: ASTM C954 except with hex washer head and neoprene or EPDM washer, No. 10 diameter, and with coating with salt-spray resistance to red rust of more than 800 hours according to ASTM B117.

2.7 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use portland cement-lime mortar unless otherwise indicated.
3. For exterior masonry, use portland cement-lime mortar.
4. For reinforced masonry, use portland cement-lime mortar.
5. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.

1. For masonry below grade or in contact with earth, use Type M.
2. For reinforced masonry, use Type M Type S Type N.
3. For mortar parge coats, use Type S or Type N.
4. For exterior, above-grade, load-bearing and nonload-bearing walls and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions; and for other applications where another type is not indicated, use Type N.
5. For interior nonload-bearing partitions, Type O may be used instead of Type N.

D. Grout for Unit Masonry: Comply with ASTM C476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi.
3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C143/C143M.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

B. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.

3.2 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch or minus 1/4 inch.
2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.
3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet, or 1/2-inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2-inch maximum.
3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2-inch maximum.
5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
3. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.

3.3 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.

C. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

D. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

E. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

3.4 MORTAR BEDDING AND JOINTING

A. Lay CMUs as follows:

1. Bed face shells in mortar and make head joints of depth equal to bed joints.
2. Bed webs in mortar in all courses of piers, columns, and pilasters.
3. Bed webs in mortar in grouted masonry, including starting course on footings.
4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Lay structural clay tile as follows:

1. Lay vertical-cell units with full head joints unless otherwise indicated. Provide bed joints with full mortar coverage on face shells and webs.
2. Lay horizontal-cell units with full bed joints unless otherwise indicated. Keep drainage channels, if any, free of mortar. Form head joints with sufficient mortar so excess will be squeezed out as units are placed in position. Butter both sides of units to be placed, or butter one side of unit already in place and one side of unit to be placed.
3. Maintain joint thicknesses indicated except for minor variations required to maintain bond alignment. If not indicated, lay walls with 1/4- to 3/8-inch- thick joints.

D. Rake out mortar joints at CMU to a uniform depth of 1/4 inch and point with epoxy mortar to comply with epoxy-mortar manufacturer's written instructions.

E. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

F. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.5 MASONRY-JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

1. Space reinforcement as indicated on structural drawings for windstorm requirments.
2. Space reinforcement per structural requirements in foundation walls and parapet walls.
3. Provide reinforcement above and below wall openings per structural requirements.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

3.6 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to comply with the following:

1. Provide an open space not less than 1/2 inch wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated on structural drawings for windstorm.

3.7 REINFORCED UNIT MASONRY

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and that of other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in TMS 602/ACI 530.1/ASCE 6 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 60 inches 12.67 ft. .

3.8 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

B. Inspections: Special inspections according to Level B C in TMS 402/ACI 530/ASCE 5.

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Prior to Construction: One set of tests.

D. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.

E. Clay Masonry Unit Test: For each type of unit provided, according to ASTM C67 for compressive strength.

F. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C140 for compressive strength.

G. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C780.

H. Grout Test (Compressive Strength): For each mix provided, according to ASTM C1019.

3.9 PARGING

A. Parge exterior faces of below-grade masonry walls, where indicated, in two uniform coats to a total thickness of 3/4 inch. Dampen wall before applying first coat, and scarify first coat to ensure full bond to subsequent coat.

B. Use a steel-trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of 1/8 inch per foot. Form a wash at top of parging and a cove at bottom.

C. Damp-cure parging for at least 24 hours and protect parging until cured.

3.10 REPAIRING, POINTING, AND CLEANING

A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes.
3. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.

3.11 MASONRY WASTE DISPOSAL

A. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Do not dispose of masonry waste as fill within 18 inches of finished grade.

B. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.

C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042000

SECTION 042200 - CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Decorative concrete masonry units.
3. Pre-faced concrete masonry units.
4. Steel reinforcing bars.

1.2 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For reinforcing steel. Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315.

C. Samples: For each type and color of the following:

1. Exposed CMUs.
2. Pre-faced CMUs.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each type and size of product. For masonry units, include material test reports substantiating compliance with requirements.

B. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
2. Include test reports, according to ASTM C1019, for grout mixes required to comply with compressive strength requirement.

1.5 QUALITY ASSURANCE

A. Sample Panels: Build sample panels to verify selections made under Sample submittals and to demonstrate aesthetic effects. Comply with requirements in Section 014000 "Quality Requirements" for mockups.

1. Build sample panels for each type of exposed unit masonry construction typical exterior and interior walls in sizes approximately **48 inches** long by 48 inches high by full thickness.

1.6 FIELD CONDITIONS

A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

B. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

PART 2 - PRODUCTS

2.1 UNIT MASONRY, GENERAL

A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6, except as modified by requirements in the Contract Documents.

B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work.

C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.

1. Where fire-resistance-rated construction is indicated, units shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

2.2 CONCRETE MASONRY UNITS

A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.

B. Integral Water Repellent: Provide units made with integral water repellent for exposed units and where indicated.

C. Insulated CMUs: Where indicated, units shall contain rigid, specially shaped, molded-polystyrene insulation units complying with ASTM C578, Type I, designed for installing in cores of masonry units.

D. CMUs: ASTM C90.

1. Density Classification: Normal weight unless otherwise indicated.

E. Concrete Building Brick: ASTM C55.

1. Density Classification: [Normal weight].

F. Decorative CMUs: ASTM C90.

1. Density Classification: Normal weight.
2. Pattern and Texture:
   a. Standard pattern, ground-face finish. Match Architect's samples.
   b. Standard pattern, split-face finish. Match Architect's samples.
   c. Standard pattern, split-ribbed finish. Match Architect's samples.
   d. Scored vertically, standard finish. Match Architect's samples.

2.3 CONCRETE LINTELS

A. Concrete Lintels: ASTM C1623, matching CMUs in color, texture, and density classification; and with reinforcing bars indicated. Provide lintels with net-area compressive strength not less than that of CMUs.

2.4 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

B. Hydrated Lime: ASTM C207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar.

E. Colored Cement Products: Packaged blend made from portland cement and hydrated lime and mortar pigments, all complying with specified requirements, and containing no other ingredients.

F. Aggregate for Mortar: ASTM C144.

1. White-Mortar Aggregates: Natural white sand or crushed white stone.

2. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

G. Aggregate for Grout: ASTM C404.

H. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C494/C494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

I. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent from same manufacturer.

J. Water: Potable.

2.5 REINFORCEMENT

A. Uncoated-Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, Grade 60.

B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

C. Masonry-Joint Reinforcement, General: ASTM A951/A951M.

1. Interior Walls: Hot-dip galvanized, carbon steel.
2. Wire Size for Side Rods: [**0.148-inch**] diameter.
3. Wire Size for Cross Rods: [**0.148-inch**] diameter.
4. Spacing of Cross Rods: Not more than 16 inches o.c.
5. Provide in lengths of not less than 10 feet , with prefabricated corner and tee units.

2.6 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:

1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A82/A82M, with ASTM A153/A153M, Class B-2 coating.
2. Steel Sheet, Galvanized after Fabrication: ASTM A1008/A1008M, Commercial Steel, with ASTM A153/A153M, Class B coating.
3. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

B. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- diameter, hot-dip galvanized-steel wire.
2. Tie Section: Triangular-shaped wire tie made from 0.187-inch- diameter, hot-dip galvanized-steel wire.

C. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Connector Section: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from [**0.060-inch- thick steel sheet, galvanized after fabrication**] [**0.105-inch- thick steel sheet, galvanized after fabrication**].
2. Tie Section: Triangular-shaped wire tie made from 0.187-inch- diameter, hot-dip galvanized-steel wire.

D. Partition Top Anchors: 0.105-inch- thick metal plate with a 3/8-inch- diameter metal rod 6 inches long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.

E. Rigid Anchors: Fabricate from steel bars 1-1/2 inches wide by 1/4 inch thick by 24 inches long, with ends turned up 2 inches or with cross pins unless otherwise indicated.

1. Corrosion Protection: Hot-dip galvanized to comply with ASTM A153/A153MorEpoxy coating 0.020 inch thick.

2.7 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene .

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D2000, Designation M2AA-805 [**or**] PVC, complying with ASTM D2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D226/D226M, Type I (No. 15 asphalt felt).

2.8 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use portland cement-lime mortar unless otherwise indicated.
3. For exterior masonry, use portland cement-lime mortar.
4. For reinforced masonry, use portland cement-lime mortar.
5. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated.

1. For masonry below grade or in contact with earth, use Type M .
2. For reinforced masonry, use Type S .
3. For mortar parge coats, use Type S .
4. For exterior, above-grade, load-bearing and nonload-bearing walls and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions; and for other applications where another type is not indicated, use Type N.
5. For interior nonload-bearing partitions, Type O may be used instead of Type N.

D. Pigmented Mortar: Use colored cement product [**or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products**].

1. Pigments shall not exceed 10 percent of portland cement by weight.
2. Pigments shall not exceed 5 percent of masonry cement by weight.
3. Application: Use pigmented mortar for exposed mortar joints with the following units:
   a. Decorative CMUs.
   b. Pre-faced CMUs.

E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.

1. Application: Use colored-aggregate mortar for exposed mortar joints with the following units:
   a. Decorative CMUs.
   b. Pre-faced CMUs.

F. Grout for Unit Masonry: Comply with ASTM C476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C476 or]paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi].
3. Provide grout with a slump of [10 to 11 inches] as measured according to ASTM C143/C143M.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

3.2 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch or minus 1/4 inch.
2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.
3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet, or 1/2-inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2-inch maximum.
3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2-inch maximum.
5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
3. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.

3.3 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.

C. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

D. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

E. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.

F. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

3.4 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:

1. Bed face shells in mortar and make head joints of depth equal to bed joints.
2. Bed webs in mortar in all courses of piers, columns, and pilasters.
3. Bed webs in mortar in grouted masonry, including starting course on footings.
4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.

B. Lay solid CMUs with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.5 MASONRY-JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

1. Space reinforcement not more than 16 inches o.c.
2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings [**in addition to continuous reinforcement**].

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

3.6 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to comply with the following:

1. Provide an open space not less than [**1/2 inch**] [**1 inch**] [**2 inches**] wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.

2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

3.7 REINFORCED UNIT MASONRY

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and that of other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in TMS 602/ACI 530.1/ASCE 6 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 60 inches.

3.8 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

B. Inspections: Special inspections according to Level [**B**] [**C**] in TMS 402/ACI 530/ASCE 5.

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Prior to Construction: One set of tests.

D. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.

E. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C140 for compressive strength.

F. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C780.

G. Mortar Test (Property Specification): For each mix provided, according to ASTM C780. Test mortar for **mortar air content and compressive strength**.

H. Grout Test (Compressive Strength): For each mix provided, according to ASTM C1019.

I. Prism Test: For each type of construction provided, according to ASTM C1314 at [**seven days and at**]28 days.

3.9 PARGING

A. Parge exterior faces of below-grade masonry walls, where indicated, in two uniform coats to a total thickness of 3/4 inch. Dampen wall before applying first coat, and scarify first coat to ensure full bond to subsequent coat.

B. Use a steel-trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of 1/8 inch per foot. Form a wash at top of parging and a cove at bottom.

C. Damp-cure parging for at least 24 hours and protect parging until cured.

3.10 REPAIRING, POINTING, AND CLEANING

A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes.
2. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.

3.11 MASONRY WASTE DISPOSAL

A. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Do not dispose of masonry waste as fill within 18 inches of finished grade.

B. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.

C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042200

SECTION 054000 - COLD-FORMED METAL FRAMING

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 064116 - PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plastic-laminate-clad architectural cabinets.
2. Cabinet hardware and accessories.
3. Wood furring, blocking, shims, and hanging strips for installing plastic-laminate-clad architectural cabinets that are not concealed within other construction.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

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

B. Sustainable Design Submittals:

1. Contractor to provide containers for recycling of products and coordination of pick-up on the construction site.

C. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Apply **WI Quality Certification** Program label to Shop Drawings.

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

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For plastic laminate casework manufacturer, company must have a minimum of 10 years continuous operation fabricating and installing plastic laminate casework.

B. Research reports.

C. Field quality control reports.

1.5 CLOSEOUT SUBMITTALS

A. Quality Standard Compliance Certificates: A**WI Certified Compliance Program** certificates.

1.6 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

1. Manufacturer's Certification: **Licensed participant in AWI's Quality Certification Program**.

B. Installer Qualifications: **Manufacturer of products Licensed participant in AWI's Quality Certification Program.**

1.7 FIELD CONDITIONS

A. Environmental Limitations without Humidity Control: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.

B. Environmental Limitations with Humidity Control: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between **25 and 55** percent during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 ARCHITECTURAL CABINET MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, Manufacturer’s shall be pre-approved based on submission of qualifications.

2.2 PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of cabinets indicated for construction, finishes, installation, and other requirements.

1. Provide **AWI** certification program indicating that woodwork complies with requirements of grades specified.

B. Architectural Woodwork Standards Grade: **Custom**.

C. Type of Construction: **Frameless**.

D. Door and Drawer-Front Style: **Flush**.

E. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by quality standard.

F. Laminate Cladding for Exposed Surfaces:

1. Horizontal Surfaces: **Grade HGS**.
2. Postformed Surfaces: Grade HGP.
3. Vertical Surfaces: **Grade HGS**
4. Edges: **Grade HGS matching laminate in color, pattern, and finish**]
5. Pattern Direction: **Vertically for drawer fronts, doors, and fixed panels**.

G. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, NEMA LD 3, Grade BKL.

H. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.

1. Join subfronts, backs, and sides with **glued rabbeted joints supplemented by mechanical fasteners**.

I. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

1. As indicated by laminate manufacturer's designations.
2. Match Architect's sample.
3. As selected by Architect from laminate manufacturer's full range.

2.3 WOOD MATERIALS

A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.

1. Wood Moisture Content: [**5 to 10**] [**8 to 13**] [**4 to 9**] percent.

B. Composite Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.

1. Particleboard (Medium Density): ANSI A208.1, **Grade M-2-Exterior Glue**.

2.4 CABINET HARDWARE AND ACCESSORIES

A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets except for items specified as follows:

B. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, B01602, **135 minimum** degrees of opening soft self-closing.

C. Back-Mounted Pulls: ANSI/BHMA A156.9, B02011.

D. Wire Pulls: Back mounted, solid polished chrome, 6" **long, 5/16 inch in diameter.**

E. Adjustable Shelf Standards and Supports: [**ANSI/BHMA A156.9, B04071; with shelf rests, B04081**] **shelves routed to receive adjustable height metal shelf clips**.

F. Drawer Slides: ANSI/BHMA A156.9.

1. Heavy-Duty (Grade 1HD-100 and Grade 1HD-200): **Side mount**
   a. **Full** extension.
   b. Material: **Zinc-plated ball bearing**] slides.

G. Door and Drawer Silencers: ANSI/BHMA A156.16, L03011.

H. Grommets for Cable Passage: Where noted on drawings.

1. Color: Verify color to coordinate with laminate selection.

I. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with ANSI/BHMA A156.18 for ANSI/BHMA finish number indicated.

1. Satin Stainless Steel: ANSI/BHMA 630.

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

2.5 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: [**Softwood or hardwood lumber**] [**Fire-retardant-treated softwood lumber**], kiln-dried to less than 15 percent moisture content.

B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

C. Adhesive for Bonding Plastic Laminate: Manufacturer's best practices adhesive recommendation for this heavy-duty application.

1. Adhesive for Bonding Edges: A**dhesive system** for extreme durable edging finish.

2.6 FABRICATION

A. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

B. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

C. Install glass to comply with applicable requirements in Section 088000 "Glazing" and in GANA's "Glazing Manual."

1. For glass in frames, secure glass with removable stops.
2. For exposed glass edges, polish and grind smooth.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.

B. Architectural Woodwork Standards Grade: Install cabinets to comply with quality standard grade of item to be installed. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with wafer-head cabinet installation screws.

C. Install cabinets level, plumb, and true in line to a tolerance of 1/8 inch in 96 inches using concealed shims.

1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
2. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
3. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches o.c. with best practices heavy duty anchoring system for each back-up wall system.

3.2 FIELD QUALITY CONTROL

1. Inspections: Provide inspection of installed Work through **WI's Certified Compliance Program** certifying that woodwork, including installation, complies with requirements of

the Architectural Woodwork Standards for the specified grade. Inspection entity shall prepare and submit report of inspection.

END OF SECTION 064116

SECTION 074213.16 – FASTPLANK LINEAR METAL WOOD GRAIN FINISHED WALL PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes prefabricated linear wood grain finished metal plate wall panels to be installed over the pre-engineered metal building wall panels.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at project site with wall mock-up.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment assembly, trim, flashings, closures, and accessories; and special details.

C. Samples: For each type of metal panel indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Warranties: Samples of special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 50 year product warranty.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Finish Warranty Period: 50 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E330:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: **As indicated on Engineering Drawings**.
3. Coordinate anchoring and attachment cleats.
4. This is a veneer application to be installed over the pre-engineered building metal wall panel system.

2.2 METAL PLATE WALL PANELS AS MANUFACTURED BY FASTPLANK SYSTEMS

A. Metal Plate Wall Panels: Furnish 6” Fastplank wood pre-finished metal wall plank system and anchoring components to be installed on the exterior face of a pre-engineered metal wall panel.

B. Panel Dimension: 6” width preformed aluminum T&G interlocking panel with perimeter finished matching trim components.

C. Finish: High performance powder coated finish passing AAMA 2604.Attachment Assembly: Manufacturer's standard.

2.3 MISCELLANEOUS MATERIALS

A. Provide miscellaneous non-ferous clip system to be anchored to pre-engineered metal wall panel system with backer tape and sealant to assure air and moisture barrier with clip anchors anchored in place against vertical metal wall panel.

2.4 FABRICATION

A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

C. Provide manufacturer submittal data showing best methods for this application and all necessary anchoring requirements to assure windstorm anchoring to the metal building side. Provide additional furring members if recommended by Fast Plank.

2.5 FINISHES

A. Aluminum Panels and Accessories:

1. Powder coated wood grain pattern on preformed aluminum linear panels, trim and components.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate with planking manufacturer to assure proper shop drawings are prepared and installation method is in compliance with FastPlank warranty requirements.

B. Do not install any damaged planks; repair or replace as required for smooth and consistent and finished appearance.

C. Attachment Assembly, General: Install attachment assembly required to support metal plate wall panels and to provide a complete weathertight wall system, including subgirts, perimeter extrusions, tracks, drainage channels, panel clips, and anchor channels.

D. Include attachment to supports, panel-to-panel joinery, panel-to-dissimilar-material joinery, and panel-system joint seals.

Coordinate attachment of signage units to proper areas of the planking to avoid any weakening of the panel structural integrity.

3.2 CLEANING

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

END OF SECTION 074213.16

SECTION 084113 - ALUMINUM-FRAMED WINDOWS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aluminum-framed window system.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at project site and review mock-up wall with window frame.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For aluminum storefront windows Include plans, elevations, sections, full-size details, and attachments to other work.

1. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.

C. Samples: For each type of exposed finish required.

1.4 INFORMATIONAL SUBMITTALS

A. Energy Performance Certificates: NFRC-certified energy performance values from manufacturer.

B. Product test reports.

C. Source quality-control reports.

D. Field quality-control reports.

E. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer and that employs a qualified glazing contractor for this Project who is certified under the North American Contractor Certification Program (NACC) for Architectural Glass & Metal (AG&M) contractors and that employs glazing technicians certified under the Architectural Glass and Metal Technician (AGMT) certification program.

B. Testing Agency Qualifications: Qualified according to ASTM E699 for testing indicated and accredited by the International Accreditation Service or the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement as complying with ISO/IEC 17025] and acceptable to Owner and Architect.

C. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

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

B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked-enamel, powder-coat, or organic finishes within specified warranty period.

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

C. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.

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

D. Dual seal Low-E Insulated tinted glass 10 year minimum spoilage warranty from date of Substantial Completion for full replacement by installer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design aluminum-framed entrances and storefronts.

B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Aluminum storefront windows shall withstand movements of supporting structure, including, but not limited to, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
2. Failure also includes the following:
    a. Thermal stresses transferring to building structure.
    b. Glass breakage.
    c. Noise or vibration created by wind and thermal and structural movements.
    d. Loosening or weakening of fasteners, attachments, and other components.

C. Structural Loads:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: Reference structural drawings for wind load requirements.

D. Deflection of Framing Members Supporting Glass: At design wind load, as follows:

1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans of up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans greater than 13 feet 6 inches] <Insert deflection limit>.
2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch.
3. Cantilever Deflection: Limited to 2l/175 at unsupported cantilevers.

E. Structural: Test according to ASTM E330/E330M as follows:

1. When tested at positive and negative wind-load design pressures, storefront assemblies, including entrance doors, do not evidence deflection exceeding specified limits.
2. When tested at **150** percent of positive and negative wind-load design pressures, storefront assemblies, including entrance doors and anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding **0.2** percent of span.
3. Test Durations: As required by design wind velocity, but not less than **10** seconds.

F. Water Penetration under Static Pressure: Test according to ASTM E331 as follows:

1. No evidence of water penetration through fixed glazing and framing areas, including entrance doors, when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than

G. Energy Performance: Certified and labeled by manufacturer for energy performance as follows:

1. Thermal Transmittance (U-factor):
   a. Fixed Glazing and Framing Areas: As mandated by current applicable IBC Energy Conservation Code.
   b. Entrance Doors: As mandated by current applicable IBC Energy Conservation Dode.
2. Solar Heat-Gain Coefficient (SHGC):
   a. Fixed Glazing and Framing Areas: As mandated by current applicable IBC Energy Conservation Code.
   b. Entrance As mandated by IBC Energy Conservation Code.
3. Air Leakage:
   a. Fixed Glazing and Framing Areas: As mandated by current applicable IBC Energy Conservation Code.
   b. Entrance Doors: Air leakage of not more thanas mandated by current applicable IBC Energy Code.
4. Condensation Resistance Factor (CRF):
   a. Fixed Glazing and Framing Areas: CRF for the system of not less than as mandated by current applicable IBC Energy Code.
   b. Entrance Doors: CRF of not less than as mandated by current applicable IBC Energy Code.

H. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for applicable windstorm as established Texas Windstorm Requirements for this geographical location.

I. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes.

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

2.2 STOREFRONT SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. EFCO Corporation.
2. Kawneer North America, an Arconic company.
3. Oldcastle Building Envelope (OBE); CRH Americas.
4. U.S. Aluminum; a brand of C.R. Laurence.
5. YKK AP America Inc.

B. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.

1. Exterior Framing Construction: Thermally Broke Insulated Low E
2. Glazing System: Retained mechanically with gaskets on four sides.
3. Finish: Clear Anodized Aluminum.
4. Fabrication Method: Field-fabricated stick system.
5. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
6. Steel Reinforcement: As required by manufacturer.
7. Interior Storefront System non-wind loaded non-insulated tempered glass.
8. Interior Storefront Medium Style Door.

C. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.

D. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

2.3 GLAZING

A. Glazing: Comply with Section 088000 "Glazing."

B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.

C. Glazing S

2.4 MATERIALS

A. Sheet and Plate: ASTM B209.

B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221.

C. Structural Profiles: ASTM B308/B308M.

D. Steel Reinforcement:

1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.

E. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM, and prepare surfaces according to applicable SSPC standard.

2.5 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Physical and thermal isolation of glazing from framing members.
4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
5. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.

E. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.6 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Comply with manufacturer's written instructions.

B. Do not install damaged components.

C. Fit joints to produce hairline joints free of burrs and distortion.

D. Rigidly secure nonmovement joints.

E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.

F. Seal perimeter and other joints watertight unless otherwise indicated.

G. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

H. Set continuous sill members and flashing in full sealant bed, as specified in Section 079200 "Joint Sealants," to produce weathertight installation.

I. Install joint filler behind sealant as recommended by sealant manufacturer.

J. Install components plumb and true in alignment with established lines and grades.

3.2 INSTALLATION OF GLAZING

A. Install glazing as specified in Section 088000 "Glazing."

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Field Quality-Control Testing: Perform the following test on **mockups**.

1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.
   a. Perform a minimum of [**two**] [**three**] <**Insert number**> tests in areas as directed by Architect.
2. Air Leakage: ASTM E783 at 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article but not more than 0.09 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..
   a. Perform a minimum of [**two**] [**three**] <**Insert number**> tests in areas as directed by Architect.
3. Water Penetration: ASTM E1105 at a minimum [**uniform**] [**and**] [**cyclic**] static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft., and shall not evidence water penetration.

C. Aluminum-framed entrances and storefronts will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 084113

SECTION 092900 - GYPSUM BOARD

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 M-Block XP gypsum board at Bathroom, Shower Ceilings, Sports Storage Rooms number of layers as indicated on drawings..
2. Type XP gypsum board all storage ceilings number of layers as indicated on drawings.
3. Type XP gypsum board all Dressing Room Ceilings and window wraps (2 layers)
4. Type X gypsum board for administrative office, break room, coach office ceilings.
5. Interior trim.
6. Exterior trim.
7. Joint treatment materials.
8. Laminating adhesive.
9. Textured finishes.
10. NOTE: **WHERE CONFLICTS IN NUMBERS OF LAYER TO BE APPLIED, DRAWING NOTATIONS SHALL GOVERN IN ALL CASES.**

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.

B. Gypsum Board, Type XP: Impact Protection

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

C. Gypsum Board, M-XP: Mold and Moisture Protective Gypsum Board.

1. Thickness: 5/84 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.

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 093013 - CERAMIC TILING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ceramic mosaic tile.
2. Glazed wall tile.
3. Tile backing panels.
4. Waterproof membrane **for thinset applications**.
5. Crack isolation membrane.
6. Metal edge strips.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. To be determined with architect on-site.

C. Samples:

1. Each type and composition of tile and for each color and finish required.
2. Assembled samples mounted on a rigid panel, with grouted joints, for each type and composition of tile and for each color and finish required.
3. Stone thresholds.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Tile and Trim Units: Furnish quantity of full-size units equal to 5 percent of amount installed for each type, composition, color, pattern, and size indicated in original boxes not broken to the next unit above the 5 percent threshold.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer is a Five-Star member of the National Tile Contractors Association or a Trowel of Excellence member of the Tile Contractors' Association of America.
2. Installer's supervisor for Project holds the International Masonry Institute's Foreman Certification.
3. Installer employs only Ceramic Tile Education Foundation Certified Installers or installers recognized by the U.S. Department of Labor as Journeyman Tile Layers for Project.
4. Installer employs at least one installer for Project that has completed the Advanced Certification for Tile Installers (ACT) certification for installation of mud floors, mud walls, membranes, gauged glazed porcelain tile and gauged porcelain tile.

B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockup of each type of floor and wall tile installations.
2. **Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.**

PART 2 - PRODUCTS

2.1 PRODUCTS, GENERAL

A. ANSI Ceramic Tile Standard: Provide Standard-grade tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

2.2 TILE PRODUCTS

A. Ceramic Unglazed Mosaic Floor Tile:

1. American Olean
2. Composition: Unglazed porcelain
3. Certification: Porcelain tile certified by the Porcelain Tile Certification Agency.
4. Module Size: 2 by 2 inches
5. Thickness: 1/4 inch.
6. Face: Single color grid.
7. Surface: Slip resistant.
8. Finish: Mat
9. Setting Bed: Mapei Ultraflex 2
10. Tile Color and Pattern: American Olean 2x2 Unglazed Mosaic *Stormy Gray.*
11. Grout Color: Mapei Kerapoxy CQ Premium Epoxy #27 Silver

12. Trim Units: Note all trim outside and inside corners to be Schluter as scheduled.

B. Ceramic Glazed Wall Tile with beveled edges:

1. American Olean **(Note: Physical samples must be in the architect and owner's hands for approval prior to ordering of material to avoid contractor expense of reordering.)**
2. Composition: Glazed porcelain
3. Certification: Porcelain tile certified by the Porcelain Tile Certification Agency.
4. Module Size: 4 by 12 inches
5. Thickness: 1/4 inch.
6. Face: Four colors scheduled on drawings by number:
   a. ***Urban Canvas* 0025412MOD1P1**
   b. ***Sapphire* 0070412MODSAM1P**
   c. ***Balance* 0014412MOD1P1**
   d. ***Storm Gray* 0040412MOD1P1**
7. Surface: High sheen glazed finish.
8. Finish: Glazed
9. Settomg Bed: Mapei Ultraflex 2
10. Grout Color: Mapei Flexcolor CQ #27 Silver
11. Trim Units: Note all trim outside and inside corners to be Schluter as scheduled.
    a. Schulter DILEX-AHK SS inside cove trim for wall inside 90 degree intersections
    b. Schulter DILEX-AHK SS inside cove trim for wall to floor tile 90 degree intersections
    c. Schulter QUADEC SS outside 90 degree flush embedded 90 degree intersections

2.3 THRESHOLDS

A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.

1. Schulter ¼"-3/8" heavy duty threshold transition to concrete finished floor (verify prior to ordering and installation.)

2.4 CRACK ISOLATION MEMBRANE

A. General: Manufacturer's standard product: Schulter Ditra XL Polyethylene Membrane Tile Underlayment or all tile floor installations.

2.5 SETTING MATERIALS (Reference tile section above for clarity all setting materials.

2.6 GROUT MATERIALS (Reference tile section above for clarity all grouting materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
2. Verify that concrete substrates for tile floors installed with setting beds/adhesives comply with surface finish requirements in ANSI A108.01 for installations indicated.

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

3.2 PREPARATION

A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with approved adhesives or thinset mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.

B. Where indicated, prepare substrates to receive waterproof membrane by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot toward drains.

C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 INSTALLATION

A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.

1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
   a. Bathrooms and showers.

B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.

E. Where accent tile differs in thickness from field tile, vary setting bed thickness so that tiles are flush.

F. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.

G. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:

1. Ceramic Mosaic Tile: verify with mock-up on site.
2. Glazed Wall Tile: verify with mock-up on site.

H. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.

I. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.

1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.

J. Stone Thresholds: Install stone thresholds in same type of setting bed as adjacent floor unless otherwise indicated.

1. At locations where mortar bed (thickset) would otherwise be exposed above adjacent floor finishes, set thresholds in approved setting bed.
2. Do not extend **cleavage membrane, crack isolation membrane** under thresholds set in mortar. Fill joints between such thresholds and adjoining tile set on with elastomeric sealant.

K. Install tile backing panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated.

L. Install waterproof membrane to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.

M. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.

END OF SECTION 093013

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes acoustical panels and exposed suspension systems for interior ceilings.

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. Classification: Fine-fissured 24 x 24 x 15/16” School Zone Fine Fissured, 9/16, beveled tegular, beveled lay-in, tile, mold and mildew resistant surface, non-directional with 30 year limited system warranty against visible sag, mold, and mildew resistant..

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: 7/8”

K. Modular Size: 24 x 24

L. METAL SUSPENSION SYSTEM 2x2 Armstrong Prelude suspension system. Metal Suspension-System Standard: Manufacturer's standard, direct-hung, metal suspension system and accessories according to ASTM C635/C635M.

M. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; pre-painted, electrolytically zinc coated, or hot-dip galvanized, G30 coating designation; with prefinished 15/16-inch- wide metal caps on flanges.

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.

B. Impact Clips: Manufacturer's standard impact-clip system designed to absorb impact forces against acoustical panels. **Girl's Conditioning Exercise Area Only.**

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 - RUBBER INTERLOCKING SPORTS TILES

PART 1 - RELATED DOCUMENTS

1.1 Drawings and general provisions of the Contracts, including General and Supplementary conditions, apply to this section.

1.2 SUMMARY

1.3 Section Includes: Furnish and installation of rubber interlocking weight room tiles, beveled edge or 3/8" TDLR compliance transition strip.

1.4 RELATED SECTIONS

1.5 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.

1.6 SUBMITTALS

A. Product Data:

1. Manufacturer's specifications and other data needed to prove compliance with specified requirements.
2. Manufacturer's installation instructions.

B. Shop Drawings: Indicate installation guidelines, colors and accessories.

C. Samples: Include color charts showing manufacturer's full range of color for Architect's selection.

PART 2 - PART 2 – PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Specifications are based on products of **Roppe Tuflex Spartus 3/8"** sports flooring.

1. 100% recycled product.
2. Red List chemical free.
3. Complying with the following ASTM test methods:

a. ASTM E90
b. ASTM E492
c. ASTM E2179

4. **Note: The design will utilize two colors from the manufacturer's standard line card of fourteen colors laid in a checker-board pattern**.

2.2 MATERIALS

A. Interlocking recycled rubber floor tiles:

1. Manufactured 27" x 27" x 3/8" tile nominal dimensions.
   a. Tensile Strength up to 1000, PSI and Durometer of 63
   b. 100% recycle composition primary materials.

PART 3 - PART 3 – EXECUTION

3.1 Examination

A. Verify before installation that all construction is complete and ready for this finished product to be installed.

B. Coordinate transition as shown on drawings for TDLR compliance accessible transition of the floor surface either cutting compliant bevel on tile surface or installation ½" transition strip secured to tile and floor for safe use.

3.2 INSTALLATION

A. Deliver factory-built units completely assembled and of dimensions indicated in details and in accordance with manufacturer's shop drawings as approved by Architect. Follow manufacturer's instructions for storage and handling of units before installation. Do not install boards on damp walls or in damp and humid weather without heat in the building.

B. Install tiles as recommended by manufacturer.

3.3 ADJUST AND CLEAN

A. Verify that all accessories are installed as required for each unit for safe use of the floor material and in compliance with TDLR accessibility requirements.

B. At completion of work, clean surfaces and trim in accordance with manufacturer's recommendations leaving all materials ready for use.

C. Install protective cardboard over floor surface until project is ready for final inspection and occupancy by the owner.

END OF SECTION 095113

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.
5. Dry fall coatings.

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.

B. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. 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.

B. 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.

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

3.5 INTERIOR PAINTING SCHEDULE

A. Drywall:

1. Interior Latex Semi-Gloss (Sherwin Williams Products)

    a. Primer: B28W02600 ProMar 200 Zero VOC Interior Latex Primer White White
    b. Intermediate Coat: B20W12651 – ProMar 200 Zero VOC Interior Latex Primer White
    c. Topcoat: B20W12651 – ProMar 200 Zero VOC Interior Latex Primer White

B. Drywall Moisture Resistant Gypsum Board Ceiling in Locker Rooms

1. Impact Moisture Resistant Gypsum Board Ceilings and Walls Locker Room:

    a. Primer: B28W0260 ProMar 200 Zero VOC Interior Latex Primer White White
    b. Intermediate Coat: B28W02600 – ProMar 200 Zero VOC Inerior Lagtex Primer White
    c. Topcoat: B20W126051 – ProMar 200 Zero VOC Interior Latex Egg Shell Extra White

C. Drywall Moisture Resistant Gypsum Board Ceiling Non-Conditioned Areas:

1. Impact Moisture Resistant Gypsum Board Ceilings and Walls Locker Room:

    a. Primer: B28W0260 ProMar 200 Zero VOC Interior Latex Primer White White
    b. Intermediate Coat: K45W01151 – PI PRECAT EG EX WH
    c. Topcoat: K45W01151 – PI PRECAT EG EX WH

D. CMU Substrates:

1. Water Based Epoxy Gloss (Sherwin Williams Products)
    a. Block Filler: B42W00046-Heavy duty Block Filler White
    b. Intermediate Coat: K45W01151 – PI PRECAT EG EX WH Semi-gloss
    c. Topcoat: K45W01151 – PI PRECAT EG EX WH Semi-gloss

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

1. Water Based Epoxy (Sherwin Williams Products)
    a. Prime Coat: B66W00310 – Pro Industrial Pro-cryl Universal acrylic Primer Off White
    b. Intermediate Coat: PI WB ALK UR SG EW Semi-gloss
    c. Topcoat: PI WB ALK UR SG EW Semi-gloss

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 101416 - PLAQUES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal plaques.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For plaques.

1. Include fabrication and installation details and attachments to other work.
2. Show plaque mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
3. Show message list, typestyles, graphic elements [**, including raised characters and Braille**], and layout for each plaque at least [**half size**] <**Insert scale**>.

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

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 plaques that fail in materials or workmanship within specified warranty period.

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in t**he USDOJ's "2010 ADA Standards for Accessible Design"**.

2.2 METAL PLAQUES

A. Cast Plaque: Cast-metal plaque with background texture, border, and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:

1. Approved Manufacturer/Suppliers: Signage International, ARK Ramos, Metal Designs, International Bronze Plaque Company, and Southwaell Company.
2. Plaque Material: A**luminum**.
3. Plaque Thickness: 0.25 inch.
4. Finishes:
   a. Integral Metal Finish: To be verified during review process.
   b. Integral Aluminum Finish: To be verified during review process. Polished letters and color selected background.
   c. Baked-Enamel Blue Finish: Background color as selected by Owner from available standards to match school colors.
   d. Overcoat: Manufacturer's standard baked-on clear coating
5. Background Texture: Leatherette .
6. Integrally Cast Border Style: **Square cut with single line, polished.**
7. Mounting: Must verify anchoring prior to fabrication as location for plaque has not been determined. Contractor will be involved in decision to facilitate proper wall backing for installation method.

2.3 MATERIALS

A. Aluminum Casting: Verify manufacture's requirements and options for alloy.

2.4 ACCESSORIES

A. Fasteners and Anchors**: Supplier must verify anchoring type to coordinate with contractor preparation for wall support materials.**

2.5 FABRICATION

A. General: Provide manufacturer's standard plaques 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. 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 plaque finish.
5. 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. Surface-Engraved Graphics: Machine-engrave characters and other graphic devices into indicated plaque surface to produce precisely formed copy, incised to uniform depth.

1. Engraved Metal: Fill engraved graphics with manufacturer's standard baked enamel.

C. Brackets: Fabricate brackets, fittings, and hardware for bracket-mounted plaques to suit plaque construction and mounting conditions indicated. Modify manufacturer's standard brackets as required. VERIFY MOUNTING METHOD AND BRACKETS PRIOR TO FABRICATION.

PART 3 - EXECUTION

3.1 INSTALLATION OF METAL PLAQUES

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

1. Install plaques level, plumb, true to line, and at locations and heights indicated, with plaque surfaces free of distortion and other defects in appearance.
2. Install plaques so they do not protrude or obstruct according to the accessibility standard.
3. Before installation, verify that plaque surfaces are clean and free of materials or debris that would impair installation.
4. 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 plaque. Remove loose debris from hole and substrate surface.
   a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place plaque in position and push until flush to surface, embedding studs in holes. Temporarily support plaque in position until adhesive fully sets.
   b. Thin or Hollow Surfaces: Place plaque in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.

2. Through Fasteners: Drill holes in substrate using predrilled holes in plaque as template. Countersink holes in plaque if required. Place plaque in position and flush to surface. Install through fasteners and tighten.
3. Brackets: Remove loose debris from substrate surface and install bracket supports in position, so that plaque is correctly located and aligned.
4. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of plaque and of suitable quantity to support weight of plaque after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as plaque is applied and to prevent visibility of cured adhesive at plaque edges. Place plaque in position, and push to engage adhesive. Temporarily support plaque in position until adhesive fully sets.

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

END OF SECTION 101416

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 Internations 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 durin 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. VERIFY ALL ANCHORING CONDITIONS DURING SHOP DRAWING REVIEW PHASE WITH GENERAL CONTRACTOR IN ORDER TO PROPERLY PREAPRE FOR ANCHORING AND BACK-UP FRAMING.

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 102113.19 - PLASTIC TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Solid-plastic toilet compartments configured as **toilet enclosures and urinal screens**.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for supports that attach f**loor-and-wall-anchored**
2. Section 102800 "Toilet, Bath, and Laundry Accessories" for accessories mounted on toilet compartments.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Solid-plastic toilet compartments:

B. Shop Drawings: For solid-plastic toilet compartments.

1. Include plans, elevations, sections, details, and attachment details.

C. Samples: For each type of toilet compartment material indicated.

1. Include Samples of hardware and accessories involving material and color selection.

1.3 INFORMATIONAL SUBMITTALS

A. Certificates:

1. Product Certificates: For each type of toilet compartment by manufacturer.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire Performance: Tested in accordance with, and pass the acceptance criteria of, NFPA 286.

B. Regulatory Requirements: Comply with applicable provisions in **the U.S. Department of Justice "2010 ADA Standards for Accessible Design", ICC A117.1 and Texas Accessibility guidelines** for toilet compartments designated as accessible.

2.2 SOLID-PLASTIC TOILET COMPARTMENTS

A. Approved manufacturers: **Scranton Products, Bradley, or other prior approved by Architect.**

B. Toilet-Enclosure Style: Floor and wall anchored

C. Entrance-Screen Style: Floor and wall anchored with top bracing rail.

D. Urinal-Screen Style: Heavy duty bracket wall hung.

E. Door, Panel and Pilaster Construction: Solid, high-density polyethylene (HDPE) panel material, not less than 1 inch thick, seamless, with eased edges, and with homogenous color and pattern throughout thickness of material.

1. Integral Hinges: Configure doors and pilasters to receive integral hinges.
2. Heat-Sink Strip: Manufacturer's standard continuous **stainless steel** strip fastened to exposed bottom edges of solid-plastic components to hinder malicious combustion.
3. Color and Pattern: **One color and pattern as selected by Architect from manufacturer's full range,**

F. Pilaster **Shoes and Sleeves (Caps)**: Manufacturer's standard design; **polymer or stainless steel**.

1. Polymer Color and Pattern: **Matching pilaster as selected by Architect from manufacturer's full range.**

G. Urinal-Screen Post: Manufacturer's standard post design of **material matching the thickness and construction of pilasters (verify during shop drawing review)**.

H. Brackets (Fittings):

1. Stirrup Type: Ear or U-brackets, **stainless steel**.
2. Full-Height (Continuous) Type: Manufacturer's standard design

2.3 HARDWARE AND ACCESSORIES

A. Hardware and Accessories, Standard Duty: Manufacturer's standard operating hardware and accessories.

1. Material: **Stainless steel**.
2. Hinges: Manufacturer's standard continuous, cam type that swings to a closed or partially open position at accessible stalls.
3. Latch and Keeper: Manufacturer's standard **surface-mounted** latch unit, designed for emergency access, and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible.
4. Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent inswinging door from hitting compartment-mounted accessories.
5. Door Bumper: Manufacturer's standard rubber-tipped bumper at outswinging doors **and entrance-screen doors**.
6. Door Pull: Manufacturer's standard unit at outswinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible.

B. Hardware and Accessories, Heavy Duty: Manufacturer's heavy-duty operating hardware and accessories.

1. Hinges: Manufacturer's minimum **continuous, cam type that swings to a closed or partially open position at accessible stalls**. Mount with through bolts.
2. Latch and Keeper: Manufacturer's heavy-duty, surface-mounted, cast-stainless steel latch unit, designed to resist damage due to slamming, with combination rubber-faced door strike and keeper, and with provision for emergency access. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible. Mount with through bolts.
3. Coat Hook: Manufacturer's heavy-duty combination cast-stainless steel hook and rubber-tipped bumper, sized to prevent inswinging door from hitting compartment-mounted accessories. Mount with through bolts.
4. Door Bumper: Manufacturer's heavy-duty, rubber-tipped, cast-stainless steel bumper at outswinging doors **and entrance-screen doors**. Mount with through bolts.
5. Door Pull: Manufacturer's heavy-duty, cast-stainless steel pull at outswinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible. Mount with through bolts.

2.4 MATERIALS

A. Aluminum Castings: ASTM B26/B26M.

B. Aluminum Extrusions: ASTM B221.

C. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304, stretcher-leveled standard of flatness.

D. Stainless Steel Castings: ASTM A743/A743M.

E. Zamac: ASTM B86, commercial zinc-alloy die castings.

2.5 FABRICATION

A. Fabrication, General: Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through-partition toilet accessories where required for attachment of toilet accessories.

B. Overhead-Braced Units: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters to suit floor conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.

C. Floor-and-Ceiling-Anchored Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment nuts at tops and bottoms of pilasters. Provide shoes and sleeves (caps) at pilasters to conceal anchorage.

D. Urinal-Screen Posts: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment nuts at [**tops and**] bottoms of posts. Provide shoes [**and sleeves (caps)**] at posts to conceal anchorage.

E. Door Size and Swings: Unless otherwise indicated, provide 24-inch- wide, inswinging doors for standard toilet compartments and 36-inch- wide, outswinging doors with a minimum 32-inch- wide, clear opening for compartments designated as accessible.

PART 3 - EXECUTION

3.1 INSTALLATION OF PLASTIC TOILET COMPARTMENTS

A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.

1. Maximum Clearances:
   a. Pilasters and Panels: 1/2 inch.
   b. Panels and Walls: 1 inch.
2. Full-Height (Continuous) Brackets: Secure panels to walls and to pilasters with full-height brackets.
   a. Locate bracket fasteners, so holes for wall anchors occur in masonry or tile joints.
   b. Align brackets at pilasters with brackets at walls.

B. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Set pilasters with anchors penetrating not less than 1-3/4 inches into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with no fewer than two fasteners. Hang doors to align tops of doors with tops of panels and adjust, so tops of doors are parallel with overhead brace when doors are in closed position.

C. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.

3.2 ADJUSTING

A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on inswinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on outswinging doors **and doors in entrance screens** to return doors to fully closed position.

END OF SECTION 102113.19

SECTION 102116.19 - PLASTIC SHOWER AND DRESSING COMPARTMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Solid-plastic compartments.
2. Shower receptors.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Shop Drawings: For shower and dressing compartments:Include plans, elevations, sections, and attachment details.

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

1.3 INFORMATIONAL SUBMITTALS

A. Product certificates.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire Performance: Tested in accordance with, and pass the acceptance criteria of, NFPA 286.

B. Regulatory Requirements: Comply with applicable provisions in [**USDOJ's "2010 ADA Standards for Accessible Design" and Texas Accessibility Guidelines** for shower and dressing compartments designated as accessible.

2.2 SOLID-PLASTIC COMPARTMENTS

A. **Scranton Products, Bradley, or other prior approved by Architect.**

B. Configuration: **Shower and dressing compartments** as **indicated on Drawings**.

C. Enclosure Style: **Overhead braced and floor/wall anchored**.

D. Panel and Pilaster Construction: Solid, high-density polyethylene (HDPE) panel material, not less than 1 inch thick, seamless, with eased edges and with homogenous color and pattern throughout thickness of material.

1. Integral Hinges: Configure doors and pilasters to receive integral hinges.
2. Heat-Sink Strip: Manufacturer's standard, continuous, **stainless steel** strip fastened to exposed bottom edges of solid-plastic components to hinder malicious combustion.
3. Color and Pattern: **One color and pattern as selected by Architect from manufacturer's full range.**

E. Door Construction: Match panels.

F. Pilaster **Shoes and Sleeves (Caps)**: Manufacturer's standard design; **stainless steel**.

1. Plastic Color and Pattern: **Match pilaster as selected by Architect.**

G. Brackets (Fittings):

1. Full-Height (Continuous) Type: Manufacturer's standard design; Stainless Steel.
2. Stirrup Type: Ear or U-brackets; **stainless steel**.
3. Dressing-Compartment Brackets: Match toilet-compartment brackets specified in Section 102113.19 "Plastic Toilet Compartments."

2.3 ACCESSORIES

A. Door Hardware and Accessories: Manufacturer's standard design, heavy-duty, operating hardware and accessories. Mount to panels with through-bolts.

1. Material: **Stainless steel** .
2. Hinges: Manufacturer's standard, **continuous, cam type that swings to a closed or partially open position**.
3. Latch and Keeper: Manufacturer's standard, **surface-mounted** latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility **at each compartment, accessible or not at compartments designated as accessible**.
4. Clothing Hooks: Manufacturer's standard clothing hooks in each dressing compartment **include one combination hook and rubber-tipped bumper at inswinging doors, sized to prevent door from hitting wall panel or compartment-mounted accessories**].
5. Door Bumper: Manufacturer's standard, rubber-tipped bumper at outswinging doors.
6. Door Pull: Manufacturer's standard unit at outswinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible.

B. Overhead Bracing: Manufacturer's standard, continuous, extruded-aluminum headrail or cap with antigrip profile; in manufacturer's standard finish.

C. Headrail with Hooks: Manufacturer's standard, continuous, extruded-aluminum headrail or cap with curtain hooks running in concealed track; with antigrip profile; in manufacturer's standard finish.

D. Curtain Rod with Hooks: Manufacturer's standard, 1-inch- diameter, **stainless steel** curtain rod with matching hooks.

E. Curtain: Flame-resistant, **polyester-reinforced vinyl fabric** that is stain resistant, self-sanitizing, antistatic, antimicrobial, and launderable to a temperature of not less than [**90 deg F**] <**Insert temperature**>.

1. Flame Resistance: Passes NFPA 701 tests when tested by a testing and inspecting agency acceptable to authorities having jurisdiction.
2. Labeling: Identify fabrics with appropriate markings of applicable testing and inspecting agency.
3. Length: Where curtain extends to a floor surface, size so that bottom hem clears finished floor by not more than 1 inch and not less than 1/2 inch above floor surface. Where curtains extend to a shower-receptor curb, size so that bottom hem hangs above curb line and clears curb line by not more than 1/2 inch.
4. Color and Pattern: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**] <**Insert color and pattern**>.

F. Soap Holder: seamless **stainless steel** soap dish.

G. Seats: Manufacturer's standard, **panel-mounted and wall-mounted** where noted on drawings.

1. Material: **Solid phenolic** Operation: Fixed.
2. Finish: **As selected by Architect from manufacturer's full range**.

H. Anchorages and Fasteners: Manufacturer's standard, exposed fasteners of stainless steel, chrome-plated steel, or solid brass, finished to match the items they are securing; with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications.

2.4 FABRICATION

A. Overhead-Braced Compartments: Manufacturer's standard, corrosion-resistant supports, leveling method, and anchors at pilasters and walls to suit floor and wall conditions. Provide shoes at pilasters to conceal supports and leveling method.

B. Floor-and-Ceiling-Anchored Compartments: Manufacturer's standard, corrosion-resistant anchoring assemblies at pilasters and walls, with leveling adjustment at tops and bottoms of pilasters. Provide shoes and sleeves (caps) at pilasters to conceal anchorage.

C. Door Sizes and Swings: Unless otherwise indicated, provide 24-inch- wide, inswinging doors for standard shower and dressing compartments, and 36-inch- wide, outswinging doors with a minimum 32-inch- wide, clear opening for compartments designated as accessible.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Comply with manufacturer's written installation instructions. Install compartments rigid, straight, level, and plumb. Secure compartments in position with manufacturer's recommended anchoring devices.

1. Clearances for Dressing Compartments: Maximum 1/2 inch between pilasters and panels; 1 inch between panels and walls.
2. Stirrup Brackets for Dressing Compartments: Secure panels to walls and to pilasters with no fewer than three brackets attached at midpoint and near top and bottom of panel.
   a. Locate wall brackets so holes for wall anchors occur in masonry or tile joints.
   b. Align brackets at pilasters with brackets at walls.
3. Full-Height (Continuous) Brackets for Dressing Compartments: Secure panels to walls and to pilasters with full-height brackets.
   a. Locate bracket fasteners so holes for wall anchors occur in masonry or tile joints.
   b. Align brackets at pilasters with brackets at walls.

B. Curtains: Install curtains to specified length, and verify that they hang vertically without stress points or diagonal folds.

C. Shower Receptors: Install prefabricated shower receptors with drain gasket compression fit to OD of waste pipe.

3.2 ADJUSTING

A. Curtain Adjustment: After hanging curtains, test and adjust each track or rod to produce unencumbered, smooth operation. Steam and dress down curtains as required to produce crease- and wrinkle-free installation. Remove and replace curtains that are stained or soiled or that have stress points or diagonal folds.

B. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on inswinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on outswinging doors to return doors to fully closed position.

END OF SECTION 102116.19

SECTION 102800 - TOILET, BATH AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Public-use washroom accessories.
2. Public-use shower room accessories.
3. Private-use bathroom accessories.
4. Healthcare accessories.
5. Hand dryers.
6. Childcare accessories.
7. Underlavatory guards.
8. Custodial accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each finish specified, full size.

1. Approved full-size Samples will be returned and may be used in the Work.

C. Delegated-Design Submittal: For **grab bars and shower seats**.

1. Include structural design calculations indicating compliance with specified structural-performance requirements.

1.3 INFORMATIONAL SUBMITTALS

A. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 WARRANTY

A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 15 years from date of Substantial Completion.

B. Manufacturer's Special Warranty for Hand Dryers: Manufacturer agrees to repair or replace hand dryers that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

B. Structural Performance: Design accessories and fasteners to comply with the following requirements:

1. Grab Bars: Installed units are able to resist 250 lbf concentrated load applied in any direction and at any point.
2. Shower Seats: Installed units are able to resist [**250 lbf**] [**360 lbf**] <**Insert load**> applied in any direction and at any point.

2.2 PUBLIC-USE WASHROOM ACCESSORIES

A. Toilet Tissue (Roll) Dispenser Furnished by Owner Installed by GC.

B. Paper Towel (Folded) Dispenser (Where Shown) Furnished by Owner Installed by GC.

C. Soap Dispenser (Furnished by Owner Installed by GC.

D. Automatic Soap Dispenser (Furnished by Owner Installed by GC.

E. Grab Bar <**Insert drawing designation**>:

1. Bobrick or other as pre-approved by architect.
2. Mounting: Flanges with **concealed** fasteners.
3. Material: Stainless steel, 0.05 inch thick.
   a. Finish: Smooth, ASTM A480/A480M No. 4 finish (satin).
4. Outside Diameter: **1-1/2 inche**].
5. Configuration and Length: Length and configuration as **indicated on Drawings**

F. Mirror Unit:

1. Frame: **Stainless steel angle, 0.05 inch thick**
   a. Corners: **Manufacturer's standard Welded and ground smooth**.
   b. Size: **As indicated on Drawings** .
   c. Hangers: **Manufacturer's standard rigid, tamper and theft resistant.**
   d. **Tempered ¼" Polished Mirror**

G. Hook:

1. Bobrick or other prior approved manufacturer.
2. Description: **Combination door bumper and coat hook (may be supplied by toilet partition manufacturer standard.**
3. Mounting: **Concealed**.
4. Material and Finish: **No. 4 finish (satin)**] **Stainless steel, ASTM A480**.

2.3 PUBLIC-USE SHOWER ROOM ACCESSORIES

A. Folding Shower Seat <**Insert drawing designation**>:

1. Bobrick other prior approved manufacturer.
2. Configuration: As indicated on the drawings. Fold down in the coach accessible showers.

B. Soap Dish :

1. (Where shown furnished by Owner Installed by GC)

C. Robe Hook:

1. **Double**-prong unit.
2. Material and Finish: **Stainless steel, ASTM A480**.

2.4 HAND DRYERS

A. Warm-Air Dryer: By MEP Divisions

2.5 FABRICATION

A. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of [**six** keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

1. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated. Remove temporary labels and protective coatings.

B. Grab Bars: Install to comply with specified structural-performance requirements.

C. Shower Seats: Install to comply with specified structural-performance requirements.

END OF SECTION 102800

SECTION 104413 - FIRE PROTECTION CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire-protection cabinets for portable fire extinguishers.

1.2 PREINSTALLATION CONFERENCE

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

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For fire-protection cabinets.

C. Samples: For each type of exposed finish required.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 COORDINATION

A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.

B. Coordinate sizes and locations of fire-protection cabinets with wall depths.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E814 for fire-resistance rating of walls where they are installed.

2.2 FIRE-PROTECTION CABINET <**Insert drawing designation**>

A. Cabinet Type: Suitable for fire extinguisher.

1. Larsen or other prior approved supplier of fire extinguisher cabinets.

B. Cabinet Construction: **Nonrated**.

C. Cabinet Material: **Aluminum sheet**.

D. Semi-recessed Cabinet: One-piece combination trim and perimeter door frame overlapping surrounding wall surface, with exposed trim face and wall return at outer edge (backbend).

1. Square-Edge Trim: 1-1/4- to 1-1/2-inch +/- backbend depth coordinate depth cabinet to fit masonry wall conditions.

E. Cabinet Trim Material: **Aluminum**.

F. Door Material: **Aluminum sheet and extruded shapes.**

G. Door Style: **Full acrylic bubble with frame**.

H. Door Glazing: **Molded acrylic bubble**.

1. Acrylic Bubble Color: **Clear**, transparent.

I. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.

J. Accessories:

1. Cam lock that allows door to be opened during emergency by pulling sharply on door handle**.**
2. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location.
    a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER identification>."
        1) Location: Applied to cabinet glazing.
        2) Application Process: Silk-screened
        3) Lettering Color: Red.
        4) Orientation: Vertical.
3. Alarm: Manufacturer's standard alarm that actuates when fire-protection cabinet door is opened and that is powered by batteries.

K. Materials:

1. Aluminum: ASTM B221 for extruded shapes and aluminum sheet, with strength and durability characteristics of not less than Alloy 6063-T5 for aluminum sheet.
    a. Finish: Clear anodic.

2.3 FABRICATION

A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Prepare recesses for semirecessed fire-protection cabinets as required by type and size of cabinet and trim style and masonry wall dimension.

B. Provide hangers for wall hung fire extinguishers in mechanical/electrical areas indicated on plans.

C. Install fire-protection cabinets in locations and at mounting heights indicated and in compliance with TDLR accessibility requirements.

D. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.

E. Identification: Apply lettering] at locations indicated.

F. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

END OF SECTION 104413

SECTION 104416 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers where cabinets are not scheduled.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Confirm compliance with building code and fire code authorities prior to order and installation..

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 COORDINATION

A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each size and capacity as required by the City of Beaumont Fire Department for each application including wall hung as required for mechanical electrical rooms.

2.3 MOUNTING BRACKETS <**Insert drawing designation**>

A. Mounting Brackets: Manufacturer's standard red baked-enamel finish.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.

1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
   a. Orientation: Vertical unless otherwise by the governing authority**.**.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

1. Mounting Brackets: Top of fire extinguisher to be at **42 inches** above finished floor and as directed by the TDLR for accessible locations by the general public.

C. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION 104416

SECTION 105113 – BREAK DOWN METAL SPORTS LOCKERS
(ALTERNATE PRICE WELDED LOCKERS SUBJECT TO DELIVERY TIME)

PART 1 -

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Knocked-down athletic lockers.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For metal lockers.

1. Include plans, elevations, sections, and attachment details.
2. Include locker identification system and numbering sequence.

C. Samples: For each color specified.

1.4 INFORMATIONAL SUBMITTALS

A. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of metal lockers that fail in materials or workmanship, excluding finish, within specified warranty period.

1. Warranty Period for Knocked-Down Metal Lockers: Two years from date of Substantial Completion.

2. Warranty Period for Alternate Price for Welded Metal Lockers: Fifteen years from dated of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: For lockers **and locker benches** indicated to be accessible, comply with applicable provisions in **USDOJ's "2010 ADA Standards for Accessible Design" and TDLR Texas Accessibility Standards Compliance.**

2.2 KNOCKED-DOWN FULL VENTED LOCKERS BASE BID

A. The following manufacturers are approved for bidding of this item subject to dimension requirements for lockers:

1. Houston Steel Equipment (713) 869-7326
2. Republic Storage Products (800) 477-1255
3. Southwest Solutions (866) 825-0796
4. Lyon LLC (800) 323-082
5. Others as approved prior to bidding.

B. Doors: One piece; fabricated from 0.075-inch nominal-thickness steel sheet; formed into channel shape with double bend at vertical edges and with right-angle single bend at horizontal edges.

1. Reinforcement: Manufacturer's standard reinforcing angles, channels, or stiffeners for doors more than 15 inches wide; welded to inner face of doors.
2. Stiffeners: Manufacturer's standard full-height stiffener fabricated from 0.048-inch nominal-thickness steel sheet; welded to inner face of doors.
3. Door Style: Full height diamond venting.

C. Body: Assembled by riveting or bolting body components together. Fabricate from unperforated steel sheet with thicknesses as follows:

1. Tops, Bottoms, and Intermediate Dividers: 0.024-inch nominal thickness, with single bend at sides.
2. Backs and Sides: 0.024-inch nominal thickness, with full-height, double-flanged connections.
3. Shelves: 0.024-inch nominal thickness, with double bend at front and single bend at sides and back.

D. Frames: Channel formed; fabricated from 0.060-inch nominal-thickness steel sheet; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral, full-height door strikes on vertical main frames.

E. Hinges:

1. Knuckle Hinges: Steel, full loop, five or seven knuckles, tight pin; minimum 2 inches high. Provide no fewer than three hinges for each door more than 42 inches high.
2. Continuous Hinges: Manufacturer's standard, steel, full height.
3. Hinges: Manufacturer's standard, steel, continuous or knuckle type.

F. Recessed Door Handle and Latch: Stainless steel cup with integral door pull, recessed so locking device does not protrude beyond door face; pry and vandal resistant.

1. Single-Point Latching: Nonmoving latch hook with steel padlock loop that projects through recessed cup and is finished to match metal locker body.
   a. Latch Hook: Equip each door with one latch hook.

G. Locks: Personal padlock.

H. Identification Plates: Manufacturer's standard, etched, embossed, or stamped **aluminum** plates, with numbers and letters at least 3/8 inch high.

I. Hooks: Manufacturer's standard ball-pointed hooks, aluminum or steel; zinc plated.

J. Coat Rods: Manufacturer's standard.

1. Loc

K. Locker designed without legs but with spacer for placement on top of concrete bench design.

L. Continuous Sloping Tops: Fabricated from **0.048-inch** nominal-thickness steel sheet.

1. Closures: Hipped end type.

M. Recess Trim: Fabricated from 0.048-inch nominal-thickness steel sheet.

N. Filler Panels: Fabricated from 0.048-inch nominal-thickness steel sheet.

O. Boxed End Panels: Fabricated from 0.060-inch nominal-thickness steel sheet.

P. Finished End Panels: Fabricated from 0.024-inch nominal-thickness steel sheet.

Q. Center Dividers: Fabricated from 0.024-inch nominal-thickness steel sheet.

R. Materials:

1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
2. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with A60 zinc-iron, alloy (galvannealed) coating designation.

S. Finish: Baked enamel.

1. Color: As selected by Architect from manufacturer's full range.

T. ADA Texas Accessible Compliant with shelf height and operation system as required for fully compliant locker system. Customize accessible lockers such that top aligns with other lockers while bottom is raised for compliance with bench heights assuring reach for latch is compliant.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lockers level, plumb, and true; shim as required, using concealed shims.

1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches o.c. Using concealed fasteners, install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion.
2. Anchor single rows of metal lockers to walls near top [**and bottom of lockers**] [**of lockers and to floor**].
3. Anchor back-to-back metal lockers to floor.

B. Knocked-Down Lockers: Assemble with manufacturer's standard fasteners, with no exposed fasteners on door faces or face frames.

C. Welded Lockers: Connect groups together with manufacturer's standard fasteners, with no exposed fasteners on face frames.

D. Trim: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.

1. Attach recess trim to recessed metal lockers with concealed clips.
2. Attach filler panels with concealed fasteners.
3. Attach sloping-top units to metal lockers, with closures at exposed ends.
4. Attach boxed end panels using concealed fasteners to conceal exposed ends of nonrecessed metal lockers.
5. Attach finished end panels using fasteners only at perimeter to conceal exposed ends of nonrecessed metal lockers.

END OF SECTION 105113

SECTION 133419 - METAL BUILDING SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pre-engineered building and components including the following:

1. Structural steel frame, secondary framing, and miscellaneous framing.
2. Roof covering system including exterior roof panels, panel attachments, sealants, mastics, trim and flashings.
3. Exterior panels including wall and soffit panels.
4. Insulation and insulation support system.

B. Wall accessories by other sections include the following:

1. Windows.
2. Service doors.
3. Louvers.
4. Wall openings.

C. Roof accessories including the following:

1. Eave gutters.
2. Structural facade system.

1.2 RELATED SECTIONS

A. Section 03300 - Cast-in-Place Concrete.

B. Section 08800 - Glass and Glazing.

C. Section 09900 - Painting and Coating.

1.3 REFERENCES

A. American Institute of Steel Construction (AISC):

1. AISC 360 - Specification for Structural Steel Buildings.
2. AISC 341 - Seismic Provisions for Structural Steel Buildings (when appropriate).
3. AISC Design Guide 3 - Serviceability for Steel Buildings

B. American Iron and Steel Institute (AISI):

1. AISI S100 - North American Specification for the Design of Cold-Formed Steel Structural Members.

C. American Welding Society (AWS):

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

D. Association for Iron & Steel Technology (AISE):

1. AISE 13 - Specifications for Design and Construction of Mill Buildings.

E. ASTM International (ASTM):

1. ASTM A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
2. ASTM A 653 / A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
3. ASTM A 792 / A 792M - Standard Specification for Steel Sheet, 55 % Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
4. ASTM B 117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
5. ASTM C 518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
6. ASTM C 1363 - Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus.
7. ASTM D 522 - Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings.
8. ASTM D 523 - Standard Test Method for Specular Gloss.
9. ASTM D 968 - Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive.
10. ASTM D 1308 - Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes.
11. ASTM D 2244 - Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.
12. ASTM D 2247 - Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
13. ASTM D 2794 - Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
14. ASTM D 3361 - Standard Practice for Unfiltered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.
15. ASTM D 4214 - Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films.
16. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
17. ASTM E 96 / E 96M - Standard Test Methods for Water Vapor Transmission of Materials.
18. ASTM E 1592 - Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference.
19. ASTM G 87 - Standard Practice for Conducting Moist SO2 Tests.

F. FM Global:

1. FMRC Standard 4471 - Approval Standard for Class 1 Roofs for Hail Damage Resistance, Combustibility, and Wind Uplift Resistance.

G. Metal Building Manufacturers Association (MBMA):

1. MBMA Metal Building Systems Manual.
2. Seismic Design Guide for Metal Building Systems.

H. North American Insulation Manufacturers Association (NAIMA):

1. NAIMA 202 - Standard For Flexible Fiber Glass Insulation to be Laminated for Use in Metal Buildings.

I. The Society for Protective Coatings (SSPC):

1. SSPC-Paint 15 - Primer for Use Over Hand Cleaned Steel performs to SSPC-Paint 15 standards.
2. SSPC-SP2 - Hand Tool Cleaning.

J. Underwriters Laboratories (UL):

1. UL 580 - Standard for Tests for Uplift Resistance of Roof Assemblies.
2. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.4 DEFINITIONS

A. Building Width: Measured from outside to outside of sidewall girts. Typically edge to edge of concrete.

B. Building Length: Measured from outside to outside of end wall girts. Typically edge to edge of concrete

C. Building Line: Outside face of steel/girt.

D. Building Eave Height: Measured from the top of the eave member at the outside of the sidewall girt line to the bottom of the sidewall column base plate or to finished floor if columns are on grout or recessed below finished floor.

E. Bay Spacing: Measured from centerline to centerline of primary frames for interior bays and from centerline of the first interior frame to outside of end wall girts for end bays.

F. Roof Pitch: The ratio of the vertical rise to the horizontal run (i.e. 1:12 = 1 inch of rise for every foot of horizontal dimension).

1.5 SYSTEM DESCRIPTION

A. General:

1. Provide metal building frame, metal wall panels, metal roof panels, accessories and miscellaneous materials for a complete enclosure including supports for building components specified in other sections.
2. Design structural systems according to professionally recognized methods and standards and legally adopted building codes.

3. Design under supervision of professional engineer licensed in the jurisdiction of the Project.

B. Design Requirements:

1. Refer to Structural Drawings

C. Performance Requirements:

1. System to withstand gravity and lateral loads in compliance with contract documents.
2. Refer to contract drawings for additional concentrated loads to pre-engineered building hanger beams and support jacks.
3. Allowable Deflections: Deflection/drift criteria shall follow recommendations outlined in AISC Design Guide 3 and MBMA Serviceability recommendations.
4. Metal wall panels (interior and exterior) shall not to be used as shear elements.
5. Construct assembly to permit movement of components without buckling, failure of joint seals, undue stress on fasteners or other detrimental effects, when subject to temperature range of 100 degrees F (37 degrees C) in a 24 hour period.
6. Design and fabricate wall and roof systems free of distortion or defects detrimental to appearance or performance. Some oil canning in rolled panels especially in the flats of the panel is normal and is not cause for rejection.
7. **Contractors reference structural drawings for required building design loads including TDI mandated wind loading which must be incorporated into the design.**

1.6 SUBMITTALS

A. Submit under provisions of Section 01340 - Submittals.

B. Design Data: Provide detailed design criteria and calculations prepared by a licensed structural engineer.

C. Certification: Manufacturer certification that the building conforms to the contract documents and manufacturer's standard design procedures.

D. Shop Drawings: Show building layout, primary and secondary framing member sizes and locations, cross-sections, and product and connection details.

1. Anchor Bolt Installation Drawings: Layouts with minimum bolt diameters (anchors are typically by others in the metal building industry).

E. Product Data: Information on manufactured products to be incorporated into the project.

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

G. Verification Samples: For each finish product specified, two samples, minimum size 6 inches square, representing actual product, color, and patterns.

H. Certificates: Welder certifications

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Not less than 5 years experience in the actual production of specified products.

1. Member of the Metal Building Manufacturer's Association (MBMA).
2. Primary manufacturer of frames, secondary steel, roof and wall sheeting, and trim.

B. Installer Qualifications - Firm experienced in application or installation of systems similar in complexity to those required for this project, plus the following:

1. Acceptable to or licensed by manufacturer.
2. 3 years experience with systems.
3. Successfully completed not less than 5 comparable scale projects using this system.

C. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.

1. Finish areas designated by Architect.
2. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
3. Refinish mock-up area as required to produce acceptable work.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.9 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

1.10 WARRANTY

A. Manufacturer shall warranty installed system for the periods described herein, starting from Date of Substantial Completion or ninety days from delivery, whichever comes first, against all the conditions indicated below. When notified in writing from Owner, manufacturer/installer shall, promptly and without inconvenience and cost to Owner, correct said deficiencies.

1. Materials and Workmanship Warranty:
   a. Warranty Period: 5 years
2. Panel Rib Standard Weathertight Warranty:
   a. Warranty Period: 20 years.
3. Standard Weathertight Endorsement:

a. Warranty Period: 20 years.

4. Structural NDL Endorsement:
   a. Warranty Period: 20 years.
5. Finish Warranty:
   a. Finish coating shall not peel, blister, chip, crack or check in finish, and shall not chalk in excess of 8 numerical ratings when measured in accordance with ASTM D 4214.
   b. Finish coating shall not change color or fade in excess of 5 NBS units as determined by ASTM D 2244.
   c. Panel finish: 25 years.
6. Performance Warranty: Furnish written warranty, stating sheet metal roofing system and flashing under this Section will be maintained in watertight condition and defects resulting from the following items will be corrected without cost to Owner for a period of 10 years.
   a. Faulty workmanship.
   b. Defective materials including sealants and fasteners.
   c. Water infiltration.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer:

1. Nucor Building Systems
2. Meuller Mnf.
3. Ram Industrial
4. Red Dot
5. Others as might be approved.

B. Substitutions: As approved by Addendum

2.2 STRUCTURAL STEEL FRAMING

A. Primary Framing: Rigid Frame solid web framing consisting of tapered rafters rigidly connected to supermarket columns with max depth of 12” up to min. 12 ft height above finish floor, tapered above. Provide a clear span that supports the loads at bay spacing indicated.

B. Primary Framing: Continuous Beam solid web framing utilizing tapered depth beams or girders supported on supermarket columns with max depth of 12” up to min. 12 ft height above finish floor, tapered above. Locate interior pipe columns where indicated and designed to support loads at bay spacing indicated.

C. End Wall Framing: Corner posts, end posts and rake beams.

2.3 SECONDARY FRAMING

A. Purlins: Zee-shaped; depth as required; with minimum yield strength of 60,000 psi (410 MPa); simple span or continuous span as required for design. G-30 galvanized standard material.

B. Girts: Zee- or Cee-shaped; depth as required, with minimum yield strength of 60,000 psi (410 MPa); simple span or continuous span as required for design. G-30 galvanized standard material.

C. Transbay Members: Bar joist, parallel chord, secondary joists; simple span, utilizing materials, sizes and yield strength as required.

D. Wind Bracing: Portal, torsional, diagonal bracing or diaphragm in accordance with manufacturer's standard design practices; utilizing rods, angles, and other members, with minimum yield strengths as required for design.

E. Primary Frame Flange Bracing: Attached from purlins or girts to the primary framing, minimum yield strength as required for design.

2.4 MISCELLANEOUS FRAMING

A. Base Angles: Nominal 2 inch by 3 inch by 0.060 inch acrylic coated G30 galvanized steel angles, with minimum yield strength of 55 ksi (380 MPa), anchored to the floor slab or grade beam with power driven fasteners or equivalent at a maximum spacing of 2 feet (610 mm) (on center and not more than 6 inches from the end of any angle member.

B. Door Headers and Jambs: Zee- or Cee-shaped; depth as required; with minimum yield strength of 60 ksi (410 MPa).

2.5 ROOF COVERING SYSTEM

A. Roof Panels: Nucor VR16II Architectural Standing Seam Roof Panels; 16 inches wide net coverage with 2 inch high major ribs formed at the panel side laps, for field seaming using electrically operated seaming machine.

1. Material (Painted): AZ50 Galvalume coated steel.
2. Thickness: 24 gage.
3. Side joints: Factory applied sealant for field seaming
4. Length: Continuous from eave to ridge up to 50 feet (15.24 m) in length.
5. End laps, where required: nominal 6 inches wide, located at a support member.
6. Panel-to-roof purlin structural attachments: clips, with movable tabs that interlock with seamed panel ribs and provide 1 inch of panel movement in either direction from center of clip to compensate for thermal effects.
7. Kynar finish applied to the zinc aluminum coated steel
8. Refer to Structural Drawings for design criteria.

2.6 EXTERIOR PANELS

A. Wall Panels: Nucor Classic Wall, 36 inch wide net coverage, with 1-3/16 inch high major ribs at 12 inches on center with (2) minor ribs spaced between the major ribs.

1. Material (Painted): AZ50 Galvalume coated steel.
2. Thickness: 26 gage.
3. Side laps: Two fully overlapping major ribs secured together with Stainless Steel capped 1/4 inch diameter color-matched carbon steel fasteners.
4. Length: Continuous from sill to eave up to 43 feet in length.
5. End laps, where required: 4 inches wide, located at a support member.
6. Crimp panels at the base to achieve no gaps against the foundation greater than 1/16 inch and notch to match roof panel configuration at the eave.
7. Cut panels square at each end.
8. Cut panels square at each end; provide base trim at sill and closure plugs.
9. Kynar 500 finish applied to the zinc aluminum coated steel

2.7 INSULATION

A. Roof Insulation:

1. Laminated fiberglass insulation R19 with tall panel clips w/ thermal blocks + R11 Liner System

B. Wall Insulation:

1. Laminated fiberglass insulation R13 + R6.5 rigid ci (Section 07200) Rigid Insulation between girts and metal wall panel

C. Roof and Wall Insulation Facing: WMP-VR-R.

1. 0.0015-inch-thick, UV-stabilized, white polypropylene laminated to metalized polyester film, reinforced with glass-fiber scrim.
2. Adhere facing to Owens-Corning Fiberglas "Certified R", NAIMA 202, fiberglass blanket.
3. Assembly of Insulation Blanket and Facing:
   a. Flame Spread Rating: Less than 25.
   b. UL Label: Submit as specified in Submittals article of this section.
   c. Perm Rating: 0.02.
4. **Roof assembly is to be with continuous liner panel bottom of girts.**

2.8 INSULATION SUPPORT SYSTEM

A. Insulation Support System: "Sky-Web II" insulation support system.

B. Description:

1. Compatible with roof system.
2. Limit to "over-the-purlin" type insulation systems.
3. Knotted Mesh:

a. Grid: Nominal 2-3/4 inches by 2-3/4 inches.
b. Material: Twisted twine of DuPont nylon Type 6-6 fiber.
c. Mesh Covering Interior Bays: 21-pound twine.
d. Five-Foot Strip Along Edge: #30 twine, with edge color coded for identification.

4. Double selvage along the 2 edges in machine direction.
5. Furnish up to 60 feet wide by building width.
   a. Cover 1 or 2 bays of building length
   b. Extend eave-to-eave across building.

C. Physical Properties:

1. Minimum Tensile Strength:
   a. #21 Twine: 205 pounds.
   b. #30 Twine: 265 pounds.
2. Runnage:
   a. #21 Twine: 960 feet per pound.
   b. #30 Twine: 605 feet per pound.
3. Cord Used to Make Mesh-to-Mesh Edge Connections: #36 DuPont nylon Type 6-6 white braided twine.
   a. Minimum Tensile Strength: 360 pounds.
   b. Runnage: 533 feet per pound.
4. Mesh Weight: 0.012 pounds per sq ft.

D. Fasteners and Attachment Hardware:

1. Connections to Eave and Gable Members:
   a. 1/8-inch-diameter wire clips looped through 20-gauge steel V-straps.
   b. Steel V-Straps: Fasten to framing with self-drilling screws.
2. Mesh-to-Mesh Edge Connections:
   a. Lace #36 nylon cord through edges of pieces of mesh being connected.
   b. Edge Connections: Plastic cable ties.

E. Fire-Hazard Classification:

1. UL Fire-Hazard Classification Ratings, UL 723:
   a. Flame Spread: 3 or less.
   b. Smoke Developed: Less than 10.

2.9 ROOF ACCESSORIES

A. Eave Gutters: Roll-formed 26 gage steel sheet, with gutter straps, fasteners and joint sealant; manufacturer's standard color.

1. Downspouts: 26 gage 4 inches by 5 inches in 10 foot lengths, with downspout elbows and downspout straps; same color as wall panels unless specified otherwise.

2.10 MATERIALS

A. Structural Steel Plate, Bar, Sheet, and Strip for Use in Bolted and Welded Constructions: ASTM A 572/A 572M, A 529/A 529M, A 1011 or A 36/A 36M Modified 50, with minimum yield strength of 55,000 psi (380 MPa).

B. Galvanized Structural Steel Material for Use in Roll Formed or Press Broken Secondary Structural Members: ASTM A 563, with minimum yield strength of 60,000 psi (410 MPa).

C. Galvanized Steel Sheet for Roll Formed or Press Broken Roof and Wall Coverings, Trim and Flashing: ASTM A 653/A 653M, with minimum yield strength of 50,000 psi (345 MPa).

D. Galvalume Steel Sheet Used in Roll Formed or Press Broken Roof Covering: Aluminum-zinc alloy-coated steel sheet, ASTM A 792/A 792M, with minimum yield strength of 50,000 psi (345 MPa); nominal coating weight of 0.5 oz per sq ft both sides, equivalent to an approximate coating thickness of 0.0018 inch both sides.

E. Hot Rolled Steel Shapes: W, M and S shapes, angles, rods, channels and other shapes; ASTM A 500, ASTM A 572/A 572M or ASTM A 36/A 36M as applicable; with minimum yield strengths required for the design.

F. Structural Bolts and Nuts Used with Primary Framing: High strength, ASTM A 325 bolts and ASTM A563 Grade C nuts.

G. Bolts and Nuts Used with Secondary Framing Members: High Strength ASTM A 325 Bolts and ASTM A 563 Grade C nuts.

H. Panel Fasteners:

1. For Galvalume and KXL finished roof and wall panels: Stainless Steel-capped carbon steel fasteners with integral sealing washer.
2. Color of exposed fastener heads to match the roof or wall panel finish.
3. Concealed Fasteners: Self-drilling type, of size as required.
4. Provide fasteners in quantities and location as required by the manufacturer.

I. Flashing and Trim: Kynar finish toatch material, finish, and color of adjacent components. Provide trim at rakes, including peak and corner assemblies, high and low eaves, corners, bases, framed openings and as required or specified to provide weather tightness and a finished appearance.

J. Sealants, Mastics and Closures: Manufacturer's standard type.

1. Provide at roof panel end laps, side laps, rake, eave, transitions and accessories as required to provide a weather resistant roof system; use tape mastic or gun grade sealant at side laps and end laps.
2. Provide at wall panel rakes, eaves, transitions and accessories.
3. Closures: Formed to match panel profiles; closed cell elastic material, manufacturer's standard color.
4. Tape mastic: Pre-formed butyl rubber-based, non-hardening, non-corrosive to metal; white or light gray.
5. Gun grade sealant: Non-skinning synthetic Elastomeric based material; gray or bronze.

2.11 FABRlCATlON

A. Fabrication: Fabricate according to manufacturer's standard practice.

1. Fabricate structural members made of welded plate sections by jointing the flanges and webs by continuous automatic submerged arc welding process.
2. Welding operators and processes: Qualified in accordance with AWS D1.1.
3. Field connections: Prepare members for bolted field connection by making punched, drilled, or reamed holes in the shop.

B. Component Identification: Mark all fabricated parts, either individually or by lot or group, using an identification marking corresponding to the marking shown on the shop drawings, using a method that remains visible after shop painting.

2.12 FINISH

A. Schedule of Finishes:

1. Kynar Roof finish and color: To Be Selected
2. Kynar Wall finish and color: To Be Selected
3. Kynar Soffit panels finish and color: To Be Selected

B. Shop Coat: Manufacturer's standard rust inhibitive primer paint; manufacturer's standard color.

1. Finish all structural steel members using one coat of manufacturer's standard shop coat, after cleaning of oil, dirt, loose scale and foreign matter.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper and or timely completion.

1. Verify foundations are properly installed, to correct dimensions and within acceptable tolerances.
2. Verify location of covered or built-in work.
3. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Framing Erection: Erect framing in compliance with AIS Specification and the latest edition of the MBMA metal building systems manual.

B. Provide for erection and wind loads. Provide temporary bracing to maintain structure plumb and in alignment until completion of erection and installation of permanent bracing. Locate braced bays as required by manufacturer.

3.3 ERECTION OF FRAME

A. Install in accordance with manufacturer's instructions.

1. Do not erect frames without complete installation of tie beams and anchorages.
2. Set column base plates with non-shrink grout to full plate bearing.
3. Do not field cut or alter structural members without written approval.
4. After erection, prime welds, abrasions, and surfaces not primed with primer used in shop painting.

3.4 INSTALLATION

A. Install in compliance with manufacturer's instructions and approved submittals.

1. Exercise care when cutting prefinished material to ensure cuttings do not remain on finish surface.
2. Fasten cladding system to structural supports, aligned level and plumb.
3. Locate end laps over supports. End lap panels according to manufacturer's recommendations. Place side laps over adjacent panel and mechanically seam or stitch fastener per erection guidelines.
4. Provide expansion joints where indicated.
5. Use concealed fasteners.
6. Install sealant and gaskets to prevent weather penetration.
7. Install system free of rattles, noise due to thermal movement, and wind whistles.
8. Install door frames, service doors, overhead doors, window and glass, and gutter system in compliance with manufacturer's instructions.
9. Seal wall and roof accessories watertight and weather tight with sealant in compliance with building manufacturer's standard procedures.
10. Rigidly support and secure gutters and downspouts. Joint lengths with formed seams sealed watertight. Flash and seal gutters to downspouts.

B. Tolerances:

1. Framing Members: 1/4 inch from level; 1/8 inch from plumb.
2. Racking: 1/8 inch from true position. Provide shoring to maintain position prior to cladding installation.

3.5 FIELD QUALITY CONTROL

A. Testing by Contractor:

1. Roof installation inspection by roof manufacturer's representative; as required as part of warranty provision.

B. Testing by Owner:

1. High Strength Bolted Connections: Specification for Structural Joints Using ASTM A 325 or A 490 Bolts, with minimum testing of bolted connections per the arbitration inspection procedure.

2. Welded Connections: AWS. Visual inspection of 100 percent of welds. Ultrasonic inspection of 50 percent of full and partial penetration welds. A rejection rate greater than 5 percent will increase the inspection to 100 percent.
3. General Testing: For materials and installed tolerances.

END OF SECTION 133419

SECTION 313116 - TERMITE CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Soil treatment.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include the EPA-Registered Label for termiticide products.

1.3 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Soil Treatment Application Report: Include the following:

1. Date and time of application.
2. Moisture content of soil before application.
3. Termiticide brand name and manufacturer.
4. Quantity of undiluted termiticide used.
5. Dilutions, methods, volumes used, and rates of application.
6. Areas of application.
7. Water source for application.

C. Sample Warranties: For special warranties.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located and who employs workers trained and approved by manufacturer to install manufacturer's products.

1.5 WARRANTY

A. Soil Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work consisting of applied soil termiticide treatment will prevent infestation of subterranean termites , including Formosan termites (Coptotermes formosanus) . If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.

1. Warranty Period: **Five** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOIL TREATMENT

A. Termiticide: EPA-Registered termiticide acceptable to authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation.

1. Manufacturer materials subject to compliance with requirements, provide the following:
   a. Bayer Environmental Science.
   b. Termidor 80WG (Fipronil) with Agreszor (Imadacloprid)
   c. Others as pre-approved.
2. Service Life of Treatment: Soil treatment termiticide that is effective for not less than ten years against infestation of subterranean termites.

PART 3 - EXECUTION

3.1 PREPARATION

A. Remove extraneous sources of wood cellulose and other edible materials, such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.

B. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated.

3.2 APPLYING SOIL TREATMENT

A. Application: Mix soil treatment termiticide solution to a uniform consistency. Distribute treatment uniformly. Apply treatment at the product's EPA-Registered Label volume and rate for maximum specified concentration of termiticide to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction.

1. Slabs-on-Grade and Basement Slabs: Under ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
2. Foundations: Soil adjacent to and along the entire inside perimeter of foundation walls; along both sides of interior partition walls; around plumbing pipes and electric conduit penetrating the slab; around interior column footers, piers, and chimney bases; and along the entire outside perimeter, from grade to bottom of footing.
3. Masonry: Treat voids.
4. Penetrations: At expansion joints, control joints, and areas where slabs and below-grade walls will be penetrated.

B. Post warning signs in areas of application.

C. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

END OF SECTION 313116

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 17

PLUMBING 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, regulating devices, water arresters 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. Prime coat finish

F. Brushed satin stainless steel finish for restroom, kitchen or cafeteria installation

G. 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 22 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. 24 inch x 24 inch for plumbing multiple isolation valves and electrical related items in ceilings
2. 8 inch x 8 inch for plumbing for single isolation valve or shock arrestor

END OF SECTION

SECTION 22 05 19

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 22, Plumbing
   1. Plumbing General Provisions
   2. Pipe and Pipe Fittings, General
   3. Valves, Strainers and Vents

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 inch 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 percent 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: Domestic Water 4CTS LF (Lead Free) 0-100 PSI

2.3 THERMOMETER WELLS

A. Brass or type 300 stainless steel. Machined bar stock, 1-piece construction (Lead Free).

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 percent into pipe.

2.4 THERMOMETERS IN PIPING SYSTEMS OR VESSELS

A. Die cast aluminum case with baked epoxy finish.

B. Adjustable angle 9 inch 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 (Lead Free).

H Accuracy: +/- 1 percent of scale range.

I. Range:
1. Hot water lines: 30 deg. F to 240 deg. 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 (Lead Free).
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 inch OD probe.
2. Four 5 inch stem pocket testing thermometers.
a. Two with range 0 deg. F to 220 deg. 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 (Lead Free).

C. Locate gauges and thermometers to be easily readable from the floor at a 5 foot-6 inch

eye level. Use adjustable angle or rigid stem as required. Install gauges in upright position.

D. Install gauges in the following locations: across pumps, storage tanks, heat exchangers.

E. Install thermometer in the following locations: At storage tanks, across heat exchangers, across boiler, leaving side of water heater, leaving water side of tempered water valves, and hot water supply and return lines.
1. Hot water lines: 30 deg. F to 240 deg. F.
2. Tempered water valves 0 deg. F to 120 deg. F.

END OF SECTION

SECTION 22 05 23

VALVES, STRAINERS AND VENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Plumbing 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 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 inch: 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 inch: Lub-O-seal
f. Conbraco Ball Valve, full port through 4 inch: 64-100 Series
h. Milwaukee Full Port ¼ inch-2 inch
i. Milwaukee Standard Port 2-1/2 inch & 3 inch
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 inch: 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 inch
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 inch.
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.

3.6 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.
   4. 3 inch and larger, provide one-piece stainless steel IBR (in building riser), Watts or Ames.

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.

F. Alternate Method of Joining Copper Pipe and Tubing: Press Fittings: Copper press fitting

shall conform to the material and sizing requirements of ASME B16.18 or ASME B16.22. O-rings for copper press fittings shall be EPDM. VIEGA. The system intended for use shall be approved by submittal. Systems from various manufacturers may vary in technology. The field personnel shall carry training credentials from the approved manufacturer for the project. Mixing of fittings from different manufacturers is strictly prohibited.

G. Projects where PEX is acceptable: PEX system must be listed ASTM F876/F877. Tubing shall be listed PEX 5006 for chlorine resistance for continuous usage up to 140°F. All tubing installed in return air plenums shall be listed ASTM E84. The listing may be for the tubing itself or for the tubing including insulation to achieve the listing. The fittings shall be of the same manufacturer as the tubing and the installation instructions of the manufacturer shall be strictly adhered to. Uponor Systems only.

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. Prior to starting work, verify system is complete, flushed and clean.

B. Inject chorine disinfectant in liquid, powder, tablet or gas form throughout the system to obtain 50 to 80 Mg/L residual.

C. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 20% of the outlets.

D. Retain disinfectant in system for 8 hours (minimum), 24 hours (maximum). During the disinfection process, operate all valves and accessories.

E. If final disinfectant residual tests less than 25 Mg/L, repeat treatment.

F. Flush disinfectant from system until chemical and bacteriological tests prove water quality equal to that of the service main.

G. Take samples no sooner than 24 hours after flushing from at least 10% of the outlets and from the water entry.
   1. Obtain a minimum of one water sample flushing from at least 10% of the outlets and from the water entry.
   2. Take samples from faucets located at highest point in the building, and farthest point from the main water supply.

H. If it is impossible to disinfect the potable water-storage tank as specified, the entire interior of the tank shall be swabbed with a solution containing 200 parts per million of available chorine. The solution shall remain for two hours before flushing and returning to service.

I. After final flushing, remove aerators, clean and replace.

J. Chemical and bacteriological tests shall be conducted by a state certified laboratory.

K. The firm performing the disinfection shall have chemical laboratory experience.

L. Provide a laboratory report to indicate the following information.
   1. Name and address of the approved laboratory testing the samples.
   2. Name and location of the project and date the samples were obtained.
   3. Mg/L chlorine during retention.
   4. Mg/L chlorine after flushing.
   5. The coliform organism count. (An acceptable test shall show absence of coliform organisms.)

M. If analysis does not satisfy the specified minimum requirements, repeat the disinfection procedure.

N. Submit for approval to the Architect/Engineer a copy of the laboratory report and the certification of performance. An approved copy of each document shall be inserted in the Owner's manual.

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 11 23

DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. General characteristics for pumps specified in Division 22 - Plumbing.

1.2 RELATED WORK

Requirements for pumps are specified in other sections of Division 22 - Plumbing, including the following:

A. Division 22 Plumbing - Electrical Provisions of Plumbing 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.

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. Select the pump for operation at or near peak efficiency.

E. Cavitation-free at all points on the curve.

F. Impeller diameter shall not exceed 90 percent of the maximum published diameter.

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. Submit 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. Show pump curves with system curve plotted.

PART 2 - PRODUCTS

2.1 DOMESTIC HOT WATER CIRCULATOR

A. Pump construction:
   1. Cast iron, designed for 125 psi working pressure
   2. Bronze fitted
   3. Grease lubricated ball bearings selected for an average life of 150,000 hours
   4. Flexible coupled
   5. Horizontal or vertical in-line
   6. Flanged connections

B. Provide each pump with a mechanical seal. Use seal materials suitable for the pumped liquid.

C. Paint entire unit with two coats of machinery enamel after completion of installation.

D. Pump motor:
   1. NEMA Standard
   2. 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.
   3. Provide insertion thermostat (Aquastat) or (timer) to control operation of the domestic hot water return pumps.

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. Amtrol/Thrush
   3. Armstrong
   4. Aurora
   5. Grundfos

2.2 DOMESTIC HOT WATER CIRCULATING PUMPS (SMALL) FRACTIONAL HORSEPOWER

A. Pump Construction:
   1. Wet-rotor, in-line, single stage
   2. Bronze housings with ½” and ¾” sweat connections
   3. Stainless steel housing with union threaded connections
   4. Integrated check valve inside union fitting on a sweat pump housing
   5. Built-in 5-foot, 115 volt AC line cord with NEMA 3 Prong male plug or line cord
   6. Built-in timer
   7. Aquastat thermostatic control

2.3 SUBMERSIBLE SUMP PUMPS AND SEWAGE EJECTORS

A. Pump Construction:
   1. Hermetically sealed motor
   2. Positive action air operated diaphragm switch
      a. High water alarm contact
   3. Housing and base cast iron construction

B. Provide an alarm terminal cabinet.
   1. In the event of a high water alarm, energize a pulsing 2" diameter red signal light with graphic "sump pump high water alarm”.

C. Test the sump pump package by operation of the completed system through four cycles of operation.

1. Fill the sump to operational levels
2. Visually check level controls
3. Pump operation
4. Verify absence of piping leaks, sump leaks, excessive noise, and excessive vibration
5. Verify alarms
6. Verify pump capacity

D. Sump pump package capacity shall be as scheduled.

E. Acceptable Manufacturers:
1. Hydromatic
2. Little Giant Pump Co.
3. Weil
4. Goulds
5. Grundfos
6. Crane (Barnes) Air Pumps
7. Ebara

2.4 FLOW INDICATOR

A. Flow Indicator
1. Bronze Construction
2. Rotating wheel
3. Line Size
4. Double Window
5. Ernst Flow Industries Model EFI E-57-3

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. Lubricate pumps prior to start-up.
3. 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.

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 MANUFACTURER START-UP SERVICE ALIGNMENT

A. 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.

3.3 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.

3.4 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 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. Plumbing Fixtures and Fixture Carriers
   3. Drains, Cleanouts and Hydrants
   4. 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. Hub Drains. Install hub drains where indicated, with the top of the hub 1/2 above the finished floor, unless otherwise indicated on the drawings.

C. 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.

D. 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. 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.

H. Compression Joints for Cast Iron Water Pipe. Use Beltite, Tyton or Grip-Tite compression joints. Install in accordance with the manufacturer's recommendations for compression joints. Provide adequate concrete thrust blocks at changes of direction, as recommended by the manufacturer.

I. Compression Gasket System. Bell and spigot cast iron pipe 4" and smaller, use flax-base lubricant, Tyler Ty-Seal Lubricant or Charlotte Regular Lubricant. 6" and larger use a neoprene base lubricant, Charlotte Adhesive Lubricant.

J. 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.

K. Press fittings for copper pipe 1/2” to 4”: Copper press fittings shall conform to the material and sizing requirements of ASTM B16.18 or ASME B16.22. O-rings for copper press fittings shall be EPDM. Pro-Press System manufactured by VIEGA. The system intended for use shall be approved by submittal. Systems from various manufacturers may vary in technology. The field personnel shall carry training credentials from the approved manufacturer for the project. Mixing of fittings from different manufacturers is strictly prohibited.

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 33 33

ELECTRIC WATER HEATER (Commercial ASME)

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Electric water heaters for domestic water systems.

1.2 RELATED WORK

A. Division 22 Plumbing
   1. Domestic Water Piping.
   2. Plumbing Piping Insulation.
   3. Division 26 Electrical.

1.3 WARRANTY

A. Provide standard manufacturer's 1 year commercial warranty for mechanical and electrical and 5 year warranty for leaks. Warranty shall start the date of the substantial completion certificate.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Lochinvar.

B. State.

C. Rheem / Ruud

D. A. O. Smith

e. Bradford White

2.2 PRODUCTS

A. Provide electric water heaters with kilowatt, recovery ratings, and storage capacities as scheduled on drawings.

B. Provide an ASME code construction tank designed for 150 psig working pressure. Furnish glass-lined tank. Lining shall be corrosion-resistant.

C. Furnish factory-assembled, integral units equipped as follows:
   1. Immersion thermostat.
   2. High temperature limit switch (energy cutout).
   3. Low-water cutoff.
   4. Heavy duty UL rated for 100,000 cycles.
   5. Temperature and pressure relief valve.
   6. Anode rod.

D. Provide heavy-duty, medium watt density elements having nicoloy sheathing and prewired leads.

E. The entire vessel shall be enclosed in a round steel enclosure with baked enamel finish and shall enclose the tank with R-16 foam insulation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installations shall be in accordance with the manufacturer's published recommendations.

C. Furnish all supports required by the equipment included in this Contract.

D. Provide a 4" thick reinforced concrete housekeeping pad beneath heaters.

E. Furnish and install all necessary valves, traps, gauges, strainers, unions, etc. to facilitate proper functioning and servicing of equipment.
   1. Install a line size shutoff valve in cold water inlet and hot water outlet close to each heater.
   2. Provide a temperature gauge in the domestic hot water piping within five feet of outlet to each heater, upstream of all shut-off valves. Size and locate gauges to be easily readable from a standing position.

F. Provide dielectric isolation device where copper lines connect to ferrous lines or equipment, such as dielectric coupling or dielectric flange fitting.

G. Route condensate to a vented receiver.

H. Pipe relief valve discharge and all equipment drains indirectly to appropriate floor drain.

I. Set the operating and safety controls.

J. Set thermostats on domestic water heaters to delivery maximum water temperature as indicated on Contract Drawings.

K. Furnish and install an expansion tank on cold water supply to heater. Locate tank as close to water heater as possible between water heater and all check valves or backflow preventers. Expansion tank capacity shall be as scheduled on Contract Drawings. Install expansion tank in accordance with manufacturer's recommendations.

L. Install water heater in galvanized drain pan piped to floor drain. Elevate water heater tank bottom above drain pan as to not allow standing water inside of drain pan to touch bottom of tank.

3.2 STARTUP

A. Startup shall be performed by factory trained and authorized personnel. The factory representative shall also provide a technical and practical operation and maintenance training seminar including a hands-on operation and maintenance demonstration, and classroom presentation with handouts and visual aids, for no less than three physical plant personnel.

END OF SECTION

SECTION 22 40 00

PLUMBING FIXTURES AND FIXTURE CARRIERS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install water closets, urinals, lavatories, electric drinking fountains, fixture carriers and plumbing appurtenances.

1.2 RELATED WORK

A. Division 22 Plumbing
1. Drains, Hydrants and Cleanouts.
2. Domestic Water Piping.
3. Soil, Waste and Sanitary Drain Piping and Vent Piping.

1.3 JOB REQUIREMENTS

A. Furnish plumbing fixtures and trim as shown and specified. Provide faucets, fittings, supply stops and similar devices of a single manufacturer. Furnish faucets and supply stops with renewable seats. Porcelain to steel and enameled cast iron fixtures shall be acid resistant. Wall hung fixtures shall be installed with a fixture carrier.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Plumbing Fixtures (Vitreous China):
1. American Standard.
2. Kohler.
3. Toto
4. Zurn

B. Plumbing Faucets:
1. American Standard.
2. Chicago.
3. T&S Brass.
4. Zurn.

C. Supports and Carriers:
1. Wade
2. Zurn
3. J.R. Smith.
4. Josam.
5. Watts
6. MIFAB

D. Flush Valves:
1. Sloan
2. Zurn
3. Moen Commercial

E. Supplies, Stops and Chrome Plated Tubular Brass:
1. McGuire

2. Kohler
3. Chicago
4. Zurn

F. Water Closet Seats:
1. Beneke
2. Church
3. Olsonite
4. Bemis

G. Electric Drinking Fountains:
1. Halsey Taylor
2. Elkay
3. Oasis

H. Floor Drains:
1. Wade
2. J.R. Smith
3. Josam
4. Zurn
5. Watts
6. Sioux Chief
7. MIFAB

I. Cleanouts:
1. Wade
2. J.R. Smith
3. Josam
4. Zurn
5. Watts
6. MIFAB

J. Shower Systems:
1. Bradley
2. Acorn
3. Willoughby

K. Shower Valves
1. Chicago
2. Acorn
3. Symmons
4. Bradley
5. Moen Commercial

L. Stainless Steel Sinks:
1. Elkay
2. Just
3. Griffin
4. Moen Commercial
5. Amtekco Industries

M. Mop Sinks:
1. Crane Fiat
2. Stern Williams
3. Acorn
4. CECO

N. Thermostatic Mixing Valves
1. Lawler
2. Symmons
3. Leonard
4. Powers
5. Bradley

O. Emergency Safety Equipment
1. Speakman
2. Bradley
3. Encon
4. Guardian
5. Haws

P. Shock Arrestors:
1. Precision Products
2. Sioux Chief

Q. Backflow Preventors
1. Watts
2. Febco
3. Wilkins
4. Beeco

R. Hose Bibbs
1. Wade
2. Chicago
3. Josam
4. Woodford
5. Zurn
6. J.R. Smith
7. MIFAB

S. Wall Hydrants
1. Wade
2. Woodford
3. Zurn
4. J.R. Smith
5. Josam
6. MIFAB

2.2 REQUIREMENTS

A. Refer to the drawings for equipment to be supplied.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with the manufacturer's instructions.

B. Make rough-in and final connection of service to each fixture provided under this Section and other Sections or Architectural or Plumbing Drawings.

C. Provide necessary stops, valves, traps, unions, vents, cold water, hot water, sanitary, etc.

for a complete installation.

D. Provide isolation valves in domestic water lines to isolate all equipment, restrooms, hose bibbs, and where shown on drawings.

E. Remove piping and services roughed-in incorrectly and install correctly, without cost.

F. Exposed piping, fittings and appurtenances shall be chrome-plated brass.

G. Coordinate with the Contractor for locations and service required for each plumbing fixture.

H. All floor drains and floor sinks shall have trap primer connections. Provide trap primer valves and 1/2-inch water line to each floor drain connection. Trap primer supply line shall have ball valve and Y strainer on inlet side of trap primer valve to facilitate cleaning.

I. All floor drains and floor sink locations are to be coordinated with all equipment. Locate drains in mechanical equipment spaces to conform to drain locations of equipment furnished. Coordinate drain location with food service equipment and Architectural Drawings.

J. All floor drains, floor sinks and cleanout covers are to be provided with stainless steel vandal resistant screws.

K. Trap primer valves installed in concealed spaces shall have approved access doors for accessibility.

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 ANSI (American National Standard) E2.180A-2000 and CSA (Canadian Standards Association Standard) CGA6.22A-M00.

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. Where there is more than one regulator at a location, each regulator shall have a separate vent to the roof / outdoors.
2. Install vent piping from regulators to location to prevent gas smells from entering building.
3. Install double elbows and insect screen at end of piping to prevent moisture and insects from entering.
4. When installed inside building route vents horizontally and terminate through building sidewall. Vents terminating through roof must have prior approval from Architect before installation. Through roof penetrations shall be minimized.
5. 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.

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. Provide and install a complete Building Management and Control System (BMCS), including industrial instrumentation necessary to obtain functions and results specified. A complete system includes items such as 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 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.

3.2 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. 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. Provide additional interlocks as indicated on fan schedule and on drawings.
   4. Interlock electrical and mechanical room exhaust fans with thermostat.

D. 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.

E. 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

F. Domestic Water System:
1. Interlock in-line circulating pumps at water heaters with return water pipe mounted thermostat to cycle pump with return water temperature.
2. Interlock high temperature entering water solenoid valve with thermostat on discharge side of tempered water mixing valves.

G. 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.
4. Install communication cable between each boiler and master controller specified by boiler manufacturer.

3.3 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.

3.4 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.

3.5 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

3.6 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

3.7 BUILDING ELECTRICAL USAGE

A. Provide digital monitoring of the building KVA and KWH. Coordinate with the switchgear manufacturer.

B. Electrical Quality monitoring:
1. Monitor Watts, VA, VAR, Demand, Imbalance, and Power Factor.

3.8 MISCELLANEOUS

A. Lighting Control:
1. Provide individual time/photo-cell and time based control of each lighting contactor specified in Division 26.
2. Provide momentary push buttons located at the central plant control panel, tennis courts, football, baseball, softball fields and/or concession stands to energize exterior lighting for a preprogrammed length of time.
a. Provide separate control of each contactor.

POINT DESCRIPTION	TYPE	DEVICE
Lighting Contactor	DO	Control Relay
Momentary Control Switch	DI	Switch

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

POINT DESCRIPTION	TYPE	DEVICE
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.

B. 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 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

3.11 SINGLE ZONE DX AIR HANDLING UNIT

A. Consists of a direct expansion coil and hot water coil in the reheat position. Control shall be as follows:
   1. A room thermistor sensing space temperature shall, acting through the Direct Digital Control Panel, energize the first stage of cooling, modulate the valve on the heating water in sequence, to maintain the desired space temperature. The air handling unit shall be started and stopped from the BMCS System.
      a. If an outside air unit provides the outside air for single zone air handling unit, the outside air unit shall be activated during the occupied periods.
   2. A discharge air temperature sensor shall stage the electric duct heat to maintain 55°F.
   3. Start/stop of the unit shall be by BMCS.
   4. Provide a temperature low limit switch located on the discharge side of the hot water reheat coil to de-energize the air handling unit and supply fan, 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 32°F. Device shall be manual reset.

POINT DESCRIPTION	TYPE	DEVICE
Start/stop	DO	Control Relay
AHU Status	DI	Current Sensitive Relay
Space Temperature	AI	Space Thermistor
Space Humidity	AI	Humidity Sensor
HW Valve	AO(1)	Electronic Operator
Condensing Unit	DO	Control Relay(s)
Discharge Air Temperature	AI	Duct Thermistor
Freeze Status	DI	Temperature Low Limit Switch

3.12 PACKAGED DX OUTSIDE AIR UNITS

A. These units are furnished with a direct expansion coil, hot gas reheat coil and gas heater in the reheat position. Control shall be as follows:
1. Start/Stop shall be by BMCS. Internal unit controls shall control operation.
2. The unit shall operate through its internal unit controls. The unit shall maintain a constant leaving air temperature off the cooling coil as scheduled and the hot gas reheat shall modulate to deliver neutral temperature air to the space at all times, 70˚F (Adjustable). The BMCS shall send an alarm if the leaving cooling coil leaving air temperature is above setpoint by more than 5 degrees (adjustable) singling unit operational issues.
4. Unit is provided with a BacNet interface card. All data available through the interface card shall be available through the BMCS system. Provide a separate graphics page for the interface card data.
5. All points listed below shall be provided by the BMCS contractor as hardwired points.

POINT DESCRIPTION	TYPES	DEVICE
Start/Stop	DO	Control Relay
Cooling Discharge Air Temperature	AI	RTD
Hot Gas Reheat Coil Discharge Temperature	AI	RTD
Unit Discharge Air Temperature	AI	RTD
Status	DI	Current Sensitive Relay

3.13 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.

A. 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.

B. 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
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

3.14 ELECTRIC DOMESTIC WATER HEATER

A. The system consists of one electric domestic water heater and one circulation pump.

B. Energize the electric water heater and circulation pump as scheduled through the BMCS system.

POINT DESCRIPTION	TYPES	DEVICE
Water Heater Enable/Disable	DO	Control Relay
Pump Start/Stop	DO	Control Relay

3.15 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.

3.16 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.

3.17 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.

3.18 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 23 00

REFRIGERANT PIPING AND APPURTENANCES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install copper tubing, valves, strainers and sight glass for refrigerant piping.

1.2 RELATED WORK

A. Division 23 Mechanical.
   1. Pipe and Pipe Fittings
   2. Piping Insulation

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Furnish refrigerant piping of Type K hard-drawn copper tubing with sweat-type, wrought copper fittings. Cast fittings are not permitted.

2.2 SERVICE VALVES

A. Provide angle or globe service valves, with sweat connections. Use packed-type, wrench operated, valves with gasketed seal cap and back seat feature. Furnish valves designed for refrigerant service, in conformance with the ARI code.

B. Place service valves at the inlet and outlet of each compressor, on both sides of each strainer and solenoid valve, and as otherwise shown and specified.

2.3 SOLENOID VALVES

A. Furnish pilot-operated, floating-piston solenoid valves suitable for operation with refrigerant.

B. Use valves with a bronze body and sweat-type connections.

C. Provide stainless steel stem and plunger assembly and a stainless steel piston.

D. Furnish sealed and moisture proof solenoid coils.

E. Use electrical characteristics of 115 volt, 60 Hertz.

2.4 SIGHT GLASSES

A. Provide suitable moisture and liquid sight glass in the liquid line leaving the condenser or receiver.

2.5 FILTER DRYER

A. Furnish replaceable core liquid line filter dryer.

B. Provide filter dryer constructed to permit the removal of the core element without removing the filter dryer from the line.

PART 3 - EXECUTION

3.1 BRAZING

A. During the brazing process, dry nitrogen shall be purged through the tubing to prevent oxides from forming.

3.2 PRESSURE TEST

A. After refrigeration and piping system items are installed, charge the system with dry nitrogen and test to 450 psig.
   1. Test joints with a Halide torch or an electronic leak detector.
   2. Repair leaks and retest each system until proved tight.

3.3 EVACUATION AND DRYING

A. After refrigerant system has been pressure-tested, connect a suitable vacuum pump and evacuate piping system, including lines and equipment.
   1. Maintain a vacuum as high as practicable for long enough to evaporate the moisture in the system (at least 48 hours).
   2. Check the humidity within the system with a wet bulb indicator, and maintain the vacuum until the wet bulb temperature is reduced to -40°F. After the system has been evacuated and dried, break the vacuum by charging proper refrigerant into the system.

3.4 PIPE SIZE

A. Pipe shall be routed and sized per condensing unit manufacturer’s instructions.

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 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. Cook

B. Greenheck

C. Penn Barry Ventilator

D. 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.

2.7 OSCILLATING AIR CIRCULATOR FAN

A. three speed CFM Low 1657 – CFM Medium 2060 – CFM High 3100

B. Totally enclosed motor voltage – 120 Voltage – 60 Hz

C. Cast Aluminum 20-inch diameter, three blade fan with OSHA Guard

D. Wall Mounted

E. Factory wired 10', 3 conductor with ground molded plug

F. Acceptable Manufacturer: Dayton 4PRV7 or approved equal

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 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 63 00

AIR-COOLED CONDENSING UNITS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install air-cooled condensing units complete with casing, compressor, condenser coil, condenser fan and controls required for a split air conditioning system.

1.2 RELATED WORK

A. Refrigerant Piping.

B. Electrical Provisions of Mechanical Work.

1.3 PERFORMANCE

A. Provide performance as scheduled on drawings, and head pressure control to enable unit to operate in temperatures as low as 20 degrees F. ambient.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Carrier

B. Daikin

C. Trane

2.2 COMPRESSOR

A. Provide a hermetic or semi-hermetic compressor with crankcase heaters, inherently protected motors, spring mounts and capacity modulation. Provide each compressor with a 5-year warranty.

2.3 CONDENSER COILS

A. Provide copper tubes with mechanically bonded aluminum fins. Protect condenser coils with a heavy gauge, corrosion resistant wire guard.

B. Provide condenser coil coated with corrosion resistant epoxy utilizing a dip and bake process. Coating shall be flexible and uniformly bonded to all condenser coil surfaces.

2.4 FANS AND MOTORS

A. Provide propeller-type fans with direct drive or belt drive and vertical discharge. Protect fan with a heavy-gauge, corrosion resistant wire guard. Provide inherently protected, permanently lubricated, and weatherproof motors.

2.5 CASING

A. Furnish a unit designed for outdoor mounting. Fabricate the casing of heavy gauge steel, zinc coated and finished with enamel. Provide removable access panels.

2.6 CONTROLS

A. Provide safety and operating controls factory wired and mounted in a separate enclosure. Include thermostatic expansion valve, high and low pressure switches and compressor motor overload devices. Furnish a time delay device to prevent short cycling. Employ a control transformer, a pressure relief device and suction and discharge valves with service connections.

2.7 THERMOSTAT

A. Low voltage, 7-day programmable thermostat is a component of the unit manufacturer unless specified in another Section.
   1. Individual Heating/Cooling setpoints.
   2. Automatic Heat/Cool change-over.
   3. Sub-Base On-Off-Auto fan selection.
   4. Sub-Base Heat-Off-Cool-Auto system selection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount condensing units on 4" foundation pads and pipe as shown on Drawings or as recommended by the equipment manufacturer. Install removable core refrigerant filter dryer and sight indicating glass.

3.2 CONTROL WIRING

A. Furnish and install control wiring as required. Install control wiring in conduit.

END OF SECTION

SECTION 23 73 13

AIR HANDLING UNITS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install air handling units with casing, fans, coils, filters, and special items.

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.

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, to enable entrance to building, or 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.

D. Unit casing panels shall be a minimum of 2” 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.

E. Provide full perimeter base rail channel under units constructed of heavy gauge galvanized steel (minimum 10 gauge) and intermediate cross members to assure unit integrity. Provide minimum size base rail to ensure proper trapping and slope of condensate drain (minimum 6 inch from bottom of drain opening).

F. Fan assembly shall be provided with 1" deflection internally mounted spring vibration isolation under the fan and motor base on units with coils less than 8 sq. ft. and 2" 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. Maximum acceptable RPM of fan shall not exceed 1000.

G. Provide factory installed removable hinged access doors in the following locations:
1. Entering side of all coils to allow for cleaning of coils on both sides 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.

H. 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.

I. Provide coils with stainless steel casings, end plates, tube supports and top & bottom plates.

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 units with a low velocity angled filter section unless otherwise specified.

2.3 DRAW THROUGH AIR HANDLING UNITS – CONSTANT VOLUME

A. Provided with:
1. V-belt drive assembly and motor with totally enclosed belt guard.
2. Insulated sheet metal cabinet with removable panels for access to the interior.
3. Hinged double wall doors with two-step safety handles.

B. Drive assembly:
1. Size for 50% overload.
2. Matched belts.
3. Minimum two belt drive.
4. Provide adjustable pitch motor pulley for motors.
5. Provide motor and fan pulley of cast iron keyed to the shaft.

C. Select the motor so that the brake horsepower required to deliver the design air quantity at the system static pressure will not exceed the motor nameplate rating.
1. Totally enclosed, fan cooled, variable speed. 1750 rpm Maximum
2. Minimum 90% nominal efficiency at loads of 70% to 100%.
3. Premium efficiency
4. Cast iron frame and end plate
5. Forged steel lifting eye
6. Oversized conduit box with ground lug
7. Provide with factory installed shaft grounding ring by Aegis on units which utilize a variable frequency drive.

D. Supply Fans:
1. Double width, double inlet, forward curve blades.
2. Statically and dynamically balanced.
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.

E. Select fan to operate at or near its maximum efficiency point when handling the required air quantity and static pressure.

F. Stainless steel condensate pan with positive slope in all directions to outlet. Line the condensate drain pan with minimum 1-1/2" waterproof insulation.

G. Fan bearings:
1. Remote grease fittings grouped on the motor access side of the unit.

2. Self-aligning.
3. Select for an average life of 200,000 hours.

H. Insulation, vapor barriers, facings and adhesives shall have:
1. Flame spread not higher than 25.
2. Smoke developed rating not higher than 50.

I. Double wall casing construction. Construct interior casing panels with 3 lb. minimum density insulation for acoustical and condensation control.
1. Condensation on the exterior of the air handling units is not acceptable.

J. Filter section:
1. Constructed with substantial hinges.
2. Neoprene gasketing.
3. Permanent quick release latching devices.
4. Arranged to accommodate the 2" thick filters as specified.
5. Low velocity angled filter section unless otherwise specified.

K. Cooling coils as specified. Extend drain and vent piping through cabinets. Provide grommets at all pipe penetrations through cabinets.

L. Heating coils as specified. Extend drain and vent piping through cabinets. Provide grommets at all pipe penetrations through cabinets.
1. Location as indicated.

M. Factory dynamic fan balancing shall be conducted from 16Hz to 60Hz to identify and eliminate critical speeds to ensure stable operation through the entire operating range of the fan and drive assembly. Field fan balancing is not acceptable. Forward factory balancing test report to Engineer upon request.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air handling units according to manufacturer's instructions.

B. Provide additional drive packages as required by the Testing and Balancing firm.

C. Air leaks detectable by sound or touch are to be corrected.

D. Air handling units are to be properly supported to prevent flexing, bending, or distorting base rails.

E. All coils are to be cleaned prior to substantial completion if units are used during construction.

F. 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.

G. Install piping to unit with full size 6-inch-long dirt leg with 1/2" valve at bottom for cleaning.

H. Provide for positive gravity drainage of coil condensate. Pipe full size of unit connection.

I. Adjust fan drives as required to obtain scheduled capacities as directed by the Test and Balance Firm to include sheave and belt replacement.

J. Align belts to eliminate wear and vibration of belts.

K. Verify correct drainage of condensate from condensate pan.

L. Verify correct rotation of fan and wiring of motor.

M. Lubricate all greaseable ball bearings with manufacturer's suggested lubricant.

N. Replace filters as required if units are used during construction.

O. 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.

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. Serial Number.
3. Model Number.
4. Capacity (CFM) and static pressure.
5. Motor HP.
6. Unit power supply: Volts / PH / Amps.
7. Supply Fan Type.
8. Coil GPM and pressure drop.
9. Sales Order #.
10. Date unit manufactured.

END OF SECTION

SECTION 23 81 18

SINGLE PACKAGE ROOFTOP AIR CONDITIONERS (100% OUTSIDE AIR)

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide and install a single-package, single-zone, electric air conditioner with gas-fired heat for 100% outside air a ground mounted application.

1.2 RELATED WORK

A. Division 15 Mechanical:
1. Ductwork
2. Air Balance
3. Electrical provisions for mechanical work
4. Air Filtration
5. Vibration Isolation

1.3 PERFORMANCE

A. Provide performance as scheduled on drawings.

1.4 QUALITY ASSURANCE

A. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.

B. Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.

C. System Seasonal Energy Efficiency Ratio/Energy Efficiency Ratio (SEER/EER) shall be equal to or greater than prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.

D. Unit shall be safety certified by ETL and be ETL US listed.

1.5 SUBMITTALS

A. Manufacturer’s certified capacity data

B. Submit manufacturer’s installation, start-up and service instructions.

C. Submit recommended clearance dimensions for air flow and service.

D. Submit coordination drawings as specified. Consideration shall be given to adjacent structures and their effect on air flow patterns.

E. Submit internal wiring diagram of Control Center

F. Submit sequence of operation in narrative form.

G. Mark-up a copy of the specifications indicating in the margin of each paragraph the following: COMPLY, DO NOT COMPLY, NOT APPLICABLE.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Unit shall be shipped with doors bolted shut to prevent damage during transport and thereafter while in storage awaiting installation.

B. Follow Installation, Operation and Maintenance manual instructions for rigging, moving, and unloading the unit at its final location.

C. Unit shall be stored in a clean, dry place protected from construction traffic in accordance with the Installation, Operation and Maintenance manual.

1.7 WARRANTY

A. Manufacturer shall provide a parts and labor warranty for a period of 5 years from the date of substantial completion.

B. Stainless steel heat exchanger shall be provided with a minimum of a 10 year non-prorated parts warranty.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Carrier

B. Daikin

C. Trane

2.2 COMPRESSOR

A. Compressors shall be a fully modulating digital scroll or variable speed scroll type with thermal overload protection, independently circuited and shall be capable of modulation from 10-100% of its capacity and allow for airflow turn down to 30% of full flow.

B. Each compressor shall include a crankcase heater.

C. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged access doors shall provide access to the compressors.

D. Compressors shall be isolated from the base pan with the compressor manufacturer’s recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.

E. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides, and service valves for liquid and suction connections. Liquid line filter driers shall be factory provided. Finished field installed refrigerant circuits shall include the low side cooling components, refrigerant, thermal expansion valve, liquid line, insulated hot gas bypass line, insulated hot gas and suction lines.

F. Unit shall include a factory holding charge of R-410a refrigerant.

G Each compressor shall be equipped with a 5 minute off, delay timer to prevent compressor short cycling.

H. The unit shall be capable of stable cooling operation to a minimum of 35°F outdoor temperature.

I. Lead refrigeration circuit shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a dehumidification control signal terminal.

J. Provide each compressor with a Removable Sound Cover that is constructed of a Silicone-fiberglass cloth outer jacket, a loaded vinyl barrier septum, fiberglass needle mat (11 lbs./ft.3 density), and a Silicone-fiberglass cloth inner jacket. The covers shall be connected together by means of a cloth straps with “D” rings and Velcro fasteners. The inner and outer jackets shall protect against UV rays, oil and water. Finished Surface Mass – 3 lbs. per sq. ft., to cover compressors and extended components for the specified equipment. Manufactured by BRD Noise and Vibration Control or engineer approved equal.

2.3 EVAPORATOR, CONDENSER AND REHEAT COILS

A. Provide the evaporator and hot gas reheat coil constructed of copper tubes with mechanically bonded aluminum fins and stainless-steel end casings.

B. Provide the condenser coil constructed of an aluminum microchannel design and shall have a series of flat tubes containing multiple, parallel flow microchannel layered between the refrigerant manifolds.

C. Provide an evaporator coil with interlaced circuitry. Provide a minimum of 12” clearance downstream of the evaporator and hot gas reheat coils.

D. Provide factory installed louvered hail / vandalism guards for condenser coils.

E. Provide coils with stainless steel casings, end plates, tube supports and top and bottom plates.

F. Provide the condenser, evaporator and reheat coils coated with corrosion resistant epoxy utilizing a dip and bake. Coating shall be flexible and uniformly bonded to all condenser coil surfaces and shall meet a minimum of 6,000 hours corrosion resistance per ASTM B117.

G. Provide a hinged access doors with quick release handle adjacent to each coil for inspection and maintenance.

2.4 EVAPORATOR FANS

A. Unit shall be equipped with a direct drive, backward curved airfoil blade, centrifugal evaporator fan.

B. Blowers and motors shall be dynamically balanced and mounted on rubber isolators.

C. Motor shall contain premium efficiency TEFCP with self-aligning ball bearings rated for 200,000 hours service with external lubrication ports grouped near the motor access side of the unit. Provide motor HP as indicated on the drawings.

2.5 GAS HEATING SECTION

A. Unit shall be equipped with stainless steel burners and heat exchangers.

B. Gas furnace shall be equipped with modulating gas valves, adjustable speed combustion blowers, stainless steel tubular heat exchangers, and electronic controller. Combustion

blowers and gas valves shall be capable of modulation. Electronic controller includes a factory wired, field installed supply air temperature sensor. Sensor shall be field installed in the supply air ductwork. Supply air temperature set point shall be adjustable on the electronic controller within the controls compartment.

C. Gas Controls.
1. Automatic gas valve and pressure regulator.
2. A manual shutoff valve.
3. Pilot valve.
4. Two flame rollout limit switches.
5. An adjustable fan control.
6. Fixed high limit controls

D. Unit shall be equipped with an electric spark pilot ignition system.
1. Electronic flame detection.
2. 100% safety shutoff.

E. Combustion air shall be induced by a positive pressure power venting fan.
1. Pre-purge of combustion chamber.

2.6 CASING, FILTERS AND DUCT CONNECTION

A. Provide a cabinet constructed of galvanized or zinc-coated steel, primed and coated with baked enamel and suitable for outdoor installation. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B117-95 test procedure.

B. Unit shall be equipped with duct connections on the bottom of each unit to coordinate with a ground mounted discharge curb as indicated on drawings.

C. Provide two-position, motorized spring return outdoor air damper constructed of extruded aluminum air foil blades with rubber edge and end seals. Damper assembly shall be Class 2 AMCA Certified.

D. Unit shall be equipped with an outside air hood with a minimum of 1” thick aluminum mesh pre-filters.

E. Unit shall be equipped with a filter frame to match the filter requirements specified in Section 23 41 00.

F. Provide with stainless steel condensate drain pan with positive slope in all directions to outlet.
1. Externally line the condensate drain pan with 1-1/2" waterproof insulation.
2. Provide a hinged access door with quick release handle adjacent to condensate drain pan for inspection. Install access door on drain connection side of unit.
3. Drain pan shall be insulated with a minimum 2’ thick foam insulation.

G. Double wall casing construction
1. Construct roof, wall, and floor with minimum 2-inch-thick, 2 lb. density, R-13 injected polyurethane foam insulated, double wall panels with thermal break for superior energy efficiency and casing longevity.
2. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 340/360. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, at a maximum 8 inches of positive or negative static pressure, to reduce air leakage. Deflection shall be measured at the midpoint of the panel height and width. Continuous sealing shall be included between panels and between access doors

and openings to reduce air leakage. Piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.

3. Roof of the air tunnel shall be sloped to provide complete drainage. Cabinet shall have rain break overhangs above access doors.
4. Access to filters, dampers, cooling coils, reheat coil, heaters, compressors, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors. Units without full hinged access doors in the cooling coil section are not acceptable.

2.7 CONTROLS

A. Provide safety and operating controls factory wired and mounted in an integral controls and electrical enclosure. Include thermostatic expansion valve, high and low-pressure switches and compressor motor overload devices. Furnish a time delay device to prevent short cycling. Employ a control transformer, a pressure relief device and suction and discharge valves with service connections. Include a high condensate level switch that shuts down the unit when a high-water level is detected in the drain pan.

B. Unit shall be provided with a fully functional DDC control system with BACnet MS/TP integration. BCMS system shall have the ability to remotely start/stop the unit, adjust supply air temperature heating and cooling setpoints, and adjust targeted supply air dew point setpoint during dehumidification mode.

1. Unit controller shall be capable of controlling all features and options of the unit. Controller shall be factory installed in the unit controls compartment and factory tested. Controller shall be capable of standalone operation with unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling available without dependence on a building management system.
2. Controller shall have an onboard clock and calendar functions that allow for occupancy scheduling.
3. Controller shall include non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.
4. Unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling shall be accomplished with connection to interface module with LCD screen and input keypad, interface module with touch screen, or with connection to PC with free configuration software. Controller shall be capable of connection with other factory installed and factory provided unit controllers with individual unit configuration, setpoint adjustment, sensor status viewing, and occupancy scheduling available from a single unit. Connection between unit controllers shall be with a modular cable. Controller shall be capable of communicating and integrating with a BACnet network.

2.8 ROOF CURB

A. Install a insulated (R-8 Minimum) welded ground mounted curb with supply air discharge as specified on Drawings.

1. Curb shall to be fully gasketed between the curb top and unit bottom with the curb providing full perimeter support, cross structure support and air seal for the unit. Curb gasket shall be furnished within the control compartment of the rooftop unit to be mounted on the curb immediately before mounting of the rooftop unit.
2. Level curb according to manufacturer's recommendations.
3. Curb height shall be a minimum of 14".

2.9 OUTDOOR FANS

A. Unit shall be equipped with a direct drive propeller type fan with permanently lubricated TEFC motor. Fan shall discharge upward.

B. Condenser fans shall be VFD driven variable speed for active condenser head pressure control.

2.10 CONVENIENCE OUTLET

A. Unit shall be equipped with a factory installed and field wired 120V, 20 AMP GFI outlet in unit cabinet.

2.11 SERVICE DISCONNECT SWITCH

A. Unit shall be equipped with a factory installed field wired, circuit breaker with external locking handle.

2.12 TEMPERATURE AND FAN CONTROL

A. Unit shall be controlled by maintaining a constant supply air temperature as scheduled on the drawings. When the outside air temperature drops below the scheduled leaving air temperature, the unit shall enter heating mode and the natural gas heater shall modulate to maintain the heating mode supply air temperature setpoint. When the outside air temperature is above the scheduled supply air temperature, the unit shall enter dehumidification priority mode, the compressor capacity shall be modulating to maintain the active evaporator coil temperature setpoint and the modulating hot gas reheat valve shall be controlled to maintain the cooling mode supply air temperature setpoint. The evaporator coil temperature must be controlled by the use of suction pressure transducers installed on each refrigeration circuit. The use of an evaporator coil temperature sensor is not allowed. The unit shall be able to independently control the supply air dry bulb and wet bulb temperatures under all OA loads during cooling mode. Open outside air damper prior to starting fan and close damper during unoccupied mode.

B. Unit shall be provided in a variable air volume configuration. Provide unit with a duct mounted pressure sensor to control the fan speed and a duct mounted discharge air temperature sensor to control unit discharge air temperature.

2.13 PHASE MONITORING PROTECTION

A. Provide unit with phase monitoring protection to protect motors and compressors against issue associated with phase loss, phase imbalance and phase reversal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install according to manufacturer's recommendations and as shown on drawings.

B. 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.

C. Seal all duct connections to roof curb for air tight connection. Install a 90 degree flanged ductwork connection to the roof curb. Provide and install gasketing around duct flanges. Provide and install gasketing around outer edge of roof curb.

3.2 START UP

A. Provide the services of a factory trained service technician employed full time by the unit manufacturer to start-up the system, or manufacturer's factory authorized representative under the supervision of the factory trained service technician. Upon completion of the installation, the system shall be started and commissioned by the manufacturer's factory

authorized representative who will verify a complete fully functional system. The factory authorized representative will verify that accessories are installed and performing the specified functions. (Contractor startup is unacceptable.)

B. The written startup report shall be provided to the owner and engineer upon completion.

C. Manufacturer shall provide 8 hours of technician time for coordination and BMCS startup and programming.

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 23 82 18

DUCTLESS MINI SPLIT DX UNITS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install mini split system. Complete with a slim silhouette, compact, high wall mounted indoor fan coil section with wireless remote controller and a slim silhouette horizontal discharge outdoor condensing unit. Unit shall be provided with constant speed compressor, pre-charged with R410A refrigerant. air-cooled condensing units complete with casing, compressor, condenser coil, condenser fan and controls required for a split air conditioning system.

1.2 RELATED WORK

A. Refrigerant Piping.

B. Electrical Provisions of Mechanical Work.

1.3 PERFORMANCE

A. Provide performance as scheduled on drawings, and head pressure control to enable unit to operate in temperatures as low as 20 degrees F. ambient.

1.4 QUALITY ASSURANCE

A. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL) and bear the ETL label.

B. All wiring shall be in accordance with the National Electrical Code (N.E.C.).

C. The units shall be rated in accordance with Air-conditioning, Heating, and Refrigeration Institute’s (AHRI) Standard 210 and bear the AHRI Certification label.

D. The units shall be manufactured in a facility registered to ISO 9001 Quality assurance Standards and ISO 14001 which are set of standards applying to sustainability and environmental protection set by the International Standard Organization (ISO).

E. A pressure charge of R410A refrigerant sufficient for up to twenty-five (25) feet of refrigerant tubing shall be provided in the outdoor condensing unit.

F. A dry air holding charge shall be provided in the indoor section.

G. System efficiency shall meet or exceed 13.0 SEER.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Carrier

B. Daikin

C. Trane

2.2 INDOOR UNIT GENERAL

A. The indoor shall be factory assembled, wired and run tested. Contained within the unit cabinet shall be all factory wiring, internal piping, electronic control circuit board and fan with fan motor.

B. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and auto restart after power interruption function, an emergency operation function and a test run switch.

C. Indoor unit and refrigerant pipes shall be charged with dry air before shipment from the factory. All refrigerant piping must be insulated.

2.3 UNIT CABINET

A. The casing shall have a smooth front, top return, in a Munsell No. 1.0Y 9.2/0.2 white finish.

B. Multi directional drain and refrigerant piping offering four (4) directions for refrigerant piping and two (2) directions for draining shall be standard.

C. There shall be a separate installation plate which secures the unit firmly to the wall. Secure mounting of plate and all mounting hardware shall be furnished by and be the responsibility of the installer.

2.4 FAN

A. The indoor unit fan shall be an assembly with a line-flow fan direct driven by a single motor mounted in rubber motor mount.

B. The fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings.

C. Manual adjustable vertical guide vanes shall be provided with the ability to change the airflow from side to side (left to right).

D. An integral, motorized, horizontal air sweep flow louver shall provide an automatic change in airflow by directing the air up and down to provide for uniform air distribution.

E. The indoor unit fan motor shall operate in four (4) selectable speeds, Powerful, High, Medium, and Low.

2.5 FILTER

A. Return air shall be filtered by means of easily removed, washable, Catechin air filter and an anti-allergy enzyme filter – blue bellows type.

2.6 COIL

A. The indoor unit (evaporator) coil shall be of nonferrous construction with smooth, pre-coated aluminum fins on copper tubing.

B. Tubing shall have inner groves for high efficiency heat exchange.

C. All tube joints shall be brazed with PhosCopper or silver alloy.

D. The coil shall be pressure tested at the factory.

E. A sloped condensate pan and drain with extension hose shall be provided under the coil. Drain connections shall be provided at each end of the drain pan. (Option: A condensate mini-pump shall be provided to provide a means of condensate disposal when a gravity drain is not available.)

2.7 ELECTRICAL

A. The unit shall be equipped with a micro-processor control system directing indoor and outdoor unit coordinated operation.

B. The indoor unit shall not have any supplemental electrical heat elements.

2.8 CONTROL

A. This system shall have a wireless remote controller to perform input functions necessary to operate the system. The controller shall consist of a Power On / Off switch, Mode Selector, Temperature Setting, Timer Control, Fan Speed Select and Auto Vane Selector.

B. Temperature changes shall be by 1°F increments with a range of 65°F to 87°F.

C. There shall be a 24 hour On / Off timer.

D. The unit shall have an emergency operation mode to allow operation without the remote controller.

E. The microprocessor located in the indoor unit shall have the capability of sensing return air temperature and indoor coil temperature, receiving and processing commands from the wireless remote controller, providing emergency operation and controlling the outdoor unit.

F. The control voltage between the indoor unit and the outdoor unit shall be 115 volts, AC.

G. The system shall be capable of automatic restart when power is restored after power interruption.

H. The control system shall control the operation of the air sweep louvers, as well as provide on / off and system / mode function switching.

2.9 OUTDOOR UNIT GENERAL

A. The outdoor unit is designed specifically for use with MS series indoor units. These units are equipped with a circuit board that interfaces to the MS indoor unit circuit board. The outdoor unit shall be completely factory assembled, internally piped and wired. Each unit shall be run tested at the factory.

B. When refrigerant lines are exposed on exterior of building provide “LINE-HIDE” line set cover system.
   1. Material, Weather resistant, UV stabilized, ASA/PVC/ABS/Poly/PE
   2. Assembly Screws, stainless steel.

2.10 UNIT CABINET

A. The casing shall be fabricated from zinc coated steel, bonderized with an electrostatically

applied, thermally bonded, acrylic or polyester powder coating for corrosion protection.

B. Case and mounting feet shall be as follows:
1. The MS-A09WA base shall be of Aluminum-Zinc-Magnesium alloy coated steel, with welded mounting feet.
2. The base for the MS-A12WA shall have a galvanized steel base with welded mounting feet.

C. Cabinet mounting and construction shall be sufficient to withstand 155 MPH wind speed conditions for use in Hurricane condition areas. Mounting, base support, and other installation to meet Hurricane Code Conditions shall be by others.

2.11 FAN

A. The unit shall be furnished with a directive drive propeller type fan, statically and dynamically balanced for smooth and quiet operation.

B. The fan motor shall have inherent protection, be equipped with permanently lubricated bearings. The fan motor shall be mounted and isolated for quiet operation.

C. The fan shall be provided with a raised guard to prevent contact with moving parts.

D. The outdoor unit shall have horizontal discharge airflow.

2.12 COMPRESSOR

A. The compressor shall be a high performance, hermetic, rolling piston, rotary type.

B. Compressor shall be mounted using rubber isolating bushings to avoid the transmission of vibration.

C. Compressor shall be protected by an automatic over current relay and a thermal overload switch.

2.13 OPERATION

A. The outdoor unit shall have an accumulator.

B. The outdoor unit must have the ability to operate with a maximum height difference of 35 feet between indoor and outdoor units.

C. The unit shall have a maximum refrigerant tubing length of 65 feet between indoor and outdoor units without the need for line size changes, traps or additional oil. All refrigerant lines must be insulated.

D. The unit shall be pre-charged for a maximum of 25 feet of refrigerant tubing.

2.14 ELECTRICAL

A. The electrical power of the system shall be 115 volts, 1 phase, 60 hertz. The unit shall be capable of satisfactory operation within voltage limits of 103 volts to 127 volts.

B. The outdoor unit shall be controlled by the microprocessor located in the indoor unit. The control voltage between the indoor unit and the outdoor unit shall be 115 volts, AC.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount condensing units on 4" foundation pads and pipe as shown on Drawings or as recommended by the equipment manufacturer. Install refrigerant filter dryer and sight indicating glass.

B. Install units on vibration isolation pads.

3.2 CONTROL WIRING

A. Furnish and install control wiring as required. Install control wiring in conduit.

3.3 DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled according to the manufacturer’s recommendations.

B. The wireless controller shall be shipped inside the carton with the indoor unit and able to withstand 105°F storage temperatures and 95% relative humidity without adverse effect.

3.4 WARRANTY

A. The units shall have a manufacturer’s parts and defects warranty for a period five (5) years from the date of the original installation. The compressor shall have a warranty of seven (7) years from date of installation. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer. This warranty does not include labor.

3.5 START-UP

A. Follow the manufacturer's start-up procedures.

B. Provide flexible elastomeric rubber closed cell insulation to prevent condensation from occurring op suction piping. After completion of successful start-up, installing contractor shall seal all openings in insulation and apply a protective aluminum sheetmetal jacket over insulation exposed on exterior of building.

END OF SECTION

SECTION 23 82 39

ELECTRIC UNIT HEATERS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide and install electric unit heaters complete with heating element, propeller mounting brackets and other options as specified.

1.2 RELATED WORK

A. Division 23 - Mechanical.
   1. Electrical Provisions of Mechanical Work.
   2. Ductwork.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Modine

B. Reznor

C. Chromalox

D. Trane

E. Markel

2.2 COMPONENTS

A. Casing:
   1. Construct casing of sheetmetal with a structural frame.
   2. Enamel or lacquer finish to manufacturers standard.

B. Electric Heating Elements:
   1. Shall bear the UL label.
   2. Corrosion resistant materials.
   3. Heating coil of 80-20 nickel-chrome wire.

C. Components:
   1. Fused control circuits
   2. Contactors in accordance with the staging requirements
   3. Control power transformer
   4. Control voltage 120

D. Louvers:
   1. Adjustable vertical and horizontal louvers for air discharge.

E. Mounting brackets:
   1. As indicated

2.3 CONTROLS

A. Automatic controls:
   1. Factory mounted
   2. Prewired to the junction box
   3. Unit mounted thermostats 24-volt low voltage

B. Safety Controls:
   1. A primary and secondary thermal cut-off to de-energize each circuit.
   2. Manual reset high limit
   3. Automatic reset thermal protection

2.4 FAN

A. Propeller blade fan:
   1. Construct the fan of aluminum or other corrosion-resistant material.
   2. Statically and dynamically balanced
   3. Substantial fan guard

2.5 MOTOR

A. Totally enclosed ball bearing motor:
   1. Permanently lubricated bearings
   2. 120 volt, single phase, 60 cycle motor
   3. Sized to operate the fan at the required capacity

2.6 ELECTRICAL

A. Single point connection:
   1. Factory wiring
   2. Only direct line supply and thermostat field connections
   3. Terminal blocks for line voltage wiring
   4. Wiring diagram permanently attached
   5. Balance phases

PART 3 - EXECUTION

3.1 INSTALLATION

A. Furnish units with suitable connections for mounting as shown or as otherwise approved.

B. Provide start-up to ensure correct operation of unit.

C. Adjust discharge louvers to control direction of air flow.

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	Wall Mounted Lighting ATS Example
ATS-1	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. Service equipment available fault current labeling: Provide a 2x3 inch label with blue lettering on contrasting background permanently affixed to the service disconnect/equipment prior to energizing the service equipment. The label shall include the date of installation and the date of calculation. The date of calculation shall be the date indicated by the Engineer of Record’s Seal on the Construction Document Electrical One-Line Diagram / Riser Drawing. Example:

SERVICE EQUIPMENT 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 8 hours dedicated instructor time
   2. 2 hours on each of 4 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 09

ELECTRIC UTILITY COORDINATION AND SERVICE ENTRANCE

PART 1 - GENERAL

1.1 WORK INCLUDED

A. General: Electrical service shall be provided by local utility company.

B. Power Company Data: Obtain from utility company information and installation standards for electrical service installation.

C. Responsibilities: Determine what equipment and labor is provided by utility company and what equipment and labor is required of this Contractor.

PART 2 - PRODUCTS

2.1 GENERAL

A. Service Data: Ensure that utility company service data is accurate and verified.

2.2 PRIMARY SERVICE

A. General: Division 26 shall provide utility service and metering equipment enclosures, manholes, and pull boxes as required and as specified.

B. Utility company shall provide primary cables, splices, utility metering instruments, terminations, and primary underground and overhead service conductors.

2.3 TRANSFORMERS AND SWITCHGEAR

A. General: Division 26 shall make provisions for service as required by utility company, including, but not limited to permanent or removable/lockable vehicular barriers, grounding rods, grounding conductors, and sleeves.

B. The utility company shall provide service transformers, primary switchgear, primary protective relaying, and connections to the customer service.

2.4 SECONDARY SERVICE CONDUCTORS

A. General: Division 26 shall provide secondary service entrance conductors, conduit and concrete duct bank.

2.5 SECONDARY SERVICE WEATHERHEAD AND UTILITY METERING CURRENT TRANSFORER ENCLOSURES

A. General: Division 26 shall provide secondary service weatherhead and utility metering current transformer enclosures as specified and as approved by the utility company. Where required or specified, enclosure shall be constructed of aluminum or stainless steel NEMA 3RX construction.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Standards: The installation of the service entrance provisions shall comply with the published standards and requirements of the utility company, the utility company's specific construction requirements for this project, and with requirements of this Division.

B. Correction: Any failure to meet the standards and requirements shall be corrected to the satisfaction of the utility company and Owner without any additional cost to the Owner.

C. Contractor shall provide all construction materials and labor that the utility company determines to be the responsibility of the customer, at no additional cost to the Owner.

D. The materials and labor required by the for a complete installation shall be provided by the contractor and includes, but is not limited to permanent or removable / lockable vehicular barriers, grounding rods, grounding conductors, sleeves, concrete pads, concrete reinforced ductbanks, conduits, metering racks and metering enclosures.

E. Utility distribution poles and service entrance ductbank locations shall be staked and surveyed prior to pole installation by the Contractor to verify their proper placement is within the Owner's property and respective utility easements. Contractor shall verify by survey that the pole and service entrance ductbank location and easements do not interfere with existing easements, right-of-ways, or other restricted properties. Conflicts with existing easements and restrictions shall be brought to the attention of the Architect prior to construction.

F. Contractor shall initiate contact with the power provider (retail seller), utility (transmission and distribution), and Owner within 14 days of Notice to Proceed to ensure permanent power will be available to the site. Any delays resulting from lack of this coordination shall be the responsibility of the Contractor.

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.

C. Mock up a typical panelboard backbox with Surge Protective Device (SPD) panelboard extension backbox or SPD device.

D. Mock up ten feet of cable tray including all supports, hardware and bonding.

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

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 26

ELECTRICAL GROUNDING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Grounding shall conform to the requirements of:
   1. National Electrical Code.
   2. Governing local codes.
   3. All Local Utility Companies

B. Ground effectively and permanently.
   1. Neutral conductor at the main service disconnect and other separately derived systems.
   2. All conduit systems.
   3. All electrical equipment and related current carrying supports or structures.
   4. All metal piping systems.
   5. All building structural metal frames.
   6. All telephone/voice/video/CATV/data utilities

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.

2. UL listed.
3. Approved thermal fusion connector methods (exothermic).

B. Metal frame of building or enclosure.

C. Foundation concrete encased rebar.

2.3 DATA / VOICE COMMUNICATIONS CLOSET GROUND BAR

A. MDF closets/head end rooms: Erico Cadweld #B544A028 ground bar with 7/16-inch holes.

B. IDF closets, Erico Cadweld #B542A004 ground bar with 7/16-inch holes.

C. Heavy-duty, two bolt type, copper alloy or bronze for grounding and bonding applications, in configurations required for particular installation.

2.4 EXOTHERMIC CONNECTIONS

A. Exothermic type for underground and structural steel; Cadweld

B. Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.

2.5 WIRE

A. Stranded, copper cable

B. Foundation Electrodes: 4/0 AWG

C. Grounding Electrode Conductor: Size to meet NFPA 70 requirements

PART 3 - EXECUTION

3.1 GROUNDING AND BONDING

A. In the service equipment, provide a separate (dedicated) ground bus.
1. Bond the ground bus with copper bus bar or cable, of equal or greater current carrying capacity of the service grounding conductor, to the neutral bar.
2. Resistance of neutral to ground shall not exceed 10 Ohms.
3. Connect the electric service grounding electrode conductors to the incoming metal water pipe system (when available, using a suitable ground clamp) and to a supplemental electrode such as a ground rod or ground .ring.
4. Provide grounding and bonding at the power company’s metering equipment.
5. Provide access and cover for access to the ground grid and removable connections for testing the system.

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 required. 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 25 Ohms 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.

C. Provide an insulated equipment grounding conductor inside all conduits, raceways, surface raceways, gutters and wireways. The ground wire shall be bonded to each box to suitable lug, bus, or bushing. All bonding jumpers shall be routed inside conduit or raceway.

D. Provide an insulated isolated equipment grounding conductor in addition to the insulated equipment grounding conductor for all isolated grounding feeders, branch circuits, outlets and isolated grounding receptacles.

E. Provide all conduit terminating in switchgear, transformers, switchboards, panelboards and voice/data outlets with grounding bushings, where required, and ground wire extended to ground bus in equipment. Install grounding bushings where reducing washers are used and concentric and eccentric knock-outs are used.

F. Main bus and building grounding electrode conductor installation shall be witnessed by the Architect / Engineer.

G. Provide bonding to meet Regulatory Requirements.

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.

O. Do not use sheetmetal or self-drilling screws for bonding connections. Provide listed or approved connectors.

P. 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.

3.2 METAL FRAME OF BUILDING OR STRUCTURE

A. Effectively ground the building steel or structure per NEC 250-52 (2).

3.3 UFER GROUND

A. Provide a UFER ground at bottom of building slab per NEC 250.52 (3), bond to building steel.

3.4 MISCELLANEOUS REQUIREMENTS

A. Continuity of the equipment grounding system shall be maintained throughout the project. Equipment grounding jumpers shall be installed across conduit expansion fittings, liquid-tight flexible metal and flexible metal conduit, and other non-electrically continuous raceway fittings.

B. Equipment grounding conductors and grounding electrode conductor shall be stranded copper conductors and run in a suitable 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. Exterior Electrical Equipment Racks:
   1. Provide driven ground electrode.

E. 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. Grounding shall conform to ANSI/TIA/EIA 607(A) – Commercial Building Grounding and Bonding Requirements for Telecommunications, National Electrical Code®, ANSI/NECA/BICSI-568 and manufacturer's grounding requirements as minimum. Bonding shall be of low impedance to assure electrical continuity between bonded elements.
   1. MDF Closets Telecommunications Main Ground Bar (TMGB): Provide Erico #EGBA14424MM ground bar, 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 nearest electrical switchboard or panelboard.
   2. IDF Closets Telecommunications Ground Bar (TGB): Provide Erico #EGBA14410FF ground bar mounted to the telecommunications plywood backboard. Provide one #6 AWG insulated ground conductor from ground bar to building steel and to ground bus of nearest electrical panelboard or switchboard.
   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, cabinets, frames, together and with #6 AWG insulated ground conductor to the local TMGB / TGB. Bond and ground equipment racks, housings, messenger cables, raceways, and rack-mounted conduit.
   6. Route TMGB – TGB ground conductor using the shortest, straightest, route practical with long radius curves.
   7. All conduits terminating to cable trays, wireways, and racks shall be mechanically fastened. When connected to a cable tray or rack, it must be connected with ground bushings, wire bonded to the tray or rack, and grounded to the main building grounding system or IDF room grounding bar using #6 AWG copper.

F. Ground lighting fixture bodies to the conduit grounding system.

G. Bond receptacle ground to the box and conduit ground system, except where and insulated/isolated grounding receptacle or outlet is specified.

H. Ground connections to building steel, grounding electrodes and all underground connections shall be by thermal fusion (exothermic).

I. Provide OZ Type “BJ” bonding jumper at all expansion joints, points of electrical discontinuity or connections in conduit where firm mechanical bond is not possible, such as flexible connections, insulating couplings, etc.

J. Ground each lighting and power panelboard by connecting the grounding conductors to the grounding stud.

K. Ground each secondary dry-type transformer to the ground bus of the primary side panelboard. Provide a bonding jumper between the ground stud and the neutral. Ground transformer ground stud to ground ring if a ground ring is installed or the nearest structural steel member.

L. Bond every item of equipment served by the electrical system to the building equipment ground system. This includes, but is not limited to, switchboards, panelboards, disconnect switches, receptacles, cable trays, controls, fans, air handing units, pumps and flexible duct connections.

M. Ground each light pole, power distribution poles, and metal conduit stub-ups at each light pole base.

N. Ground all metal conduit including metal conduit used for bends and penetrations through concrete.

O. Bond hot water and cold water piping together at each domestic water heater.

3.6 MANHOLE AND/OR PULL BOX GROUNDING

A. Provide a driven ground rod and ground bond ring in each power and telephone manhole or pull box. Bond cable racks and medium voltage cable shields at splices and terminations, ductbank conduit ground bushings and all other metal components in manholes or pull box to the ground ring.

3.7 COORDINATION

A. General: Coordinate installation of grounding connections for equipment with equipment installation work.

3.8 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. True 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 should 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.

E. Notify Owner’s Commissioning Authority (CxA) prior to performing any tests to the CxA may witness tests at his/her discretion. Refer to Section 26 01 00 Commissioning of Electrical Systems.

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 or Plasti-Bond, – 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 or Plasti-Bond, – 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.

D. Conduits for Building Entrance Facilities:
1. Underground Outside Plant: Install a pull box every 300-feet or after 180 degree turns.
2. Inside Plant: Install a pull box every 150-feet or after 180 degree turns. All turns shall be large sweeps, not sharp 90s, with the radius of the sweep at least 10X the diameter of the conduit. Hence, a 4-inch conduit requires a 40-inch minimum radial sweep. If field conditions absolutely mandate a sharp 90-degree bend to be installed, then a pull box shall be installed at that location regardless of distance.
3. Building entrance facilities shall not terminate in an IDF or any other space except the MDF.
4. Coordinate the termination location of the building entrance facilities in the MDF with the room layout and equipment configuration.
5. Provide 4-inch conduit unless indicated otherwise. Provide (3) fabric innerducts in each 4-inch conduit.

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 ALUMINUM ALLOY CONDUCTORS

A. Where aluminum alloy conductors are specified, approved and substituted for copper conductors, provide the required conduit size based on conduit fill using NEC or recognized cable manufacturer’s conduit fill tables for aluminum alloy compact conductors.

3.8 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 38

ELECTRICAL FLOOR BOXES AND FITTINGS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide electrical floor box and fitting work as required, scheduled, indicated, and specified.

1.2 QUALITY ASSURANCE

A. UL Label: Electrical boxes and fittings shall be UL labeled.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS – Provide products manufactured in the USA

A. Thomas & Betts, Memphis, TN

B. Hubbell

C. Wiremold

2.2 CONCEALED SERVICE - FLOOR BOXES

A. Series 665/667 as manufactured by Thomas & Betts

B. Shall be electro-galvanized, 14-gauge sheet steel except at ground floors or waterproof membrane floors where they shall be cast iron.

C. Construction shall be as required by UL 514A.

D. Carpet frame shall be nylon UL Recognized Component QMFZ2.

E. Hinged outer cover shall be reinforced with a 5/32" steel plate.

F. Shall deliver electric power from duplex receptacles installed below the surface of the floor.

G. Shall deliver telephone or data cable without interference from the electric power delivery

H. Shall protect delivery of both services by a hinged cover with a retractable opening and foam plastic dust seal

I. Hinged cover shall accept carpet or tile to match floor covering and be 180 degrees reversible.

J. Shall accept conduit sizes up to 1-1/4 inches

K. Box shall be listed by UL

L. When hinged cover is closed and no services in place, device shall have no obstructions above surface of floor.

PART 3 - EXECUTION

3.1 GENERAL

A. Locate position for floor boxes and runs of conduit as shown on the plans, or as required. Coordinate with the Architect for dimensional locations of floor boxes prior to cutting or pouring slab.

B. Select appropriate size of floor boxes, poke-through, or multiple services floor boxes for quantity of wiring devices indicated and as recommended by manufacturer.

3.2 INSTALLATION

A. Position floor boxes and conduit runs

B. After concrete pour, pull wires and install devices according to manufacturer’s recommendations.

C. Activate in accordance with the National Electrical Code.

D. Coordinate with floor covering contractor to complete installation.

E. Core drill openings for poke-through service fitting and install in accordance with manufacturer’s instructions.
   1. Minimum spacing of 2' on center and not more than one unit per each 65 square feet of floor area in each span; required by Fire Resistance Directory.

END OF SECTION

SECTION 26 05 40

ELECTRICAL GUTTERS AND WIREWAYS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide electrical gutter work as shown, as specified and as required.

B. Application: The types of electrical gutters required for the project include the following:
1. Electrical wiring gutters
2. Voice / Data / Video / Communication and signal distribution wireway

1.2 QUALITY ASSURANCE

A. UL Label: Gutters and wireways shall be UL labeled.

PART 2 - PRODUCTS

2.1 ELECTRICAL GUTTERS AND WIREWAYS

A. General: Provide hinged electrical gutters and wireways in the types and sizes indicated or required, minimum 16 gauge thickness, with rounded edges and smooth surfaces; constructed in compliance with applicable standards; with features required.

B. Size: Provide size indicated. Where size is not indicated, construct in accordance with the NEC and other standards. Gutters shall be of manufacturer’s standard lengths, without field cutting or field extensions.

C. Accessories: Provide gutter and wireway accessories where indicated, constructed of same metal and finish as gutters or wireways.

D. Supports: Provide gutter and wireway supports indicated, conforming to NEC, and as recommended by the manufacturer, and as specified in Section 26 05 33 Conduit Systems.

E. Materials and Finishes: NEMA 1 gutters and wireways shall have gray powder coat finish over galvanized steel. Gutters and wireways installed outside shall be NEMA 3RX minimum. Gutters or wireways installed within 100-feet of cooling towers, at kitchen or food preparation areas, and natatorium, spa or therapy pool areas shall be of 304 stainless steel NEMA 4X construction.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide gutters and wireways only where specified or required. Use of gutters and wireways shall be kept to a minimum.

B. Finishing: Remove burrs and sharp edges of gutters and wireways wherever they could be injurious to conductor insulation or jacket.

C. Installation: Install gutters and wireways where shown or required, in accordance with the manufacturer's written instructions, NEC, NECA "Standard of Installation," and with recognized industry practices to ensure that the gutters and wireways comply with the

specified requirements. Comply with requirements of NEMA and the NEC pertaining to installation of electrical gutters.

D. Grounding: Electrically ground gutters and wireways to ensure continuous electrical conductivity. Provide equipment grounding conductor.

E. Conductors:
   1. Complete gutter and wireway installation before starting the installation of conductors.
   2. Provide sufficient space to permit access for installing, splicing, and maintaining the conductors.

F. A maximum of 12 conduits containing branch circuits shall be allowed to be installed in any gutter or wireway.

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 43

LIGHTING CONTROLS

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Lighting control system and components:
   1. Touch panel controls
   2. Lighting management panels
   3. Lighting management modules
   4. Low voltage wall stations
   5. Power interfaces
   6. Wired sensors
   7. Stand-alone room based architecture. Provide hardware capable of system network architecture without network connectivity or network interface hardware.

1.2 SUMMARY

A. The lighting control system specified in this section shall provide, sensor-based (both occupancy and daylight), and manual lighting control, and time based control when configured as a networked system.

B. The system shall be capable of turning lighting loads on/off as well as dimming lights (if lighting load is capable of being dimmed). Specific dimmers shall be capable of “dimming lights to off”.

C. All system devices within a group or controlled area shall be networked together, enabling digital communication between devices.

D. The system architecture shall be capable of enabling stand-alone groups (areas) of devices. If the system is networked together the groups or areas shall continue to function in a default capacity, even if network connectivity to the greater system is lost.

E. The system architecture shall facilitate remote operation via a computer connection when the system is networked together.

F. The system shall not require any centrally hardwired switching equipment.

G. The system shall be capable of wireless, wired, or hybrid wireless/wired architectures.

H. 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 and Software 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 steps in sensor manufacturing process shall occur in North America; including population of all electronic components on circuit boards, soldering, programming, wiring, and housing.

B. All components and the manufacturing facility where product was manufactured must be RoHS compliant.

C. In high humidity or cold environments, the sensors shall be conformably coated and rated for condensing humidity and -40 degree Fahrenheit (and Celsius) operation.

D. All applicable products must be UL / CUL 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. - System: nLight
2. Legrand North America, LLC - System: WattStopper DLM
3. Eaton Corporation, PLC – System: Greengate
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 3) network capable backbone for remote or time based system operation.

B. 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.

C. System may interface directly with intelligent LED luminaires such that only CAT-5 cabling is required to interconnect luminaires with control components such as sensors and switches, refer to Networked LED Luminaire section below.

D. Lighting control zones shall consist of one or more intelligent lighting control components, be capable of stand-alone operation, and be capable of being connected to a higher level network backbone.

E. Devices within a lighting control zone shall be connected with low voltage cabling in any order.

F. Lighting control zone shall be capable of automatically configuring itself for default operation without any start-up labor required.

G. When Network architecture is implemented, individual lighting zones must continue to provide a user defined default level of lighting control in the event of a system communication failure with the backbone network or the management software becoming unavailable.

H. Power for devices within a lighting control zone shall come from either resident devices already present for that zone, controls enabled luminaires, or from the network backbone. Standalone “bus power supplies” are not acceptable.

I. 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. Specific applications may require remote switching and shall be capable of being networked into the system.

J. Networked systems shall have one or more primary network control “gateway” devices that are capable of accessing and controlling connected system devices and linking into an Ethernet LAN.

K. Networked Systems may use a network bridge device to route communication and distribute power to directly connect lighting zones together for purposes of decreasing system wiring requirements.

L. Network system communications shall be hard wired. When systems devices are capable of WiFi, they shall be capable of wirelessly connecting a lighting zone to a WiFi (802.11n) wireless data network for purposes of eliminating the network bridge devices and all cabling that connects zones to bridge devices. Use of WiFi shall only be enabled with written permission and documentation from the Owner.

M. Networked systems shall have a web-based software management program that enables remote system control, status monitoring, and creation of lighting control schedules and profiles.

N. Individual lighting zones shall be capable of being segmented into several local channels of occupancy, photocell, and switch functionality for more advanced configurations and sequences of operation.

O. Devices located in different lighting zones shall be able to communicate occupancy, photocell (non-dimming), and switch information via either the wired or WiFi backbone.

P. Networked systems shall be capable of operating a lighting control zone according to several sequences of operation. System shall be able to change a space's sequence of operation according to a time schedule so as to enable customized time-of-day, day-of-week, utilization of a space.

Q. Operating modes shall be utilized only in manners consistent with local energy codes.
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)
    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. 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 (network capable):

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 one integrated dry contact switching relays, 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. All sensors shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate of a potential wiring issue
7. Every sensor parameter shall be available and configurable remotely from the software (when networked) and locally via the device push-button.
8. System shall have sensors that can be embedded into luminaire such that only the lens shows on luminaire face.
9. Embedded sensors shall be capable of both PIR and Dual Technology occupancy detection. Embedded sensors shall have an optional photocell
10. Ceiling, fixture, recessed, & corner mounted sensors shall be available.
11. Sensors shall have optional features for photocell/daylight override, dimming control, and low temperature/high humidity operation.
12. Sensors shall be the following nLight model numbers, with device options as specified:

C. 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, lamp depreciation, or lamp outages).
4. Combination units that have all features of on/off photocell and dimming sensors shall also be available.
5. A dual zone option shall be available for On/Off Photocell, Automatic Dimming Control Photocell, or Combination units. The second zone shall be capable of being controlled as an “offset” from the primary zone.
6. Luminaire mounted dimming photocells shall be embedded into luminaire such that only the lens shows on luminaire face.

D. 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 remotely from the software (if networked) and locally via the device push-button.

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 lighting loads or 120/277 VAC line voltage dimmable fluorescent ballasts (2-wire and 3-wire versions).
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.

E. Relay & Dimming Panels:
1. Panel shall incorporate up to 4 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 be capable of operating as either two networked devices or as one.
6. Panel shall supply current limited low voltage power to other networked devices connected via CAT-5.
7. Panel shall provide auxiliary low voltage device power connected wired directly to a dedicated terminal connection.

F. Networked Auxiliary Input / Output (I/O) Devices:
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 dimmable ballasts or LED drivers by sinking up to 20 mA of current.
4. Specific I/O devices shall have an input that reads a 0-10 VDC signal from an external device.
5. 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.
6. Specific I/O devices shall sense state of low voltage outdoor photocells.
7. Specific I/O devices shall enable RS-232 communication between lighting control system and Touch Screen based A/V control systems.
8. 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).

G. Low Voltage Wall Switches & Dimmers:

1. All 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
5. Devices with a single “on” button shall be capable of selecting all possible lighting combinations for a bi-level lighting zone such that the user confusion as to which of two buttons (as is present in multi-button scenarios) controls which load is eliminated.

H. 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.

I. 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. When networked, the device shall be capable of selecting a lighting profile be run by the system’s upstream Gateway so as to implement selected lighting profile across multiple zones (and not just its local zone).
6. 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 system software is installed.

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.

C. Label each controller with 120/277 Volt circuit (i.e. “HD-27) and room graphic name and number. Do not use architectural room name or number on drawings, use room graphic identification only.

C. Provide ceiling mounted sensors. Wall mounted sensors shall only be used where ceiling mounted sensors are proven by the manufacturer to be impractical.

D. For ceilings up to 12-feet AFF, control equipment shall be mounted Above ceiling control equipment shall be wall mounted above an accessible ceiling on 24x24-inch fire resistive 0.75-inch thick plywood back board mounted to the wall above the ceiling, 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.

E. 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.

3.2 INSTALLATION

A. When using wire for connections other than Cat 5e with RJ-45 connectors, provide detailed point to point wiring diagrams for every termination. Provide wire specifications and wire colors to simplify contactor termination requirements. 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.

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, floor, or ceiling in where they are installed.

J. Install wall occupancy sensor switches in boxes on the strike side of doors as hung. Install a uniform position so the same direction will open and close the circuit throughout the project. 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. Fasten all plates outdoors with type 302 Allen Head "tamper-proof" screws.

L. 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.

M. Unless indicated otherwise, circuit relays/switchpacks ahead of local control switches. Source –> relay/switchpack –> local toggle switch(s).

N. Coordinate with BMCS/BAS Contractor for interface of BMCS/BAS System and wiring connections.

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.

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:
1. Time delay = maximum
2. Zero Time Delay = Off
3. Auto-On = On (Occupancy) Auto = OFF (Vacancy)
4. Manual-On = Off
5. Self-Adjust = Off
6. Disable Self-Adjust = On
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.

3.4 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 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 12 17

ULTRA HIGH EFFICIENCY K-RATED TRANSFORMERS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Copper-wound three-phase transformer exceeding US Department of Energy 2016 Efficiency Standards, with extremely low no load losses.
   1. Transformers shall be designed to an efficiency standard higher than NEMA Premium.

B. Load Mix: Transformer shall be UL 1561 Listed to feed a mix of equipment load profiles such as computers without derating or significant degradation of efficiency.

1.2 REFERENCES

A. FEDERAL REGISTER – US Department of Energy, Office of Energy Efficiency and Renewable Energy. 10 CFR Part 431. Energy Conservation Program for Commercial and Industrial Equipment: Energy Conservation Standards for Distribution Transformers; 2016 Standards

B. DOE Test Method For Measuring The Energy Consumption Of Distribution Transformers Under Appendix A To Subpart K Of 10 CFR Part 431.

C. Metering Standards:
   1. Computational algorithms per IEEE Std 1459-2000
   2. UL 916, UL 61010C-1 CAT III

D. IEEE-1100 – Recommended Practice for Powering and Grounding Sensitive Electronic Equipment
   1. IEEE Standard 1100 documents how typical transformers feeding electronic equipment produce substantially higher losses under electronic equipment load compared to under linear load, requiring derating.

E. LEED – Leadership in Energy and Environmental Design, U.S. Green Building Council.

F. ISO 9000:2000 – International Standards Organization - Quality Management System

G. ISO 14000:2004 – International Standards Organization - Environmental Management System

H. NFPA 70 - National Electrical Code (Latest Edition)

I. NEMA ST20-2014 - Dry-Type Transformers for General Applications

J. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment

K. US Department of Energy, 10 CFR Part 431, 2015. Energy Conservation Program: Energy Conservation Standards for Distribution Transformers; Final Rule.

L. IEEE C57.110-2008 – IEEE Recommended Practice for establishing transformer capability when feeding non-sinusoidal load currents.

M. ISO 17025 – International Standards Organization - General requirements for the competence of testing and calibration laboratories.

N. UL 1561 - Dry-Type General Purpose and Power Transformers.

1.3 SUBMITTALS

A. Submit product data including the following:
1. Copy of ISO 14001:2004 Certification of manufacturing operation.
2. Copy of ISO 9001:2000 Certification of manufacturing operation.
3. Construction Details including enclosure dimensions, kVA rating, primary & secondary nominal voltages, voltage taps, BIL, unit weight
4. Basic Performance characteristics including insulation class, temperature rise, core and coil materials, impedances & audible noise level, unit weight
5. Inrush Current (typical 3 cycle recovery)
6. Short Circuit Current data: Primary (Sym. O/P S/C) & Secondary (L-N/G S/C)
7. Efficiency Data
   a. No load and full load losses per NEMA ST20
   b. Linear load Efficiency data @ 1/6 load
   c. Linear load efficiency data @ 1/4, 1/2, 3/4 & full load
   d. Linear Load Efficiency @ 35% loading tested per NEMA TP-2.
   e. Efficiency under specified K rating load profile at 15%, 25%, 50%, 75%, 100% of nameplate rating.
8. Copy of Factory ISO 9001 documentation describing nonlinear load test program
   a. Meter and CT details including model, accuracy, serial numbers and calibration information.
9. Copy of Linear & Nonlinear load test report for a representative 75kVA transformer
10. 25 year Product Warranty Certificate

B. Description of manufacturer’s factory nonlinear load test program.
1. In light of the significant degradation of transformer performance when feeding nonlinear load compared to linear load, it is mandatory that the manufacturer test the transformers under nonlinear load representative of real world load mix. Transformers that have not been subject to testing under nonlinear load will not be considered for this project due to the uncertainty related to their real world performance.
2. Given the lack of a standard for testing transformers under nonlinear load, the manufacturer must have a nonlinear Load Test Program operating in the production environment that is audited and documented per quality standard ISO 9001.
3. The nonlinear load bank shall consist of a phase-neutral loading with a specified K rating load profile, representative of a mix of typical commercial equipment.
4. Meters and CTs shall both be revenue class accurate. CTs shall be operated within their approved accuracy loading range. Dual meters shall gather simultaneous primary and secondary energy and harmonic data. Meter and CT details including model, accuracy, serial numbers and calibration information.
5. Efficiency: Measurements shall be taken at multiple load levels and plotted to show compliance with specification and correlation to the designed efficiency curve.
6. Efficiency shall be determined purely by measurements using method and instrumentation per NEMA TP-2 Standard. Other methods are not acceptable.
7. Harmonic data including current and Voltage THD at the different load levels shall be included with the test report.

1.4 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.

1.5 DELIVERY, STORAGE AND HANDLING

A. Store and protect products

B. Store in a warm, dry location with uniform temperature. Cover ventilation openings to keep out dust, water and other foreign material.

C. Handle transformers using lifting eyes and/or brackets provided for that purpose. Protect against unfavorable external environment such as rain and snow, during handling.

1.6 WARRANTY

A. Transformer shall carry a 25-year pro-rated warranty, which shall be standard for the product line.

1.7 INTERNATIONAL STANDARDS ORGANIZATION REGISTRATION OF MANUFACTURING PLANT

A. Registration to current ISO standard is required.

B. Independent annual audits are conducted.

C. Product shall be manufactured in registered facility

D. ISO 9001:2000 Registered – Quality Management System

E. ISO 14001:2004 Registered – Environmental Management System
   1. Transformer manufacturing can produce significant emissions of volatile compounds and significant other waste. To minimize environmental impact, the transformer must the product of a manufacturing process that has been independently audited to comply with the ISO 14001:2004 Environmental Management System Standard, where strict quality control of raw material sourcing and construction techniques maximize product efficiency and minimize emissions and waste byproducts.
   2. ISO 14001:2004 ensures that a facility has had an independent environmental impact assessment of raw material sourcing and all manufacturing processes, and has implemented an independent annually audited program that minimizes environmental impact during manufacturing process and includes a strictly monitored continuous improvement program.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS/PRODUCT

A. Powersmiths E-Saver OPAL

B. Power Quality International (EY e-Rated)

C. Mirus - ULLTRA

2.2 TRANSFORMER SPECIFICATION

A. Minimum UL Listed and Labeled K-Rating: K7

B. Copper-wound, 3-phase, common core, ventilated, dry-type, isolation transformer built to NEMA ST20 and relevant NEMA, UL and IEEE standards; 200% rated neutral; 60Hz rated; Transformers 750 kVA and less, 600 volt primary and less, shall be UL Listed and bear the label. All terminals, including those for changing taps, must be readily accessible by removing a front cover plate. Windings shall be continuous with terminations brazed or welded. 10kV BIL.

C. Insulation System:
1. Shall be NOMEX-based with an Epoxy Co-polymer impregnate for lowest environmental impact, long term reliability and long life expectancy
   a. Class: 220 degrees C
   b. Impregnate Properties for low emissions during manufacturing, highest reliability and life expectancy
   c. Epoxy co-polymer
   d. VOC: less than 1.65 lbs./gal (low emissions during manufacturing)
   e. Water absorption (24hrs @25C): less than 0.05% (superior insulation, longer life)
   f. Chemical Resistance: Must have documented excellent performance rating by supplier
   g. Dielectric Strength: minimum of 3200 volts/mil dry (for superior stress, overvoltage tolerance)
   h. Dissipation Factor: max. 0.02 @25C to reduce aging of insulation, extending useful life

D. Operating Temperature Rise: Maximum 115 degree C in a 40 degree C maximum ambient

E. Noise levels:
1. 3dB Below NEMA ST-20
2. Production Test every unit. Data to be available upon request.

F. Exceed minimum efficiency requirements of US Department of Energy, 10 CFR Part 431, April 18, 2013, Energy Conservation Program: Energy Conservation Standards for Distribution Transformers: Final Rule which takes effect January 1, 2016, and comply with the table of maximum no Load Loses, efficiency requirements at 1/6 load, efficiency at 35% load per 10 CFR Part 431, and efficiency at 25% load under the transformer specified K-rating load profile.

G. Maximum losses and minimum efficiency under linear load conditions per Table 1.

Table 1
Max and Min Values for Losses and Efficiency for “High Efficiency” Transformers
Under K1 Linear and Specified K-Rating Nonlinear Loading

kVA Rating	No Load	16.5% Load		25% Load		35% Load	
		K1 Linear	Nonlinear	Linear	Nonlinear	K1 Linear	Nonlinear

Table 1
Max and Min Values for Losses and Efficiency for "High Efficiency" Transformers
Under K1 Linear and Specified K-Rating Nonlinear Loading

	Max Loss (kW)	Max Loss (kW)	Min Eff. (%)	Max Loss (kW)	Min Eff. (%)	Max Loss (kW)	Min Eff. (%)	Max Loss (kW)	Min Eff. (%)	Max Loss (kW)	Min Eff. (%)	Max Loss (kW)	Min Eff. (%)
15	0.054	0.066	97.38	0.067	97.36	0.082	97.86	0.085	97.78	0.109	97.97	0.117	97.82
30	0.091	0.112	97.79	0.113	97.77	0.138	98.19	0.144	98.12	0.183	98.29	0.200	98.13
45	0.124	0.152	98.00	0.154	97.97	0.187	98.36	0.197	98.28	0.248	98.45	0.276	98.28
75	0.181	0.221	98.24	0.225	98.22	0.273	98.56	0.288	98.49	0.362	98.64	0.404	98.48
112.5	0.245	0.300	98.41	0.305	98.38	0.370	98.70	0.393	98.62	0.490	98.77	0.555	98.61
150	0.303	0.370	98.53	0.377	98.50	0.457	98.80	0.486	98.72	0.605	98.86	0.688	98.71
225	0.410	0.501	98.67	0.510	98.64	0.619	98.91	0.659	98.84	0.820	98.97	0.937	98.82
300	0.509	0.622	98.76	0.636	98.73	0.769	98.99	0.829	98.91	1.018	99.04	1.194	98.88
500	0.741	0.906	98.91	0.928	98.89	1.119	99.11	1.213	99.04	1.482	99.16	1.754	99.01

H. Voltage Taps: For transformers 30kVA-300kVA, provide two 2-1/2% full capacity taps above and below nominal primary voltage. For transformers 15kVA and smaller as well as 500kVA and larger provide one 5% full capacity tap above and below nominal primary voltage.

I. Impedance: Between 3.0% and 6.0% unless otherwise noted.

J. Enclosure type: Ventilated NEMA 2; NEMA 3RX aluminum or stainless steel when located outdoors, or as indicated otherwise

K. Finish Color: Provide light gray ANSI-61 paint finish for transformers located outdoors. Provide manufacturer's standard paint finish color indoors.

L. Transformer Options:
1. Electrostatic Shield: Each winding is independently single shielded with a full-width copper electrostatic shield

M. Closed delta 120/240-Volt secondary, 3-phase, 4-wire with center tap neutral winding transformers:
1. KVA rating indicated shall be for balanced 3-phase loading. Center tap winding shall allow for a maximum nominal 70-percent of three-phase kVA rating for unbalanced single phase neutral connected 120/240-Volt loads. The center tap winding shall be individually rated or constructed at twice the capacity of each of the other delta connected windings. (Example: a 225kVA rated center tap transformer would consist of two 75-kVA windings and one 150-kVA center tap winding).

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install transformers where shown, in accordance with the manufacturer's written instructions and industry practices to ensure that the transformers meet the specifications. Comply with requirements of NEMA and NEC standards, and applicable portions of NECA Standard of Installation, for installation of transformers. Transformers shall be floor mounted. Ceiling mounted transformers are not acceptable.

B. Dry-Type Transformer Mounting: Indoor, floor mount transformer on properly sized Amber/Booth Type RVD rubber-in-shear vibration isolators. Transformer enclosures shall make no contact with wall surfaces.

C. Conduit directly connected to transformer enclosures shall be flexible liquid tight conduit extending for a minimum of 18-inches and a maximum of 24 inches from transformer enclosure as measured along the conduit centerline. Include a ground wire, size in accordance with NEC, internal in each length of flexible conduit.

D. Grounding: Ground and bond transformers as a separately derived system unless noted otherwise, refer to NEC 250. Installation of bonding strap or bonding conductor between ground and neutral bus shall be witnessed by the Engineer prior to applying power and terminating secondary conductors.

E. Check for damage and loose connections.

F. Set the transformer plumb and level.

G. Provide Seismic restraints where required.

H. Coordinate all work in this Section with that in other sections.

I. Verify all dimensions in the field.

J. Adjust transformer secondary voltages to provide the required voltage at the loads.

3.2 TESTING

A. Insulation Tests: Before energizing, check transformer windings for continuity.

B. Winding Current: During initial no-load energizing, check current in each primary winding.

C. Tap Settings: Measure and record load current and voltage of transformers while loaded to verify proper transformer tap settings.

D. Submittals: Furnish instruments and personnel required for tests. Submit four copies of certified test results to Engineer for review. Reports include transformer tested, date and time of tests, relative humidity, temperature, and weather conditions.

E. Performance Validation: To ensure that the products shipped to the job site meet this specification, provide on-site revenue class accurate efficiency and harmonic measurements of transformers once installed and operating at customer’s site. Data shall be collected from primary and secondary sides of the transformer simultaneously on a synchronized cycle by cycle basis. The use of two discrete meters that are not synchronized is not acceptable. Sampling shall be of 10% of transformers on the project once installed and operating, as selected by customer. Submit a detailed report to the project engineer.

F. Identify non-compliant products to the engineer and replace at no cost to the Owner.

G. Notification: Notify Engineer in writing of any deviation from manufacturer’s pre-shipment test data.

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 16

PANELBOARDS AND ENCLOSURES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Panelboards and enclosures, including cabinet, as shown, scheduled, indicated, and specified.

1.2 QUALITY ASSURANCE

A. UL Standards: Panelboards and enclosures shall confirm to all applicable UL standards and shall be UL labeled.

1.3 SUBMITTALS

A. Indicate:
1. Detailed dimensions.
2. Enclosure material, finish, and NEMA classification type.
3. Location of main circuit breaker.
4. Mounting and trim.
5. Acceptable incoming conductors' size.
6. Electrical characteristics including voltage, ampacity, overcurrent device frame size and trip ratings, bus material and rating, withstand ratings, lugs, and time current curves of all overcurrent devices and components.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Schneider Electric - Square D

B. ABB-General Electric Co.

C. Siemens

D. Eaton

2.2 MATERIALS AND COMPONENTS

A. General: Panelboards shall be dead-front type equipped with fusible switches or circuit breakers as shown and as required.

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. Busing Assembly: Panelboard phase, neutral, and equipment ground busing shall be copper. Bus structure and mains shall have ratings as shown and scheduled. Furnish a bare uninsulated ground bus inside each panelboard enclosure. Two section panelboards shall be connected with copper cable, with an ampacity conforming to the upstream overcurrent device. Neutral bus termination quantity for branch circuit panelboards shall match or exceed the maximum number of single pole circuit breakers the panelboard will accept.

D. Main circuit breakers and feeder / branch circuit breakers:
1. Less than 125 Amps: Thermal magnetic with factory fixed trip.
2. 125-600 Amps: Thermal magnetic with adjustable instantaneous trip of 5X – 10X with short time tracking.
3. 601 Amps and larger: Solid state true RMS sensing with adjustable: current set by rating plug or adjustable dial, I^2t settings, ground fault (where required), instantaneous trip, and short time trip; 80-percent continuous current rating.
4. Provide permanent lock-off device for all fire alarm system branch circuit breakers, for all smoke control fans and equipment, and where indicated or required for circuit breaker to be used as a remote safety disconnect switch.
5. General requirements:
    a. Make prepared space provisions for additional breakers or fused switches so that no additional bus or connectors will be required to add circuit breakers or fused switches in the available device mounting space.
    b. Two and three pole breakers shall have internal common trips.
    c. All circuit breakers used as the main or branch mounted back-fed main shall be bolt-on. All circuit breakers used in 600 Amp and smaller panelboards shall be bolt-on breakers. Circuit breakers for distribution panelboards rated 601 amps and larger shall have plug-on or bolt-on circuit breakers.
    d. Branch circuit panelboard shall have interrupting capacity as shown or as required, but in no case less 10k AIC for 120/208/240-Volt systems, and 18k AIC for 277/480-Volt systems.
    e. 15 and 20 Amp circuit breakers for lighting circuits shall be UL listed switch duty (SWD).
    f. Personnel ground fault interrupter (GFI) circuit breakers, where shown, shall be maximum 5 mA ground fault trip and shall include a TEST button.
    g. Equipment ground fault interrupter (EGFI/EGPD) circuit breakers, where shown or required shall be 30mA ground fault trip and shall include TEST button.
    h. Circuit breakers with 1,200 Amp and larger frame shall have Energy Reducing Maintenance Switching with local status indicator (ERMS).

E. Fusible Switches for distribution panelboards: Fusible switches shall be quick-make, quick-break type. Each switch shall be enclosed in a separate steel enclosure. The enclosure shall employ a hinged cover for access to the fuses. Interlock cover with the operating handle to prevent opening the cover when the switch is in the ON position. This interlock shall be constructed so that it can be overridden for testing fuses without interrupting service. The switches shall have padlocking provisions in the OFF position. Switches shall include positive pressure rejection type fuse clips for use with UL Class J fuses and be UL labeled for 200,000 AIC.

F. Spaces: Where space for future breakers or switches is shown, panelboard enclosure shall include removable blank panels or knockouts to allow installation of future breakers or switches, prepared spaces, and panelboard busing shall be complete, including required connectors.

G. Integrated Equipment Rating: Do not apply series ratings. Each panelboard, as a complete unit, shall have a short-circuit rating equal or greater than the available short circuit current. Rating shall have been established by tests on similar panelboards with the circuit breakers or fusible switches installed.

H. Panelboard Enclosures:
1. Provide sheet steel enclosures, minimum 16-gauge nominal thickness, with multiple knockouts, unless shown otherwise. Provide all NEMA 1 panelboard fronts with spring-loaded door pulls, and flush lock and key, panelboard enclosures keyed alike to match the Owner's standard key system; coordinate with Owner.
2. All NEMA 1 enclosure panelboards shall be hinged "door-in-door" type with interior hinged door with hand operated latch or latches, as required providing access only to circuit breaker or fusible switch operating handles, not to exposed energized parts. Outer hinged door shall be securely mounted to the panelboard box with factory bolts, screws, clips, or other fasteners, requiring a tool for entry. Hand operated latches are not acceptable. Push inner and outer doors shall open left to right. Manufacturer hardware (OEM), screws, and bolts shall be used to secure dead fronts and covers. Do not used third party hardware. Do not use power tools to secure panel hardware. Provide gray powder coat finish over a rust inhibitor.
3. Equip with interior circuit directory frame, card, and clear plastic covering for panelboards.
4. Panelboards located in kitchen preparation or natatorium areas shall have Type 316 stainless steel front, door, and trim with a NEMA 1 rating for the entire enclosure.
5. Panelboards at exterior locations shall be NEMA 4X Type 316 stainless steel.
6. Panelboards at hose down areas, cooling towers, in greenhouses, and other corrosive locations shall be NEMA 4X 316 stainless steel.
7. Enclosure shall be for recessed or surface mounting as shown or as required.
8. Enclosures shall be fabricated by the same manufacturer as panelboards to be enclosed. Multi-section panelboards shall have same physical dimensions.

PART 3 - EXECUTION

3.1 INSTALLATION OF PANELBOARDS AND ENCLOSURES

A. General: Install panelboards and enclosures, as shown, including electrical connections, in accordance with the manufacturer's written instructions, the requirements of NEC, NECA Standard of Installation, and industry practices. Circuit breakers shall be factory installed except for required field modifications due to actual site conditions.

B. Coordination: Coordinate installation of panelboards and enclosures with conductor and raceways installation work.

C. Anchoring: Anchor enclosures to walls and structural surfaces ensuring that they are permanently and mechanically secured.

D. Directory Card: Provide a typed circuit directory card(s) upon completion of work. Directory card shall be of super heavy-weight index card stock, 110 lb, white. Directory shall include type of load (i.e.: receptacles, lighting, exhaust fan, etc.) and location (i.e.: Room 102, Office, etc.) Room number shall be identified as the actual graphics room number assigned to the space and not the room number identified on the Plans. Circuits with shunt trip shall be identified with the control circuit operating the shunt trip (i.e.: Kitchen Hood No. 2). Shunt trip breakers with common trip circuit shall be grouped in the

panelboard (i.e.: circuits 1, 3, 5 and 7).

E. Fuses: Install fuses, of the ratings and class shown.

F. Circuit Arrangement: Branch circuits shall be arranged to provide the best possible phase balance, unless shown otherwise.

G. Panelboards not intended to be used as service entrance (SE) rated or for establishing a separately derived neutral system shall have the factory installed neutral to ground bonding screws and straps removed and disposed of.

H. Recessed or flush mounted panelboards: Terminate spare conduits in junction box 18-inches above accessible ceiling close to panelboard location. Label junction box cover as “not used” and include panel identification.
1. Provide (3) 1-inch and (3) ¾-inch spare conduits above accessible ceiling to j-box from each panelboard section.
2. Where recessed panelboard is located above another building floor, also provide (3) 1-inch and (3) ¾-inch conduits to j-box in ceiling space on floor below.

I. Conductors shall be bent neatly opposite the fuse switch or circuit breaker to which they are to be attached. Vertically installed conductors shall be neatly tie-wrapped. Conductors shall be connected in a neat and professional manner. Conductors brought in from the top or bottom of the cabinet shall be bent neatly opposite the fuse or circuit breaker to which they are to be attached. Each conductor shall be run along the full height of the panel and returned to the circuit breaker or fuse location to allow relocation of the conductor to any position along the bus. Panelboard shall be cleaned of all construction debris prior to substantial completion review. Neutral and grounding conductors shall be installed similar to the phase conductors.

J. Circuit breakers and conductors installed for SPD devices shall be located on the same side as the SPD to allow the shortest and straightest run of conductors in respect to the location of the SPD device. Route all conductors to the SPD device with straight as possible run, using longest sweep bends and the shortest conductor length possible. Twist all SPD conductors and secure with tie straps wherever possible.

K. Install copper ground bus for copper ground conductors. Ground conductors size #1 and larger are to be landed to panelboard enclosure with mechanical lugs and not to ground bus.

L. Install panels so that breaker number 1 is the top left breaker.

M. In panels that contain multi-layered neutral bus, install neutrals beginning with the back neutral bus row and work forward. Do not make up neutrals on front neutral bus row unless all other rows are full.

N. Label breaker mounting space with stick-on number labels.

O. Mount the fully aligned panelboard such that the maximum height of the top circuit breaker above the finished floor shall not exceed 78-inches. Mount panelboards as high as practical and such that the bottom of the cabinets will not be less than 6 inches above the finished floor.

3.2 TESTING

A. Before energizing, energization, check for continuity of circuits and short circuits.

B. Provide thermal infrared scan of panelboards under full load as directed and witnessed by Owner. Correct any deficiencies causing abnormal heating and repeat the scan. Provide digital video documentation with deficiencies corrected for comparison to future test. 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 close-out.

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, or as directed by Owner. 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

SECTION 26 43 00

SURGE PROTECTION DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION/SCOPE

A. The Surge Protection Device (SPD) covered under this section includes all service entrance type surge protection devices suitable for use as Type 1 or Type 2 Devices per UL1449 4th Edition, applied to the line or load side of the utility feed inside the facility. The unit shall be connected in parallel with the facility's wiring system. The unit shall be manufactured in the USA by a qualified manufacturer of suppression filter system equipment, which has been engaged in the commercial design and manufacture of such products for a minimum of five years.

B. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to finish and install surge protection devices.

1.2 QUALITY ASSURANCE

A. Reference Standard: Comply with the latest edition of the applicable provisions and recommendations of the following, except as otherwise stated in this document:
1. UL 1449 Fourth Edition
2. ANSI/IEEE C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
3. ANSI/IEEE C62.45, Guide for Surge Testing for equipment connected to Low-Voltage AC Power Circuits.
4. IEEE 1100 Emerald Book.
5. National Fire Protection Association (NFPA 70 (NEC), 75, and 78).
6. UL 1283 – Electromagnetic Interference Filters

1.3 SUBMITTALS

A. Submit shop drawings complete with all technical information unit dimensions, detailed installation instructions, maintenance manual, and wiring configuration.

B. Copies of Manufacturer’s catalog data, technical information and specifications on equipment.

C. Copies of documentation stating that the Surge Protection Device is listed from a Nationally Recognized Testing Laboratory (NRTL) (UL, ETL, etc.) and are tested and multi-listed to UL 1449 4th Edition and UL 1283.

D. Copies of actual let through voltage data in the form of oscilloscope results for both ANSI/IEEE C62.41 Category C3 (combination wave) and B3 (Ring wave) tested in accordance with ANSI/IEEE C6245.

E. Copies of test reports from a recognized independent testing laboratory, capable of producing 200kA surge current waveforms, verifying the suppressor components can survive published surge current rating on both a per mode and per phase basis using the ANSI/IEEE C62.41 impulse waveform C3 (8 x 20 microsecond, 20kV/10kA). Test data on an individual module is not acceptable.

F. Copy of warranty statement clearly establishing the terms and conditions to the building/facility owner/operator.

G. Provide detailed marked-up copy of this specification with line-by-line compliance or exception statements to all provisions of this specification.

1.4 WARRANTY

A. The manufacturer shall provide a minimum 20-year warranty for high and very high exposure SPDs. Very high exposure unit warranties shall include exposure to temporary over-voltage conditions. Provide a minimum 15-year warranty for all medium exposure SPDs, and a minimum 10-year warranty for all other SPDs for parts from date of substantial completion against failure. Contractor shall install in compliance with applicable national / local electrical codes and the manufacturer's Installation, Operation and Maintenance Instructions. Contractor shall assist the Owner with manufacturer warranty registration.

PART 2 – PRODUCTS

2.1 APPROVED MANUFACTURER

A. Low exposure, minimum 10-year parts warranty, minimum 50k Amps per mode, 100k Amps per phase, Type 1 and Type 2.
   1. Recessed mount panelboard extension with brushed stainless-steel front:
      a. ACT Communications:471- ###V-050-SS-F-PB flush series.
      b. Current Technology PX3-050-VVV- #X-SF-X-F- # series.
      c. PSP Hurricane HxC100-4XN-S-F series.
      d. SSI Surge Suppression, Inc. CSMx12-FMPxSS series.
   2. Branch panelboard surface mounted:
      a. ACT Communications 455 series.
      b. Current Technology CGC50 series.
      c. PSP Hurricane HxC100-4XH-S series.
      d. SSI Surge Suppression, Inc. CSMx12 series.

B. Medium exposure, minimum 15-year parts warranty, minimum 120k Amps per mode, 240k Amps per phase, Type 2.
   1. ACT Communications 471 series.
   2. Current Technology CGP120 series.
   3. PSP Hurricane HxC300-4NT1-S series.
   4. SSI Surge Suppression, Inc. CSMx24 series.

C. High exposure, minimum 20-year parts warranty, minimum 200k Amps per mode, 400k Amps per phase, Type 2 SPD.
   1. ACT Communications 471 x200 series.
   2. Current Technology TG 200 series.
   3. PSP Hurricane HxC400-4NT1-S series.
   4. SSI Surge Suppression, Inc. CHLxM series.

D. Very high exposure at service entrance 1,201 Amps and above: Minimum 20-year parts warranty; minimum 200k Amps per mode; 400k Amps per phase, Type 2 SPD:
   1. ACT Communications 471 SEL series.
   2. Current Technology SEL3 200 series.

   The service entrance protector shall incorporate a combination of TPMOV and Selenium technology allowing for transient surge and temporary over voltage protection. The unit shall be able to prevent common temporary over voltages and high impedance faults from damaging the MOVs, increasing their longevity and ability to protect the critical load. Limited and Intermediate current TOVs can be caused by a loss of the neutral conductor

in a split phase or three phase power system. The available fault current will be determined by the impedance of the loads connected to the phases opposite the SPD and are typically in the range of 30A to 1000A. Minimum 20-year parts warranty, extended over-voltage protection, minimum 200k Amps per mode, 400k Amps per phase, Type 2 SPD. The Selenium elements must limit voltage to the MOV as a percent of nominal as outlined below:

Overvoltage seen by MOVs as % of Nominal				
	available current			
time	30A	100A	500A	1000A
1 cycle	120%	130%	150%	160%
10 cycles	130%	150%	160%	160%
30 cycles	140%	150%	160%	160%

*To verify damage to the MOVs has been mitigated, the percent overvoltage seen at the MOV must be less than 200% for split-phase applications or 173% for three-phase applications (100% is nominal).

2.2 MANUFACTURED UNITS / ELECTRICAL REQUIREMENTS

A. Declared Maximum Continuous Operating Voltage (MCOV) shall be greater than 115 percent of the nominal system operating voltage and in compliance with test and evaluation procedures outlined in the nominal discharge surge current test of UL1449, section 37.7.3. MCOV values claimed based on the component's value or on the 30-minute 115% overvoltage test in UL1449 will not be accepted.

B. Unit shall have not more than 10% deterioration or degradation of the UL1449, Voltage Protection Rating (VPR) due to repeated surges.

C. Protection Modes SVR (6kV, 500A) and UL1449 VPR (6kV, 3kA) for grounded WYE/delta and High Leg Delta circuits with voltages of (480Y/277), (208Y/120), (600Y/347). 3-Phase, 4 wire circuits, (120/240) split phase shall be as follows and comply with test procedures outlined in UL1449 section 37.6: Values Depicted are based on a system Without Disconnect / With Disconnect

System Voltage	Mode	MCOV	C3 Wave	UL 1449 VPR Rating
120/240	L-N	150	650/775	700/800
120/208	L-G	150	650/825	700/900
	N-G	0	500/500	900/1000
	L-L	300	950/1250	900/1200
277/480	L-N	320	1125/1225	900/1200
	L-G	320	1075/1225	1200/1200
	N-G	0	900/900	1200/1500
	L-L	550	1950/2200	1800/1800

D. Electrical Noise Filter- each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric noise shall be as follows using the MIL-STD-220A insertion loss test method.
1. 14 dB from 10 kHz to 1 MHz.

E. Each Unit shall provide the following features:
1. Phase Indicator lights, Form C dry contacts, counter and audible alarm.
2. Field testable while installed.
3. High performance interconnecting cable.
4. The UL 1449 Voltage Protection Rating (VPR) shall be permanently affixed to the SPD unit.

5. The UL 1449 Nominal Discharge Surge Current Rating shall be 20Ka
6. The SCCR rating of the SPD shall be 200kAIC without requiring an upstream protection device for safe operation.
7. The unit shall be listed as a Type 2 SPD per UL1449.
8. Power wiring: SPD shall be equipped with mechanical lugs that can accept up to #2 AWG wire on High Exposure units and up to #6 on Medium and Low Exposure units

2.3 POWER CABLES FOR CONNECTION

A. Power wiring: Conductors between all SPDs and switchgear shall be high performance interconnect system “Low Z Cable” cables with Ultra Low impedance characteristics at 10kHz and above.

B. Low Impedance cable shall be #6 AWG minimum for Very High, High, and Medium Exposure SPDs and #10 AWG minimum for Low Exposure SPDs.

PART 3 – EXECUTION

3.1 GENERAL INSTALLATION

A. The unit shall be installed as close as practical to the facility's wiring system in accordance with applicable national/local electrical codes and the manufacturer's recommended installation instructions. Connection shall be with high performance, low impedance cables in conduit and shall not be any longer than necessary, avoiding unnecessary bends. Minimum wire size and overcurrent protection shall be provided and as indicated or recommended by the manufacturer.

B. Units specified for lighting and appliance panel boards as panelboard extensions (EGPE) shall be mounted directly above or below the first section of the panel board it is protecting. Any other mounting location will not be acceptable and shall be corrected, without exception, at no additional cost to the Owner.

C. Units specified for panelboards, switchboards, or motor control centers shall be mounted directly above or adjacent to the panelboard, switchboard or motor control center using unistrut supports secured to structure as required. Conduit length between power distribution panelboard or switchboard shall be less than two inches. Mounting above equipment is not acceptable.

D. Overcurrent device and conductors for devices shall be the maximum recommended by the manufacturer. Manufacturer’s recommendations shall prevail over the information given in the plans and specifications.

E. Provide recessed mounted panelboard extension type enclosures for devices protecting recessed panelboards. Enclosure front shall match panelboard front. Provide brushed stainless-steel front at kitchens and food processing areas.

3.2 UNIT SELECTION BASED ON EXPOSURE LEVEL

A. (SPDVH) Provide very-high exposure SPDs with Selenium and TPMOV technology for the following new electrical equipment and where also indicated:
   1. Service entrances 1,201 Amps and above.

B. (SPDH) Provide high exposure SPDs for the following new electrical equipment and where indicated:
   1. Service entrances 801 – 1,200 Amps

C. (SPDM): Provide medium exposure SPDs at the following new electrical equipment and where otherwise indicated
   1. Service entrances 401 - 800 Amps.
   2. Panelboards 601 - 1,200 Amps.
   3. Motor control centers 601 Amps and above.
   4. Non-service entrance switchboards located outside.

D. (SPDL): Provide low exposure SPDs at the following new electrical equipment and where indicated
   1. Service entrances 400 Amps and below.
   2. Panelboards 600 Amps and below.
   2. Motor control centers 600 Amps and below.

3.3 TESTING

A. Factory Trained Representative shall provide start-up to include initial verification of proper installation and initiate factory warranty. The technician will be required to do the following as a minimum:
   1. Verify overcurrent device rating
   2. Verify all wiring connections and installation conforms to manufacturer’s recommendations.
   3. Record information for each product installed and include in O&M Manual

B. A copy of the Factory diagnostic test report and written approval of the installation shall be included with the Electrical Operating and Maintenance Manual. The Contractor shall make all adjustments, changes, corrections, etc. as required by the Factory Trained Representative so that the installation follows the manufacturer’s installation and operation instructions without additional charge to the Owner.

END OF SECTION

SECTION 26 51 13

LIGHTING FIXTURES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Work Included: Lighting fixture work is as shown, scheduled and specified.

B. Applications: The applications of lighting fixtures required for the project include the following:
   1. General lighting
   2. Emergency lighting
   3. Outdoor area lighting

1.2 QUALITY ASSURANCE

A. Provide interior building LED fixtures that comply with the Design Lights Consortium (DLC) standards and are DLC or DLC Premium listed as a Qualifying Product at time of proposal submittal date.

B. UL Standards: Lighting fixtures shall conform to applicable UL standards, and be UL or ETL labeled.

C. Light fixtures shall conform to the requirements of NFPA 101, and 70 (NEC).

1.3 SUBMITTALS

A. Submit product data for light fixtures, and emergency lighting equipment, including generator transfer devices.

B. Specification Compliance Review: 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.

C. Submittal data shall include luminaire efficiency parameters.

D. Submittal data for exterior luminaries shall include IESNA BUG ratings, backlight, uplight, and glare ratings of each unique luminaire for the orientation and tile specified. Indicate total absolute lumens per luminaire and absolute lumens emitted above horizontal based by each luminaire for the orientation and tile specified.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Provide products produced by manufacturers shown or scheduled for each type of lighting fixture. Refer to drawings for additional approved manufacturers.
   1. Light fixtures:
      US LED
      Extra Light

Acuity
Hubbell
Signify
Cooper Lighting Solutions
Pinnacle
HE Williams
GE Current
LSI

2. LED Drivers:
   Philips
   Osram Optotronic
   Eldo LED
3. Emergency Battery Packs with self-testing drivers/inverters:
   Bodine
   Chloride
   Lithonia
   Dual Lite
   IOTA
4. Emergency Generator/Inverter Load Control Bypass Relay (ELC); UL924 listed and 0-10Vdc compatible:
   Bodine
5. Emergency Generator / Inverter Branch Circuit Transfer Switch, UL 1008 listed and 0-10Vdc compatible:
   Bodine GTD20A

2.2 MATERIALS AND COMPONENTS

A. General: Provide lighting fixtures of the size, type, and rating indicated, with all accessories for a complete aesthetic installation.

B. Fixture Types:
   1. General:
      a. LED Lay-in edge lit or back flat panel / troffer fixtures: Opaque, edge or back lighted, 4000 Kelvin color temperature. 0-10 Vdc dimmable, L70: 60,000 minimum hours.
      b. Safety chains and wire guards at fixtures in mechanical and electrical rooms, and high abuse areas. Provide safety chains only for gymnasium fixtures which shall be inherently vandal proof, no wire guards.
      c. Fixtures located outdoors, in interior unconditioned spaces, and in wet locations shall be of aluminum construction.
      d. Fixtures with door frames shall be of aluminum construction, white finish where located in kitchens, food prep areas, toilets, restrooms, locker rooms, dressing rooms, showers, and unconditioned spaces.
      e. DLC, DLC Premium or Energy Star qualified unless specified otherwise.
      f. Warranty: 2x2 and 2x4 lay-in light fixtures: 5-year fixture warranty for fixture, driver, and light engine. All other light fixtures: 5-year replacement warranty for fixture, driver, and light engine.
      g. Outdoor fixtures shall include a discrete / replaceable surge suppression device in addition to the surge suppression incorporated in the LED driver.
      h. Operating temperature rating shall be between -40 degrees F and 120 degrees F.
      i. Color Rendering Index (CRI): ≥ 80 Indoor; ≥ 65 Outdoor
      j. The manufacturer shall have performed JEDEC (Joint Electron Devices Engineering Council) reliability tests on the LEDs as follows: High Temperature Operating Life (HTOL), Room Temperature Operating Life

(RTOL), Low Temperature Operating Life (LTOL), Powered Temperature Cycle (PTMCL), Non-Operating Thermal Shock (TMSK), Mechanical Shock Variable Vibration Frequency, and Solder Heat Resistance (SHR).

2. Downlight Fixtures: Provide recessed downlight fixtures with trim rings compatible with the ceiling material where fixture is to be installed.
3. LED Exit Signs: Provide red lettering. The exit lighting fixtures shall meet the requirements of Federal, State, and Local Codes.
   a. Gymnasiums, locker rooms, athletic/PE wing and associated corridors, black box theaters, auditorium stages, cafetoriums and kitchens: Vandal resistant, wet location cast aluminum with polycarbonate protective cover exit signs, Lithonia Extreme Series.
4. Emergency Lighting Units: Lead Calcium batteries with self-diagnostics. Provide full light output at 90 minutes of battery operation. LED lamps.
5. Gymnasium light fixtures, glass or acrylic refractors or lenses, round profile, single point swivel pendant or hook mounting, designed to be vandal proof without the need for wire guards, no wire guards.

C. LED drivers:
1. NEMA 410 compliant for in-rush current.
2. Starting Temperature: -40˚ F [-40˚ C].
3. Input Voltage: 120 to 480 (±10%) V.
4. Power Supplies: Class I or II output.
5. Surge Protection: The system must survive 250 repetitive strikes of “C Low” (C Low: 6kV/1.2 x 50 µs, 10kA/8 x 20 µs) waveforms at 1-minute intervals with less than 10% degradation in clamping voltage. “C Low” waveforms are as defined in IEEE/ASNI C62.41.2-2002, Scenario 1 Location Category C.
6. Power Factor (PF): ≥ 0.90.
7. Total Harmonic Distortion (THD): ≤ 20%.
8. Comply with FCC Title 47 CFR Part 18 Non-consumer RFI/EMI Standards.
9. Drivers shall be reduction of hazardous substances (ROHS)-compliant.

D. Voltage: Equipment for use on 120V systems shall be suitable and guaranteed for voltage range of 100V to 130V. Equipment on 277V systems shall be suitable and guaranteed for voltage range of 225V to 290V. Universal voltage equipment shall be suitable and guaranteed for a voltage range of 100V to 290V.

E. Light fixture housing for exterior use: Provide aluminum or stainless housing. Where stainless steel hardware is used, both male and female fasteners shall be stainless steel.

F. Emergency LED battery self-testing drivers and inverters; 5-year warranty. Basis of Design:
1. Bodine BSL-ST Series for OEM installation
2. Bodine BSL310-SI Series for field installation
3. Bodine ELI-S Series for line voltage sine wave inverter field installation

G. Emergency Battery Packs – Exit Signs: Nickel Cadmium battery with self- diagnostics; Minimum 3-year non-prorated replacement warranty.

H. Emergency Generator / Inverter Load Control Device (ELC):
1. 16 Amp minimum ballast / driver load
2. Compatible with 0-10 Volt dimmer switches
3. UL 924
4. Minimum 3-year warranty
5. Integral or remove test switch.

I. Emergency Generator / Inverter branch circuit transfer switch:

1. UL 1008
2. 20 Amp ballast/driver load
3. 0-10Vdc dimming compatible

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install lighting fixtures of the types indicated, where shown, and at indicated heights in accordance with the fixture manufacturer's written instructions and industry practices to ensure that the fixtures meet the specifications. Fixtures shall fit the type of ceiling system scheduled.

B. Standards: Comply with NEMA standards, applicable requirements of NEC pertaining to installation of interior lighting fixtures, and with NECA Standard of Installation.

C. Attachment: Fasten fixtures to the indicated structural support members of the building. Provide four separate wire supports for recessed ceiling mounted lighting fixtures, one at each corner of fixture. Check to ensure that solid pendant fixtures are plumb. Provide T-bar locking clips on all four sides for lay-in fixtures.

D. Coordination: Field coordinate and locate lighting fixtures in open ceiling areas including mechanical and electrical rooms so that light is not obstructed by piping, ductwork, etc. Locate light fixtures in front of electrical and mechanical equipment to provide adequate illumination for testing and maintenance. Relocate installed light fixtures as directed by Owner / Architect at no additional cost.

E. Final adjustment of all aimable exterior light fixtures shall be in coordination with, and to the satisfaction of, the Owner’s designated representative. Pre-aim all fixtures prior to scheduled final aiming and adjustment with Architect / Owner. Verify that all rotatable optics are in their proper orientation prior to final aiming.

F. Provide vandal resistant exit signs without wire guards in all physical education and athletic sports areas, including egress corridors adjacent to these areas, black box theaters, auditorium stages, vocational shops, cafetoriums and kitchens.

G. Provide exit sign directional arrows as required. Provide a minimum of two and a maximum of 10% spare exit signs to be installed as directed by Architect.

H. Install in accordance with manufacturers instructions.

I. Install suspended luminaires using pendants supported from swivel hangers. Provide pendant length required to suspend luminary at indicated height.

J. Locate recessed ceiling luminaires as indicated on the Architectural reflected ceiling plan.

K. Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prohibit movement.

L. Exposed Grid Ceilings: Support surface mounted luminaires on grid ceiling directly from building structure. Provide auxiliary members spanning ceiling Ts to support surface mounted luminaires. Fasten surface mounted luminaires to ceiling T using bolts, screws, rivets, or suitable clips.

M. Install recessed luminaires to permit removal from below.

N. Install recessed luminaires using accessories and fire stopping materials to meet regulatory requirements for fire rating.

O. Install wall-mounted luminaires at height as directed by Architect.

P. Install accessories furnished with each luminary.

Q. Connect luminaires to branch circuit outlets using flexible conduit as specified.

R. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaires.

S. Bond products and metal accessories to branch circuit equipment grounding conductor.

T. Provide emergency transfer devices for light fixtures powered by generator or inverter emergency lighting circuits which are used for normal lighting and to be switched with the switched normal lighting circuit in the same room, corridor or area.

U. Provide un-switched, constant-hot circuit to all battery powered emergency lighting equipment and emergency load control devices (ELC). Where normal light fixture circuit is switched or contactor controlled, non-switched battery charging or ELC circuit shall originate from same branch circuit breaker as switched lighting circuit.

V. Provide emergency powered light fixture in front of all electrical switchgear, including but not limited to panelboards, switchboards, motor control centers, low voltage control panels, transfer switches, motor controllers and disconnect switches.

W. Provide emergency battery operated light fixtures at all transfer switch locations and at all central battery emergency lighting inverters.

X. Provide automatic controls for exterior light fixtures. Exterior building mounted light fixtures shall be circuited through lighting contactors. Lighting contactors shall be controlled by the Building Management System. Provide separate lighting contactors for:
   1. Parking Lot Lighting
   2. Building Mounted Lighting
   3. Exterior Signage

Y. Lighting contactors shall not be installed above ceiling and shall be readily accessible, located in same room as panelboard serving load.

Z. Wall mounted light fixtures shall be attached to the studs in the walls. Attachment to gypsum board only is not acceptable. Where wall mounted fixtures attach to junction box only, firmly secure junction box to adjoining studs in wall.

AA. Lighting Fixture Supports:
   1. Shall provide support for all of the fixtures. Supports may be anchored to channels of the ceiling construction to the structural slab or to structural members within a partition, or above a suspended ceiling.
   2. Shall maintain the fixture positions after cleaning and relamping.
   3. Shall support the lighting fixtures without causing the ceiling or partition to deflect.

BB. Hardware for surface mounting fixtures to suspended ceilings:
   1. In addition to being secured to any required outlet box, fixtures shall be bolted to a grid ceiling system at four points spaced near the corners of each fixture. The bolts shall be not less than 1/4 inch secured to channel members attached to and

spanning the tops of the ceiling structural grid members. Non-turning studs may be attached to the ceiling structural grid members or spanning channels by special clips designed for the purpose, provided they lock into place and require simple tools for removal.

2. In addition to being secured to any required outlet box, fixtures shall be bolted to ceiling structural members at four points spaced near the corners of each fixture. Pre-positioned 1/4-inch studs or threaded plaster inserts secured to ceiling structural members shall be used to bolt the fixtures to the ceiling. In lieu of the above, 1/4-inch toggle bolts may be used on new or existing ceiling provided the plaster and lath can safely support the fixtures without sagging or cracking.

CC. Lighting Fixture Supports for aluminum canopies:

1. Light fixtures mounted under aluminum canopies shall be UL wet location from above listed without a protective ceiling or cover. Light fixture shall not have conduit penetrations or mounting hole penetrations field made in the top of the fixture. Conduit penetration shall be at the end of the fixture only.

3.2 TESTING

A. General: Upon installation of lighting fixtures, and after building circuits are energized, apply electrical energy to demonstrate proper operations of lighting fixtures, emergency lighting, and controls. When possible, correct malfunctioning units at the site, then retest to demonstrate proper operation; otherwise, remove and replace with new units, and proceed with retesting.

B. Pre-Inspection Tasks: Immediately before final inspection, clean fixtures inside and out, including plastics and glassware, adjust trim to fit adjacent surfaces, replace broken or damaged parts, and lamp and test fixtures for electrical and mechanical operations. Any fixtures, or parts of fixtures that show signs of rust or corrosion at the time of completion, shall be removed, and replaced with protected metal parts.

C. Final aiming and Adjustment: Aim and adjust aimable and adjustable lighting fixtures for their intended purpose. Re-aim and re-adjust as required to the satisfaction of the Architect / Owner, including nighttime adjustment of exterior lighting in the presence of the Architect / Owner.

END OF SECTION

SECTION 27 01 00

COMMUNICATIONS OPERATING AND MAINTENANCE MANUALS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Compile product data and related information appropriate for Owner's operation and maintenance of products furnished under Contract. Prepare 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 Speakers, Amplifiers, Sound Equipment, Etc.
   12. Schedule of Handsets and other Peripheral Devices, Etc.
   13. Schedule of Cable, Jacks, Outlets, Etc.
   14. Other required operating and maintenance information that are complete.
   15. Cable pathway layout drawings and station map

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) 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. Manufacturer's printed operating and maintenance instructions.
   e. Original manufacturer's parts list, illustrations, assembly drawings and diagrams required for maintenance.
   f. Schedule of fuses
   g. Complete equipment field accessible wiring diagrams
   h. Each Contractor's coordination drawings
   i. 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 27.
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 27 05 00

COMMUNICATIONS GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Except as modified in this Section, General Conditions, Supplementary Conditions, applicable provisions of Division 01 General Requirements, and other provisions and requirements of the Contract Documents apply to work of Division 27 Communications.

B. Applicable provisions of this section apply to all sections of Division 27, Communications.

C. The general provisions of the Contract and the requirements of the following Sections apply to the Work specified in this Section. See Division 26 for related general and specific requirements.

1.2 CODES AND STANDARDS

A. All equipment and work performed shall comply with all of the current and applicable Codes, Rules, Ordinances, Regulations and Standards (including those not specifically listed in this Specification) as interpreted and enforced by the authorities having jurisdiction including:
1. Americans with Disabilities Act (ADA)
2. Authorities Having Jurisdiction (AHJ) - Local
3. American National Standards Institute (ANSI)
4. American Society of Testing and Materials (ASTM) *Communications Cables - B694, B736, D4565, D4566, D4730, D4731, D4732*
5. Building Industry Consulting Services International (BICSI)
6. Code of Federal Regulations - Title 47
7. Electronics Industries Association (EIA) *Standard Test Procedures for Fiber Optic Fibers, Cables, Transducers, Connecting and Terminating Devices - EIA-455 Series*
8. Federal Communications Commission (FCC) - Communications Act and FCC Rules
9. Federal Information Processing Standards (FIPS) *Federal Building Standard for Telecommunications Pathways and Spaces - FIPS PUB 175, FIPS PUB 176*
10. The Insulated Cable Engineers Association (ICEA) *Communications Cable Stands - P-47-434, S-56-434, S-80-576, S84-608, S-85-625, S-86-634, S-87-640, S-89-648, S-90-661, S-98-688, S-99-689, S-100-685*
11. International Electro-technical Commission (IEC)
12. Institute of Electrical and Electronic Engineers (IEEE) *Local Area Networks/Metropolitan Networks Standards Collection - LAN/MAN 802 Series*
13. International Organization for Standardization (ISO) (ISO/IEC) *Premise Wiring Core and LAN/MAN Core Equivalents-11801, 8802, 14763-1*
14. International Telecommunication Union (ITU-T) *Telecommunications Standardization*
15. National Electrical Code (NEC) *National Electrical Code - NFPA 70*
16. National Electrical Contractor's Association (NECA) *Standards of Installation*
17. National Electrical Manufacturers Association (NEMA) *Performance Standard for Twisted Pair Premise Voice and Data Communications Cable-WC 63.1, WC 63.2, WC 66*
18. National Electrical Safety Code (NESC)
19. National Fire Protection Association (NFPA) - *National Fire Alarm Code NFPA 72, Life Safety Code NFPA 101*

20. Society of Cable Telecommunications Engineers (SCTE)
21. Local Accessibility Standards
22. Telecommunications Industries Association (TIA) *(ANSI/TIA/EIA) Wiring and Cabling Standards - 526, 568, 569, 570, 571, 598, 606, 607, 758, TSB 31-B, 63, 67, 72, 75 and 95*
23. Uniform Building Code (UBC)
24. Underwriters Laboratories, Inc. (U.L.) - *497A, 910, 1077, 1863, 1283, 1459, 1604, 1651, 1681, 1690, 1778, 1977*

B. 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.

C. 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.

D. Obtain all permits required.

1.3 SUMMARY

A. Provide complete and working Communications Systems including equipment, conduit, wiring, material, labor and training as described in this Specification and the Drawings. The Communications Systems Drawings and Specifications are the sole property of the Architect and are not to be duplicated, scanned, loaned or in any way made available to persons not designated as authorized by the Architect. All Communications Systems plans and specifications are to be returned to the Architect following completion of bid.

1.4 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.

1.5 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 connections to all communications equipment indicated on the drawings, except as noted.

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.

1.6 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.

1.7 GUARANTEE

A. Guarantee work for a minimum of two years or as noted longer elsewhere 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.

1.8 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.

1.9 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.

1.10 ACCEPTABLE MANUFACTURERS

A. Manufacturers names and catalog number specified under sections of Division 27 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 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 complete design and performance data to the Architect. The Architect and Owner issue approvals of acceptable manufacturers as addenda to the Construction Proposal Documents.

1.11 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.

1.12 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. 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.

1.13 ABBREVIATIONS AND DEFINITIONS

A/V	Audio/Visual
AWG	American Wire Gauge
BCR	Building Communications Room
CATV	Cable Antenna Television
CCTV	Closed Circuit Television
CMP	Communications Media Plenum
CMR	Communications Media Riser
dB	Decibel
EMI	Electromagnetic Interference
ER	Equipment Room
FACP	Fire Alarm Control Panel
FCR	Floor Communications Room
Gbps	Giga Bits Per Second
Hz	Hertz
IC	Intermediate Cross-connect
IDF	Intermediate Distribution Frame
IM	Information Management
IS	Information Systems or Information Services (also see MIS)
IT	Information Technology
Km	Kilometer
LCD	Liquid Crystal Display
LED	Light Emitting Diode
M	Micron
MATV	Master Antenna Television *(A.K.A. Main Antenna Television)*
Mbps	Mega Bits Per Second
MC	Main Cross-connect
MDF	Main Distribution Frame
MHz	Megahertz
MIS	Management Information Systems or Services
NEXT	Near-End Cross Talk
nm	Nano-meter
OFN	Optical Fiber Non-conductive
OFNP	Optical Fiber Non-conductive Plenum
OFNR	Optical Fiber Non-conductive Riser
OTDR	Optical Time Domain Reflectometer
PBX	Private Branch Exchange

POS	Point of Sale
PSELFEXT	Power Sum Equal Level Far-End Cross Talk
PSNEXT	Power Sum Near-End Cross Talk
SMATV	Satellite Main Antenna Television
TC	Telecommunications Closet *(Now referred to as TR)*
T.O.	Telecommunications Outlet
TR	Telecommunications Room *(A.K.A. TC - Telecommunication Closet)*
UTP	Unshielded Twisted Pair Wire

Definitions:

Administration Subsystem - Cable, connectors, cross-connect and inter-connect hardware, patch cords, and other equipment that allows easy reconfiguration of the telecommunications system to accommodate personnel and floor plans changes.

Campus Backbone Subsystem - Connects telecommunications processing equipment in different buildings on the same campus.

Communications Cabling - Any fiber optic, copper, coaxial or other transmission media used for transmitting or receiving communications systems data.

Communications System - Communications Systems and associated wired or wireless interconnection.

Communications Drawings - All floor plans, elevations, details, schematics, block diagrams, legends, tables, notes or attachments associated with any or all of the Communications Systems.

Distribution Cable - The telecommunications UTP wiring between the telecommunications room and the outlet connectors.

Equipment Subsystem - Telecommunications cable, connectors, support hardware, blocks, and protective devices that serve to connect the network interface and the backbone subsystem through the administrative subsystem.

Horizontal Subsystem - Telecommunications cable, outlets and distribution cords that extend the riser backbone from the administrative points in the TRs to work stations.

Information Systems - Software systems including operating systems, programs, data manipulation and management systems, control software and various forms of proprietary and off-the-shelf software.

Information Technology - The practical application of knowledge associated with designing, installing and maintaining the equipment, hardware and infrastructure utilized for control, distribution, or display of telecommunications, audio, video and data signals. Because computers are central to information management, computer departments within companies and universities are often called (IT Departments) and are responsible for MIS or IS personnel and services.

Low Voltage Wire - Wire or cable used for one or more systems that operate on 24 volts or less. Low Voltage Wire is used to install and interconnect one or more of the Communications Systems. Low Voltage Wire includes patch cords, jumpers and all portions of cable or wire used to make the Communications Systems operational or for system communications.

Management Information Systems - A class of software that provides managers with tools for organizing and evaluating their department. Typically, MIS systems are written in COBOL and run on mainframes or minicomputers. Within companies and large organizations, the department responsible for computer systems is sometime called the MIS department. Another name for MIS is Information Services (IS).

Multiplexer - A communications device that multiplexes (combines) several signals for transmission over a single medium. A multiplexer is sometimes called a "mux". A demultiplexer is required to complete the process by separating multiplexed signals from a transmission line. Frequently a multiplexer and demultiplexer are combined into a single device capable of processing both outgoing and incoming signals.

Riser Backbone Subsystem - Telecommunications cable, splice enclosures, and associated hardware that provide the main cable routes in a building. It interconnects building floors and larger areas of a single floor. It also interconnects administrative points in satellite TRs to the administrative points in the building main equipment room.

Station Cable - The wiring between the outlet connections and the work area equipment.

Communications Systems - One or more of the following and associated equipment: Data/Networking Systems, Telecommunications Systems, Paging / Intercom Systems, Clock/Control Systems, Master Antenna Television Systems, Cable Antenna Television Systems, Broadcast Video Systems, Audio/Visual Presentations Systems, Microwave/Wireless Systems.

Telecommunications - The transmission, emission or reception of signs, signals, images, sound or intelligence of any nature by wire, radio, optical or other technical transmission system.

Work Area - Location of an employee or student and their data/telecommunications equipment or devices.

Work Area Subsystem - Station mounting cords, extension cords, connectors, adapters, and interface units that provide physical and electrical connectivity between workstation equipment and the horizontal subsystem.

1.14 QUALITY ASSURANCE:

A. Equipment Standards:
   1. System and all components shall be brand new stock from manufacturer.
   2. All electronics shall be 100% solid state.
   3. System and all components shall bear a UL Label.

B. Contractor Qualifications:
   At the time of Proposal, the Contractor shall:
   1. Have manufactured, supplied or installed at least three (3) other systems of similar size, complexity, and general operation as the systems described in these specifications. The Contractor shall furnish in writing to Architect proof of compliance with this paragraph at the time of proposal.
   2. Hold all legally required Texas State Contractor's licenses necessary to accomplish the installation and activation of the described system at the facilities indicated. The Contractor shall submit copies of licenses to the Architect prior to the start of work
   3. Hold all legally required state registrations to meet local requirements for submittal drawings.

4. Have a local office within fifty (50) miles of the project site staffed with factory trained technicians who have experience on systems of similar complexity and function as the systems described in these specifications. These technicians shall be fully capable of system engineering support, installation supervising, system start-up, and providing the Owner with training and service on both hardware and software for the systems specified.
5. Certify complete and total compliance with the provisions of these specifications by letter or submittal of the proposal response forms, signed by an officer of the corporation, or a principal if other ownership currently exists. In addition, the letter or forms shall include a complete listing of exceptions, if any.

1.15 SUBMITTALS

A. Provide SUBMITTALS according to Division 01 and the following.

B. Requirements:
1. Submit paragraph-by-paragraph specification review indicating compliance or deviation with explanation.
2. Submit proof that all system components and cables are U.L. Listed.
3. An equipment list with names of manufacturers, model numbers, and technical information on all equipment proposed. Clearly mark exact model number proposed to be installed.
4. Product technical information sheets for each principal components in the proposed system, including cable, wire, terminal marking, and wire marking material.
5. Certification from the manufacturer stating that the system Contractor is an authorized distributor or installer of the proposed system when such certifications exist.
6. A statement listing every technical and operational parameter wherein the submitted equipment varies from that which was originally specified. If the submitter fails to list a particular variance and his submittal is accepted, but is subsequently deemed to be unsatisfactory because of the unlisted variance, the submitter shall replace or modify such equipment at once and without cost to the Owner.

1.16 EXAMINATION OF SITE

A. The Contractor shall have visited the site and familiarized himself with all existing conditions prior to submitting his proposal and shall be prepared to carry out the work within the existing limitations. Failure or neglect to do so shall not relieve the Contractor of his responsibilities not entitle him to additional compensation for work overlooked and not included in his proposal.

B. The Contractor shall confirm the availability of the proper power source for each piece of specified equipment, through site visits and Drawings as necessary. Where proper power does not exist, the Contractor shall provide the required power, circuits, outlets, conduits, and wire as specified under Division 26.

1.17 DATA ACCURACY

A. Absolute accuracy of information regarding existing conditions cannot be guaranteed. The Drawings and Specifications are for the assistance and guidance of the Contractor and exact locations, distances, elevations, etc., shall be governed by actual field conditions. Where variations from the contract documents are required, such variations shall be approved by the Architect / Owner.

1.18 SECURITY

A. The Contractor is responsible for complying with all of the Owner's and facility security's requirements to prevent theft or damage to equipment, tools and materials. If any deviation from facility security requirements is necessary, approval for such deviation shall be coordinated with the Owner.

B. The Contractor shall not disclose any confidential information of the Owner. The Contractor acknowledges that such action is highly injurious and can do damage to the Owner. The Contractor will agree to and comply with the standard policies and provisions of the Owner regarding outside Contractors and Consultants.

1.19 UTILITIES

A. It shall be the responsibility of the Contractor to provide all temporary connection and cables, lighting, light stands and power. The facilities shall be used in accordance with all applicable regulations regarding operations, safety and fire hazards of the governmental Authorities Having Jurisdiction, provided they are not used in a wasteful manner.

1.20 PERMITS

A. All permits required for the specified performance and completion of the work shall be secured by the Contractor. These permits shall be presented and reviewed at the initial project progress meeting.

1.21 NOTIFICATION

A. The Contractor shall not shut off any existing systems. The Contractor shall give the Owner at least ten (10) calendar day’s notice of any requirements to shut off or interference with existing alarm, regulating, computer or other service systems. The Owner will arrange and execute any shutdown. All work such as splicing, connections, etc., necessary to establish or re-establish any system shall be completed by the Contractor in close coordination with the Owner.

1.22 INTERFERENCES WITH THE OWNER

A. Transportation and storage of materials at the facility, work involving the facility, and all other matters affecting the habitual use by the Owner of its buildings, shall be conducted so as to cause the least possible interference, and at times and in a manner acceptable to the Owner. The Contractor shall make every effort to delivery equipment per the schedule required by the project.

1.23 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 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 underslab cables installed, dimensioning exact location and elevation of such installations.

B. At conclusion of project, obtain without cost to the Owner, electronic AutoCAD 2014 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, reproducible and prints is a condition of final acceptance.

1. 3 sets of electronic AutoCAD (2014 dwg) 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 or black-line prints of each contract as-built drawing.

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 AS-BUILT DRAWINGS.
4. Clearly indicate: DOCUMENT PRODUCED BY:
5. Indicate all changes to construction during construction. Indicate actual routing of all conduit and cables, etc that were deviated from construction drawings.
6. Indicate exact location of all underground communications 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 communications equipment in building. Label panel schedules to indicate actual location.
10. Exact location of all communications equipment in and outside of the building.
11. Location, size and routing of all communications cables, conduits, equipment, etc. shall be accurately and neatly shown to dimension.
12. Exact location of all roof mounted equipment, wall, roof and floor penetrations.
13. Cloud all changes.

1.24 OPERATING TESTS

A. After all communications 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.

1.25 WARRANTY

A. All equipment shall be covered for the full manufacturers warranty period and systems shall be warranted by the Contractor for a period of two years commencing with the filing date of substantial completion. The Warranty shall cover all costs for warranty service, including parts, labor, prompt field service, pick-up, transportation, delivery, reinstallation, and retesting. A contract for service shall cover the period starting with the first expected activation of each system and shall continue without interruption to cover the period to the end of the two-year warranty as defined above. The end of the warranty period shall be handled such that a smooth transition to a maintenance agreement with the Owner shall be achieved with no lapse in coverage.

B. Submit 3 copies of all warranties and guarantees for systems, equipment, devices and materials. These shall be included in the Operating and Maintenance Manuals.

1.26 BUILDING CONSTRUCTION

A. It shall be the responsibility of the sub-contractor to consult the Architectural and Engineering 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 piping, cables, pathways, raceways, and other items are placed in the walls, furred spaces, chases, etc., so that there shall be no delay in the job.

1.27 TEMPORARY FACILITIES

A. General: Refer to Division 01 for general requirements on temporary facilities.

B. Temporary Wiring: Temporary power and lighting for construction purposes shall be provided under Division 26. Installation of temporary power shall be in accordance with NEC Article 305.

C. Temporary facilities, wire, lights and devices are the property of this Contractor and shall be removed at the completion of the Contract.

1.28 EXTRA MATERIALS

A. Keys: Provide three (3) sets of all keys for system cabinets.

PART 2 - PRODUCTS

2.1 WORK INCLUDED

A. All materials listed in PART 2 - PRODUCTS of this Division Sections and on the Drawings shall be provided by the Contractor unless specifically excluded or modified in other portions of this Specification or Addendums.

PART 3 - EXECUTION

3.1 INSTALLATION

A. This project has a critical path, which must be closely followed in order to meet the completion date. The Contractor shall review the proposed schedule at the Award of Contract meeting and be prepared to staff his work force according to the schedule constraints presented at that time.

B. Aesthetics are an important consideration in this installation. All components shall be installed so as to have aesthetically pleasing results as determined by the Owner and Architect. Actual locations of all visible components shall be coordinated in advance with the Owner and Architect.

C. Install, make fully operational and test the system as indicated on the Drawings and in the Specifications. Where information is not available the worst-case condition must be assumed to ensure a complete, functional system.

D. Any interfacing with other systems shall be the Contractor's responsibility under this contract, and the details, both logical and physical, of such interfaces shall be reflected in the Submittals and As-Built drawings.

E. If appropriate, interfaces with the Owner's Data Network, Telecommunications and Communications System shall be coordinated with the Owner and Architect.

F. All necessary back boards, back-boxes, pull-boxes, connectors, supports, conduit, cable and wire shall be furnished and installed to provide a complete and reliable system. Exact location of all backboards, boxes, conduit and wiring runs shall be presented to the Owner / Architect for approval in advance of any installation. Provide as required and as specified in Division 26.

G. Where required provide 120-VAC, 60 Hz power from nearest electrical panel through a junction box, to the system devices. Provide as required and as specified in Division 26.

H. Where required, install conduit, cable and wire parallel and square with building lines, including raised floor areas. Conduit fills shall not exceed 40%.

I. All equipment shall be mounted with sufficient clearance to minimize EMI as well as meet all applicable codes and facilitate observation and testing. Securely hand and/or fasten with appropriate fittings to ensure positive grounding, free of ground loops, throughout the entire system. Units shall be installed parallel and square to building lines.

J. Quiet and vibration-free operation of all equipment is a requirement of this installation. Properly adjust, repair, balance or replace any equipment producing objectionable (in the judgment of the Owner or Architect) noise or vibration in any of the occupied areas of any building and provide additional brackets and bracing if necessary. Any such additions or changes shall be at no additional cost to the Owner.

K. Installation shall comply with the CODES AND STANDARDS portion of this Section. Where more than one code or regulation if applicable, the more stringent shall apply.

L. Where new equipment is replacing old equipment, the Contractor is responsible for removing and disposing of the old equipment and doing whatever repair work is necessary as specified by the Owner / Architect.

M. Install firestopping, as specified in Division 26 for all penetrations in slabs and firewalls to meet code at the completion of work and prior to final testing demonstration to the Owner.

N. The installation shall be performed in a professional manner.

O. On a daily basis, clean up and deposit in appropriate containers all debris from work performed under the appropriate specification sections. Stack and organize all parts, tools and equipment when not being used.

P. Preparation, handling and installation shall be in accordance with the Manufacturer's written instructions and technical data appropriate to the product specified.

Q. All work shall conform to the National Electrical Contractor's Association "Standard of Installation" for general installation practice.

R. At the conclusion of the installation, all work areas, including all enclosures and boxes, shall be vacuumed and cleaned to remove all debris and grease.

3.2 COORDINATION WITH OWNER / ARCHITECT

A. Close coordination with the Owner / Architect is vital to achieve a complete, aesthetically pleasing job. The Contractor shall ensure that the Owner / Architect is kept fully apprized of job progress.

3.3 CUTTING, PAINTING, AND PATCHING

A. Structural members shall not be drilled, bored or notched in such a manner that shall impair their structural value. Cutting of holes in structural members, if required, shall be done with core drills and only with the specific approval of the Owner / Architect for each instance.

B. All walls that require cutting or repair during the installation process shall be returned to their original condition, including the matching of colors and finishes to the satisfaction of the Owner / Architect, and at no additional cost to the Owner.

3.4 WIRE AND CABLE

A. All low voltage cable shall be low smoke plenum rated, limited energy, with 300-volt insulation.

B. All wires in exposed areas shall run through conduit as specified in Division 26.

C. Provide conduits, cable trays, raceways, wireways, boxes and outlets as specified in Division 26.

D. After installation, and before termination, all wiring shall be checked and tested to insure there are no grounds, opens, or shorts on any conductors. In addition, all wires between buildings or underground and all coax cables shall have insulation tested with a megohmeter (megger) and a reading of greater than 20 megohms shall be required to successfully complete the test.

E. Run wires continuously from termination to termination without splices.

F. Wire and cable shall be supported in each equipment and terminal cabinet and in each terminal and pull box in vertical risers and horizontal runs with wire duct and strap-type supports. At any point where wire duct is required for good wire management, whether shown on elevations or not, install appropriate duct. Where terminal boards are used, wire ducts shall be supplied on both sides and at not rime shall wires cross over terminal boards. Arrange cables neatly to allow inspection, removal and replacement. Lace cables as required. Spot tie wire bundles with plastic cable ties and securely affix to panels. If screw type terminals are specified, terminal strip connections shall be locking, tongue style, pressure crimp, and solderless spade lug.

G. Visually inspect wire and cable for faulty insulation prior to installation. Protect cable ends at all times with acceptable end caps except during actual termination. At no time shall any coaxial cable be subjected to a bend less than a 6-inch radius. Protect wire and cable from kinks. Install 1 pull rope for all 2” or larger sized conduits.

H. Provide plastic bushings and strain relief material at all conduit exit points and where necessary, to avoid abrasion of wire and excess tension on wire and cable.

I. Cables above accessible ceilings shall not rest on ceiling tiles. Use Velcro tie wraps, J-hooks or D-rings to hold cables. Provide independent support for all cables. Support is to be from building structure (do not support from pipes or conduits). Communications cables shall not tie off on HVAC supports, all-thread, ceiling grid hanger wire or electrical / mechanical piping system.

J. Ground and bond equipment and circuits in accordance with NEC and Division 26.

3.5 IDENTIFICATION AND TAGGING

A. All cables, wires, wiring forms, terminal blocks and terminals shall be identified by labels, tags to other permanent markings in accordance with TIA/EIA-606. The markings shall clearly indicate the function, source, or destination of all cabling, wiring and terminals. All cables and wires shall be identified, utilizing heat-shrink, machine printed, polyolefin wire markers (Brady Type B-32 *or equal*). Hand written tags are not acceptable.

B. Should a situation arise where the wire tagging format as shown on the drawings cannot be used, a substitute format shall be submitted which complies with the intent to provide documentation that will permit end-to-end tracing of all Communications Systems wiring.

C. All panels shall be provided with permanently attached engraved lamacoid labels with identifying names and functions. All terminal points shall be appropriately labeled. Labels shall be consistent in form, color, and typeface throughout the system and all must contain the name of the system or subsystem as part of the label textual information. Design, color, font and layout shall be coordinated with, and approved by, the Owner.

D. 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.
   2. A black-white-black 3 layer laminated plastic engraved identifying nameplate shall be permanently secured to each wireway, terminal cabinet, and communications (voice, data, video) cabinet or rack.
      a. Identifying nameplates shall have 1/2-inch high, engraved letters. For equipment designation and ¼-inch letters indicating source circuit designation, (ie: “IDF(FCR) XXYY –served from MDF (BCR) XXGG).
   3. Permanent, waterproof, black markers shall be used to identify each communications grid junction box, clearly indicating the type of system available at that junction box.
   4. Pull Boxes: Field work each with a nameplate showing identity, and identifying equipment connected to it. Nameplates shall also indicate where pull box is fed from.
   5. Communication hardware located above accessible ceilings: Provide ½-inch high black name plate with white 1/4-inch letters glued to bottom of t-grid ceiling below hardware located above ceiling. Identification shall be as short as possible yet identifying device above ceiling, i.e. “A/V-EQ”.

E. 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.

F. Warning Signs: Provide warning signs where there is hazardous exposure associated with access to or operation of communications 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.

G. Wire and Cable Labeling: Provide wire markers on each conductor in all boxes, pull boxes, gutters, wireways. Identify with drop/circuit number.

H. Underground Warning Tape: Thomas and Betts or approved equal. Six-inch wide plastic tape, colored red or orange with suitable warning legend describing buried communications lines. All underground 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 conduits.

3.6 CUTTING AND PATCHING

A. General: Comply with the requirements of Division 01 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.

3.7 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 communications 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.

B. Time to be allocated for instructions.
1. Minimum of 20 hours dedicated instructor time
2. 4 hour on each of 5 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.

3.8 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.

3.9 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.

3.10 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.

B. Proof of delivery of these items to the Owner shall be included in the Operating and Maintenance Manuals.

3.11 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.

3.12 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 location shown.
   2. Provide minimum of two 4-ft. by 4-ft. sheets of plywood for each communications location.

3.13 SITE MANAGEMENT RESPONSIBILITY

A. The Contractor shall provide an on-site Project Manager as defined in SUPERVISION OF WORK portion of this Section.

3.14 START-UP RESPONSIBILITY

A. The Contractor shall initiate System operation. The Contractor shall provide competent Start-Up personnel on each consecutive working day until all Communications Systems are functional and ready to start the acceptance test phase. If the Contractor, in the Owner / Architect's judgment, is not demonstrating progress in solving any technical problems, the Contractor shall supply Manufacturer's factory technical representation and diagnostic equipment at no cost to the Owner, until resolution of those defined problems. Where appropriate, the Contractor shall bring the Systems on-line in their basic state (i.e., alarm reporting, facility code access control, etc.) It is the responsibility of the Owner to provide the specific database information that will be utilized for initial system programming.

B. Properly ground each piece of electronic equipment prior to applying power. Properly ground all shielded wire shields to the appropriate earth ground at the hub end only, not at the remote or device end.

C. Use a start-up sequence that incrementally brings each portion of the system on-line in a logical order that incorporates checking individual elements before proceeding to subsequent elements until the entire system is operational. The basic steps should include:
   1. Establish ground planes at the equipment rooms and hub end of the systems as specified in Division 26.
   2. Disconnect power, connect the first device, reconnect power, and verify operational correctness. Repeat until the entire system is verified and operational.

3.15 PREPARATION FOR ACCEPTANCE (SUBSTANTIAL COMPLETION)

A. All systems, equipment, and devices shall be in full and proper adjustment and operation, and properly labeled and identified.

B. All materials shall be neat, clean and unmarred, and parts securely attached.

C. All extra material as specified shall be delivered and stored at the premises as directed.

D. Test reports of each system and each system's components and As-Built Project Drawings shall be complete and available for inspection and delivery as directed by the Owner.

3.16 SYSTEM ACCEPTANCE REQUIREMENTS

A. Before final acceptance or work, the Contractor shall perform and/or deliver each of the following in the order stated.

B. The Contractor shall deliver three (3) composite "System Operations and Maintenance" manuals in three-ring binders, sized to hold the material below, plus 50% excess. Each manual shall contain in appropriately tabbed sections:
   1. A statement of Guarantee including date of termination and the name and phone number of the persons to be called in the event of equipment failure.
   2. A set of Operating procedures for the overall System that includes all required Owner activities, and that allows for the Owner operation of all attributes and facilities of the System.
   3. A section for each specific type of equipment containing the vendor manuals, instruction sheets, and any related literature that cam in the original shipping container for that piece of equipment. Include all warranty cards.

C. Testing:
1. The Contractor shall perform all tests required by Division 26 and those submitted as part of this Section.
2. The Contractor shall activate all devices for proper system operation, including supervisory and trouble circuit tests. Similarly, audible alarms will not be activated except on a one-time, coordinated basis, to check the actual sounding devices.
3. A test report for each piece of equipment shall be prepared by the Contractor and submitted to the Owner. This report shall include a complete listing of every device, the date it was tested, by whom and the results. The final test reports shall indicate that every device tested successfully. Failure to completely test and document the tests will result in a delay of final testing and acceptance.

D. As-Built Drawings:
1. After completion of all the tests listed above, and prior to the final acceptance test, The Contractor shall submit the complete As-Built drawings as identified in PART 1 – PROJECT RECORD DRAWINGS.
2. The final As-Built Drawings shall consist on one set of reproducible prints, two (2) sets of Point-to-Point Detail Drawings, Equipment Schedules, and the complete detailed technical data that was shipped by the manufacturer with all installed equipment.

E. Final Acceptance Test: The Final Acceptance Test shall demonstrate the installed and activated System's performance and compliance with System Specifications. However, before this testing can begin the following must have received and reviewed by the Owner.
1. System Operations and Maintenance Manuals
2. System Test Reports
3. As-Built Drawings

3.17 NOTICE OF COMPLETION

A. When the Final System Acceptance Requirements described above including the Final Acceptance Test described above have been satisfactorily completed. The Owner / Architect shall issue a Letter of Completion to the Contractor indicating the date of such completion. The Notice of Completion shall be recorded by the Contractor upon receipt of the Owner / Architect completion letter. This date of record shall be the start of the warranty period.

END OF SECTION

SECTION 27 05 07

COMMUNICATIONS SHOP DRAWINGS, COORDINATION DRAWINGS & PRODUCT DATA

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Prepare submittals as required by Division 01 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 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 relation to adjacent or critical features or work or products.

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: 1/4"=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 room containing technology equipment and each rack with technology equipment, submit plan and elevation drawings. Show:
1. Actual technology equipment and components to be furnished.
2. NEC working space and NEC access to NEC working space.
3. Relationship to other equipment and components and openings, doors and obstructions
4. Rack location and dimensions

D. Identify field dimensions. Show relation to adjacent or critical features of work or products.

E. Verify location of communications station devices, telephone outlets and other work

specified in this Division.

1. Coordinate with drawing details, site conditions and millwork shop drawings prior to installation.
2. Where required for clarification, submit shop drawings prior to rough-in and fabrication.

F. Submit shop drawings in plan, elevation and sections, showing outlets and other devices in casework, cabinetwork and built-in furniture.

1.4 PRODUCT DATA

A. 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.

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 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:)

1.5 MANUFACTURERS INSTRUCTIONS

A. Submit Manufacturer's instructions for storage, preparation, assembly, installation, start-up and adjusting.

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 four opaque reproductions.
2. Product Data: Submit the number of copies the contractor requires, plus those to 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 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

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 resubmittals under procedures specified for initial submittals.
   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.

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. 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.

1.12 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 Division 1.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 SHOP DRAWINGS AND PRODUCT DATA

A. Submittals shall not be combined or bound together with any other material submittal.

B. Submit individually bound shop drawings and product data for the following when specified or provided:
   1. Structural Cabling
   2. Communications System
   3. Sound Reinforcement System
   4. CATV System

3.2 COORDINATION DRAWINGS

A. Submit coordination drawings as specified.

END OF SECTION

SECTION 27 05 09

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 / 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 a manufacturer’s qualified personnel to observe:
1. Field conditions.
2. Condition of installation.
3. Quality of workmanship.
4. Start-up of equipment.
5. Testing and adjusting 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

PART 2 - PRODUCTS

2.1 REFERENCE APPLICABLE SPECIFICATION SECTIONS.

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.

3.2 MOCK-UPS

A. Mock-up a typical classroom, science lab of each type, and computer lab with all wiring devices, cover plates, rough-in boxes, conduits, etc. Provide all conductors from all wiring devices to above ceiling space to demonstrate conduit routing and conductor fill.

END OF SECTION

SECTION 27 05 10

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 smoke stop.

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.

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 27 10 00

DATA COMMUNICATIONS STRUCTURED CABLING

PART 1 - GENERAL

1.1 SUMMARY OF WORK

A. Furnish and install horizontal cabling inclusive of Category 6 cabling, jacks, faceplates, patch cords, above-ceiling supports, labels, testing and all supporting equipment to provide a complete and fully functional solution as described in this specification.

B. Furnish and install backbone cabling inclusive of fiber, multi-pair copper, connectors, bulkheads, patch cords, above-ceiling supports, testing, and all supporting equipment to provide a complete and fully functional solution as described in this specification.

C. Furnish and install head-end equipment inclusive of 2-post racks, patch panels, fiber termination boxes, wire managers, ladder rack, fire-rated plywood, power-strips, grounding and all supporting equipment to provide a complete and fully functional solution as described in this specification.

1.2 QUALITY ASSURANCE – STRUCTURED CABLING

A. Installer Qualifications:
1. The structured cabling contractor shall be licensed and shall meet all applicable regulations.
2. The contractor shall be certified by the manufacturing company in all aspects of design, installation, and testing of the products described herein.
3. The manufacturer shall have, at the district's disposal, a certified employee or support phone number that can be reached during normal operating hours for product support and service.
4. The contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size. The contractor shall own and maintain tools and equipment necessary for successful installation and testing of optical and metallic premise distribution systems and shall have personnel who are adequately trained in the use of such tools and equipment. Contractor shall provide evidence of minimum five (5) years' experience on similar structured cabling systems.
5. A resume of qualifications shall be submitted with the contractor's proposal indicating the following:
    a. A list of five (5) recently completed projects of similar type and size with contact names, telephone numbers, and e-mail addresses for each.
    b. A list of procedures, inclusive of testing equipment and best practices, for testing the integrity of the cabling systems on this project.
    c. A technical resume of experience for the contractor's project manager and on-site installation supervisor who shall be assigned to this project.
    d. A list of technical product training attended by the contractor's personnel that shall install the structured cabling systems shall be submitted.
    e. Any subcontractor who shall assist the contractor in performance of this work shall have the same training and certification as the contractor.
6. The contractor shall employ full time local technicians and installers.

B. The Contractor shall attend a mandatory pre-construction meeting with individuals deemed necessary by the Owner's representative prior to the start of the work.
1. Items requested by the Owner/Engineer to finalize rack equipment configuration, rack cable management, rack cable terminations and other miscellaneous minor

changes shall become part of the Contract Documents as supplementary information.

C. The products specified in Part 2 of this Specification shall be supplied by a single manufacturer, within the acceptable manufacturer groups, except for data racks and other hardware that is not defined as part of the channel test configuration by TIA/EIA TSB67, Transmission Performance Specifications for Field Testing of unshielded Twisted-Pair Cabling Systems outside plant (OSP) copper cable. Manufacturer shall have a minimum of seven (7) years' experience and shall be ISO 9001 Certified.

D. The Owner's representative reserves the right to reject all or a portion of the work performed, either on technical or aesthetic grounds.

1.3 REGULATORY REQUIREMENTS

A. Standards: All work shall be performed in accordance with the latest revisions of the following standards and codes:
1. Local Building Code
2. Local Electrical Code
3. NEC National Electrical Code

B. Other references:
1. ANSI/TIA-568-C.0 – Generic Communications Cabling for Customer Premises
2. ANSI/TIA-568-C.1 – Commercial Building Communications Cabling Standard Part 1: General Requirements.
3. ANSI/TIA 568-C.2 – Balanced Twisted-Pair Telecommunications Cabling and Components Standards
4. ANSI/TIA 568-C.3 – Optical Fiber Cabling Components Standard
5. ANSI/TIA-568-C.4, Coaxial Cabling Component Standard
6. ANSI/TIA-569-C – Commercial Building Standard for Telecommunications Pathways and Spaces.
7. ANSI/TIA-492.AAAC-B – Detail Specification for 850-nm Laser-Optimized, 50-um Core Diameter/125-um Cladding Diameter Class 1a Graded-index Multimode Optical Fibers (OM3/OM4). Current Edition
8. ANSI/ICEA S-83-596, Fiber Optic Premises Distribution Cable.
9. ANSI/TIA/EIA-598, Color Coding of Optical Fiber Cables
10. ANSI/ICEA S-87-640, Fiber Optic Outside Plant Distribution Cable.
11. ANSI/TIA/EIA-758: Customer-Owned Outside Plant Telecommunications Cabling Standard.
12. ANSI/TIA/EIA-526-7, Optical Power Loss Measurements of Installed Single mode Fiber Plant: OFSTP-7.
13. ANSI/TIA/EIA-526-14-A, Optical Power Loss Measurements of Installed Multimode Fiber Plant: OFSTP-14A
14. ANSI/TIA/EIA-TSB-125, Guidelines for Maintaining Optical Fiber Polarity Through Reverse-Pair Positioning
15. ANSI/TIA/EIA-TSB-140, Additional Guidelines for Field Testing Length, Loss, and Polarity of Optical Fiber Cabling Systems.
16. ANSI/TIA-606-B – Administration Standard for the Commercial Telecommunications Infrastructure
17. TIA/EIA-607-B - 2011 - Commercial Building Grounding and Bonding Requirements for Telecommunications
18. Institute of Electrical and Electronic Engineers (IEEE 802.xLAN)
19. TIA/EIA 942 Data Center Standards
20. Current BICSI Telecommunications Distribution Methods Manual
21. NFPA 70 – National Electrical Code (NEC).
22. BICSI – TDMM, Building Industries Consulting Services International,

Telecommunications Distribution Methods Manual (TDMM)

C. Governing Codes and Conflicts: If the requirements of these specifications or the Project Drawings exceed those of the governing codes, regulations, and manufacturer installation requirements, then the requirements of these specifications and the drawings shall govern. However, nothing in the drawings or specifications shall be construed to permit work not conforming to all governing codes, regulations, and manufacturer installation requirements.

1.4 ABBREVIATIONS

A. The following abbreviations are used in this document:
IDF Intermediate Distribution Frame
MDF Main Distribution Frame
UTP Unshielded Twisted Pair
SCS Structured Cabling System
RCDD Registered Communications Distribution Designer

1.5 SUBMITTALS

A. Shop Drawings: Submit the following items, for Owner review and approval, within twenty-eight (28) days of Notice to Proceed:
1. Proposed circuit routing and circuit grouping plan prepared by a BICSI certified RCDD. The RCDD certification shall have been granted on or before five years previous of proposal due date.
2. Products: Provide standard manufacturer's cut sheets and/or other descriptive information.
3. Testing: UTP cable test result forms, fiber optic cable test result forms, and a list of instrumentation to be used for systems testing.
4. Provide a line-by-line item specification review indicating compliance or deviation with full description of deviation.
5. Samples: Complete manufacturer's product literature and samples of patch panel, fiber terminations, and station jacks with cover plate.
6. Provide coordination drawing with IDF/MDF equipment layout and rack elevations for approval, by Owner, prior to installation.

B. Documentation: Contractor shall provide documentation to include test results, and shop drawings. An example of test results as they will be presented should be included with the shop drawings.
1. Work Station Cable Results: The results of the workstation cable tests shall be provided in the form of printouts from the test equipment.
2. Fiber Test Results: Hand written results are not acceptable. Copies of test results are not acceptable. Results to be provided on disk and printed form.

C. Project Completion: As a condition for project acceptance, the Contractor shall submit the following for review and approval:
1. Complete manufacturer's product literature for all products installed during the Project for Operation & Maintenance.
2. Inspection and Test Reports: During the Project, the Contractor shall maintain an adequate inspection system to ensure that the materials supplied and the work performed conforms to contract requirements. The Contractor shall provide written documentation that indicates that materials acceptance testing was conducted as specified. The Contractor shall also provide documentation, which indicates that all connectivity testing was completed and that all irregularities were corrected prior to job completion.
3. Operating and Maintenance Instructions for all devices within the system. These

instructions shall reflect any changes made during construction, and shall be provided to the Owner, for their use, in a three-ring binder labeled with the project name and description. Provide three printed (3) copies.

4. As-built Drawings shall include equipment layout and rack elevations. The as-built drawings shall be prepared using Auto Cad 2014 electronic format or later CD.

D. Bill of Materials: The contractor shall provide an itemized pricing breakdown for the turnkey solution that includes: labor, materials, wiring, termination, electrical equipment, electrical hardware, installation, etc. Pricing breakdown shall include the list price for each item provided.

PART 2 - PRODUCTS

2.1 GENERAL

A. Materials shall be as listed or shall be approved equivalent products of other manufacturers meeting the intent and quality level of the TIA/EIA specifications.

B. Ratings: All products shall be new and brought to the job site in the original manufacturer's packaging. Electrical components (including innerduct) shall bear the Underwriter's Laboratories label. All communications cable shall bear flammability testing ratings as follows:

CM Communications Cable
CMP Plenum Rated Communications Cable
CMR Riser-Rated Communications Cable
OSP Outside Plant Cable

C. Initial Cable Inspection: The contractor shall inspect all cable prior to installation to verify that it is identified properly on the reel identification label, that it is of the proper gauge, containing the correct number of pairs, etc. Note any buckling of the jacket that would indicate possible problems. Damaged cable or any other components failing to meet specifications shall not be used in the installation.

D. Cable Lubricants specifically designed for installing communications cable may be used to reduce pulling tension as necessary when pulling cable into conduit.

2.2 ACCEPTABLE MANUFACTURERS

A. Horizontal Cabling Systems:
1. Leviton/Berk-Tek
2. Hubbell
3. Commscope
4. Belden

B. Backbone Cabling Systems:
1. Leviton/Berk-Tek
2. Hubbell
3. Commscope
4. Belden
5. Corning

C. Above-Ceiling Support Systems:
1. Tomarco CEAS
2. Panduit
3. Caddy
4. Arlington

D. Head-End Systems:
1. Chatsworth (CPI)
2. Hoffman
3. Commscope
4. Belden

2.3 PERFORMANCE REQUIREMENTS

A. Horizontal Cabling Systems:
1. Cable:
a. The Structured Cabling System provided shall be unshielded twisted pair, four-pair, solid copper conductor, meeting the intent and quality level of the TIA/EIA-568 Commercial Building Wiring Standard.
b. Cabling shall be rated CMP.
c. Shall be Category 6
2. Jacks:
a. Flush mount jacks shall be high quality 8p 8c modular jacks with circuit board construction and IDC style or 110-style wire, T568B terminations (verify with Owner). Jacks shall meet EIA/TIA TSB40 recommendations for connecting hardware.
b. Shall be standard 8-position, RJ-45 Style, FCC compliant
c. Shall be designed for 4-pair, 100 Ohm balanced UTP Cable
d. Shall terminate 26-22 AWG solid or stranded conductors
e. Shall accept FCC compliant 6 position plugs.
f. Shall have attached wiring instruction labels to permit either T568A or T568B wiring configurations.
g. Shall be backward compatible with existing Category 3, 5 and 5E cabling systems for fit, form and function
h. Shall meet or exceed transmission requirements for connecting hardware, as specified in ANSI/TIA/EIA-568-C2, Transmission Performance Specifications for 4-Pair 100 Ohm.
i. Shall be UL Listed and CSA certified.
j. Each jack shall have category rating identified on the front face.
k. Shall be Cat 6.
3. Patch Cords
a. Shall be factory terminated, with strain-relief boot
b. Shall match manufacturer of horizontal cabling system
c. Shall be Category 6
d. Patch Cables shall be provided by Contractor for each station outlet and each patch panel jack (i.e. 2 cables per drop/tie cable). Patch cables shall be pinned per EIA 568B and shall be terminated with 8p8c non-keyed plugs at both ends. Patch cords shall be a length suitable to neatly run from farthest two jacks on patch panel and still provide slack to dress cable.
4. Faceplates
a. Minimum four (4) ports with ID windows
b. Blank insert covers shall be provided for unused workstation ports.
c. Wall mount phone faceplate
d. Provide 106-Style frame for floor-mounted boxes
e. Faceplates shall be compatible with standard NEMA openings and boxes.
f. Faceplates shall be UL Listed and CSA Certified
5. Cabling Support Systems
a. J-Hooks or Saddle Bags
1) Hold up to 5” diameter bundle of cable without sagging, bending

or damaging cable
2) All Velcro used above ceilings must be rated CMP

6. Labels
   a. Labels: The Contractor shall label all outlets using permanent machine engraved labels approved by the Owner. Label patch panels in the wiring closet to match those on corresponding data outlets. The font shall be at least one-eighth inch (1/8”) in height, block. All labels shall correspond to as-builts and to final test reports.
   b. Contractor shall ensure complete durable laser printable cable labels typed labeling of all outlets and cables with numbers that correspond to locations on the punch down block. Labeling system shall correspond to the Owner’s labeling system. Verify with Owner. Provide tags (black letters on white labels, plastic coated) on all cables and outlets.
      1) Durable laser printable cable labels.
      2) Designed to function in most desktop laser printers.
      3) Durable Polyester label stock.
      4) Self -Laminating wrap around design.
      5) Available in US letter sheet size of 8.5" x 11".
      6) Clear Polyester with White and Colored Print-on areas.
      7) Polyester rated for 0F to 275F for indoor and outdoor applications.
      8) Patch Panel Port Identification.
      9) Face Plate and Port Labels.
      10) 110 & NS6-110 Cross Connect Labels
      11) Rack and Cabinet Labels.
      12) Fiber Adapter Labels.
      13) Pre-Printed Port Labeling.

B. Backbone Cabling Systems
   1. Fiber:
      a. Physical Characteristics;
         1) Shall be suitable for use in indoors or in indoor/outdoor applications.
         2) Appropriately flame rated optical cable shall be suitable for use in risers, plenums and horizontal applications.
         3) Plenum rated optical cables shall have and be marked with an UL-OFNP and OFN FT6 Flame Rating. Riser rated optical cables shall have and be marked with an UL-OFNR and OFN FT4 Flame Rating
         4) Shall comply with the requirements of ICEA S-83-596 (Premises), ICEA S-104-696 (I/O), or ANSI/ICEA S-87-640 (Outside Plant, OSP).
         5) Suitable for underground or aboveground conduits.
         6) Optical cables and fibers shall be color coded in accordance with EIA/TIA-598-C.
         7) Shall have a ripcord for overall jacket.
   2. Fiber Optic products:
      a. Fiber Optic Cable Shall be UL listed type OFNP Fiber Non-Conductive Plenum. No Premise fiber shall be constructed of any conductive material.
      b. Singlemode Fibers, each with a color-coded PVC tight buffer shall have a maximum attenuation of 1.0 dB at 1310 nm and 1.0 dB/km at 1550 nm.
      c. 12-Strand Singlemode, with plenum rated indoor/outdoor jacket shall be utilized.
      d. Approved Product: Leviton / Berk-Tek PDP012AB0707I/O
   3. Backbone Copper:

a. Cat 6 – Match horizontal cabling

C. Head-End Systems:
1. Racks/Grounding
a. Racks
1) 7’ Tall
2) Black
3) 19” Wide
b. Patch Panels
1) Modular
2) Flat
3) 24/48-Port
c. Ladder Rack
1) Black
2) 12” Wide
3) Elevation and Top Plate Kits
d. Vertical Wire Managers
1) Black
2) 6”
3) Double-Sided
e. Grounding
1) #6 AWG copper grounding wire
2) 12” grounding bus bar, TMGB pattern
3) 2-hole grounding lugs
2. Fiber Head-End Systems
a. Fiber LIU
1) 1RU - IDF
b. Bulkheads
1) 12-Port Duplex
2) SC
c. Connectors
1) SC
d. Patch Cords
1) 3-Meter
2) SC-LC terminations

PART 3 - EXECUTION

3.1 GENERAL

A. At completion the horizontal cabling system shall be inclusive of Cat 6, jacks, faceplates, patch cords, above-ceiling supports, labels, testing, and all supporting equipment to provide a complete solution as described in this specification.

B. At completion the backbone cabling system shall be inclusive of fiber, multi-pair copper, connectors, bulkheads, patch cords, above-ceiling supports, testing, and all supporting equipment to provide a complete solution as described in this specification.

C. At completion the head-end system shall be inclusive of 2-post racks, patch panels, fiber termination boxes, wire managers, ladder rack, fire-rated plywood, power-strips, grounding and all supporting equipment to provide a complete solution as described in this specification.

D. Conformance to the installation practices covered above is to be verified when completed. In some cases, the Owner/Engineer may observe before acceptance.

E. All clean-up activity related to work performed shall be the responsibility of the contractor and shall be completed daily before leaving the facility.

3.2 EXISTING CONDITIONS

A. It is encouraged that the contractor be familiar with the site and existing district infrastructure before submitting proposal. Congested building areas shall be inspected by the contractor to ensure coordination with the other trades during construction. No extras shall be permitted because of the contractor's failure to properly investigate existing conditions or building design at the time of the proposal.

B. The Contractor shall coordinate with other system vendors, where appropriate, to facilitate equipment installation, scheduling, protection of equipment and access to the project site in order to provide the Owner a substantially complete project in a timely manner.

3.3 HORIZONTAL CABLING

A. Colors/Types
   1. Jacks/Patch Cords
      a. Data – Blue
      b. Wireless Access Points – Orange
      c. CCTV – Purple
      d. Menu Boards – White
      e. POS – Black
   2. Faceplates
      a. Coordinate with Division 26

B. Installation
   1. Horizontal Cabling
      a. One (1) cable shall be provided for each port shown on the drawings, unless otherwise shown on drawings. Cable shall be rated CMP. The SCS shall serve as a vehicle for transport of data, video and telephony signals throughout the network from designated demarcation points to outlets located at various desk, workstation and other locations as indicated on the contract drawings and described herein. Applications standards supported should include, but be not limited to, IEEE 802.3, 10Base5, 10BASE-T, IEEE 802.5, 4 Mbps, 16Mbps 328 ft. [100m], and TP-PMD. In addition, these links/channels shall be capable of supporting applications such as 100 Base-T and 52/155 Mbps ATM AND 77 Channel Analog Broadband Video to 550 Mhz. Gigabit cable performance shall be capable of supporting applications including AES/EBU Digital Audio, 270 Mbps Digital video, 622 Mbps 64-CAP ATM, 1000BASE-T Gigabit Ethernet and 1.2 Gigabit ATM.
      b. The cabling shall be installed per requirements of the manufacturer and the Project Documents, utilizing material meeting all applicable TIA/EIA standards. The contractor is responsible for providing all incidental and/or miscellaneous hardware not explicitly specified below as required for a complete and operational system.
      c. Cable shall not run near (6 inches' perpendicular, 12 inches parallel) to power conduits (and other electrical noise sources). No patch panel, cable, outlet or punch block shall be within 6 feet of transformers or 12 inches of fluorescent lights, light fixtures, A/C wiring, radio systems or any other RF emitting device in ceilings or in/on walls.
      d. Furnish and install pull strings in all new conduits, including all conduits with cable installed as part of this contract. Pull test is not to exceed 200

pounds.

e. Conduit sleeves shall be provided from outside IDF/MDF location to below ceiling area above ladder rack inside IDF/MDF. Minimum conduit size for data cabling sleeves shall be 4 inch.

f. Any data cabling installed in any conduit that is run underground in or under building slab shall be outside plant rated and sealed at each end with approved gel cable/conduit sealant.

g. Cable runs shall be free of splices, kinks, excessive slack, and damage to the outer jacket

h. Cables shall not be painted.

i. Cables shall be placed with sufficient bending radius so as not to kink, shear or damage the cable jacket or to otherwise diminish the transmission capability of the wire inside.

j. Cable and/or cable bundles shall not be attached to any electrical wiring or light fixtures, nor will its vertical deflection allow it to encounter HVAC mechanical equipment, electrical wiring, conduits, piping, or fluorescent light fixtures.

k. All data cables shall be home runs from outlet at final termination to patch panel at IDF/MDF.

l. Cable Termination:
   1) Number of twists per foot shall be maintained all the way to cable termination point.
   2) Provide three (3) foot service loop above ceiling for each drop, on workstation and head-end side
   3) Cable shall be terminated using tools specified by the cable manufacturer.

m. If there is no IDF/MDF within 90-meter cable limitations of drop, contractor shall be responsible for additional IDFs as required for a complete system. Locate additional IDFs in Mechanical/ Electrical Rooms or as directed by Owner. Provide additional 120-volt power and receptacles as required for additional IDF locations, like those IDFs indicated or specified elsewhere.

n. Cable Supports:
   1) In suspended ceiling and raised floor areas where duct, cable trays or conduit are not available, the Contractor shall bundle, in bundles of 50 or less, station wiring with cable ties snug, but not deforming the cable geometry. Cable bundles shall be supported and attached to the building structure and framework at a maximum of five (5) foot intervals.
   2) Cables shall not be attached to lift out ceiling grid supports or laid directly on the ceiling grid.
   3) Cables shall not be attached to or supported by fire sprinkler heads or delivery systems or any environmental sensor located in the ceiling air space.

o. Fire Wall Penetrations: The Contractor shall avoid penetration of fire rated walls and floors wherever possible. Contractor shall also seal all floor, ceiling and wall penetrations in fire or smoke barriers and in the wiring closet.

p. Wall Penetrations: Where penetrations are necessary, they shall be sleeved with metallic conduit and resealed with an Underwriter Laboratories (UL) approved sealant.

q. After installation, exposed cable and other surfaces must be cleaned free of lubricant residue.

r. Mounting heights shall conform to the Local Building Code Accessibility Standards. Mounting height shall match adjacent wiring devices unless noted otherwise.

s. Two (2) duplex receptacle(s) shall be installed at all IDF locations and circuited to the nearest computer power panel board. Coordinate with Division 26.
t. Contractor shall not hang cabling on pipes or wiring looms. Provide and install separate J-Hooks, cable saddles or cable trays to carry cable plant that is installed. Cable support shall be secured to building structure.
u. Cable shall run parallel and perpendicular to building lines. Changes in direction will be made with smooth bends, not exceeding minimum bend radius.
v. Patch Cords:
    1) Furnish and install quantity one (1) 7’ at workstation side, WAPs, Cameras get (1) 1’
    2) Furnish and install quantity one (1) 1’ at head-end side
w. Emergency phone copper –Shall be provided, at minimum, at the following locations, coordinate with drawings:
    1) Emergency phone locations.
    2) Building Management Control Panel.
    3) Security System.
    4) Fire Alarm Panel
x. Wireless Access Points:
    1) Install surface mounted box above ceiling.
y. Security Cameras:
    1) Install surface mounted box above ceiling.
z. Damage:
    1) The Contractor shall replace or rework cable showing evidence of improper handling including stretches, kinks, short radius bends, over-tightened bindings, loosely twisted and over-twisted pairs at terminals and excessive cable sheath has been removed.
    2) The Contractor shall replace any damaged ceiling tiles that are broken during cable installation. Ceiling tiles shall match existing or new as specified elsewhere.

3.4 BACKBONE CABLING

A. Colors
    1. Fiber:
        a. OM3 – Aqua
    2. Backbone Copper
        a. Cat 6 – Match horizontal cabling

B. Installation
    1. Fiber:
        a. Furnish and install 6-Strand OM3 Fiber Between MDF and new IDF. Each side of interlocking armor shall be grounded.
        b. Furnish and install factory terminated SC connectors, quantity to match number of strands installed.
        d. Furnish and install quantity one (1) 3- meter SC-LC patch cord, factory terminated, for every 2-strands installed.
    2. Copper Backbone:
        a. Furnish and install quantity two (2) – Category 6 Cables
        b. Furnish and install quantity of connectors necessary to terminate one pair per port, on both sides.
        c. Furnish and install quantity (1) patch cord for each connector provided.
        d. Furnish and install 24-Port Patch Panel in each closet for termination of backbone copper

3.5 HEAD-END SYSTEMS

A. Installation
1. Floor Mounted Equipment racks shall be assembled and mounted in IDF/MDF locations as required in locations indicated on the drawings. Each rack shall be securely mounted to the floor and braced to the wall with cable tray in accordance with the manufacturer's instructions and recommendations. Racks shall be mounted such that the side rails are plumb. Racks and cable tray shall be grounded in accordance with NEC requirements. Rack shall be installed for future expansion and with proper access behind after electronic equipment is installed.
2. Patch Panel Installation in order from starting at 10RU:
   a. Fiber tie
   b. 2U blank for Owner equipment
   c. 2U patch panels as specified.
3. Backboard: Furnish and install a minimum of (2) walls of FR Plywood at each MDF/IDF equipment location. Backboard shall be ¾" x 8' x 4' minimum Grade AC fire retardant plywood, with fire retardant paint. Coordinate placement of all equipment with Owner.
4. Wire Management Components: 6" Vertical cable management panels shall be installed on each side of the rack. In instances where more than one rack is installed in a single location, 10" vertical cable management shall be installed between the racks.
5. Cable Placement: Cable installation in the wiring closet must conform to the Project Drawings. All cabling shall be routed to avoid interference with any other service or system, operation, or maintenance location. Avoid crossing areas horizontally just above or below any riser conduit. Lay and dress cables to allow other cables to enter the conduit/riser without difficulty later by maintaining a working distance from these openings.
6. Cable shall be routed as closely as possible to the ceiling, floor or corners to ensure that adequate wall or backboard space is available for current and future equipment. All cable runs within the wiring closet shall be horizontal or vertical within the constraints of minimum cable bending radii. Minimum bend radius shall be observed. Cables shall not be tie-wrapped to electrical conduit or other equipment. All incoming cables shall be routed on the cable tray and neatly dressed down to the patch panels.
7. Patch Panels shall be separated by system, and also allow for 10% growth.

3.6 HORIZONTAL & BACKBONE CABLE TESTING/LABELING

A. Notification: The Owner/Architect/Engineer shall be notified one week prior to any testing so that the testing may be witnessed.

B. Final Acceptance: Before requesting a final acceptance, the Contractor shall perform a series of end-to-end installation performance tests. The Contractor shall submit for approval a proposal describing the test procedures, test result forms and timetable for all copper and fiber optic cabling.

C. Procedures: Trained personnel shall perform all testing. Acceptance of the test procedures discussed below is predicated on the Contractor's use of the recommended products and adherence to the inspection requirements and practices set forth. Acceptance of the completed installation shall be evaluated in the context of each of these factors.

D. Errors: When errors are found, the source of each error shall be determined, corrected and the cable retested. All defective components shall be replaced and retested. Retest

results must be entered on the test results form. All corrections shall be made prior to final acceptance test.

E. Twisted Pair Cable Testing
1. At a minimum, the Contractor shall test all station drop cable pairs from data closet termination patch panel port to station insert. Products shall be tested for compliance to ANSI/TIA/EIA 568 and ISO/IEC 11801 for a rated installation. Test equipment used shall meet TIA/EIA TSB-67, Level 4 accuracy. Further, the Contractor shall have a copy of TSB-67 in their possession and be familiar with its contents. Testing shall be against either appropriate category standards or the manufacturer's specifications whichever is more stringent and applicable.
2. Each wire/pair shall be tested at both ends for the following:
   a. Wire map (pin to pin connectivity)
   b. Length (in feet)
   c. Attenuation
   d. Near End Cross Talk (NEXT)
   e. Power Sum
   f. Structural Return Loss
   g. Delay Skew
   h. PSNEXT
   i. ACR
   j. PSACR
   k. Equal Level Far End Crosstalk (ELFEXT)
   l. PSELFEXT
   m. Far End Crosstalk (FEXT)
   n. Propagation Delay
3. Test equipment shall provide an electronic and printed record of these tests. Test equipment calibration documentation shall be available for on-site inspection.
4. Test results of each four-pair UTP cable must be submitted with identification to match labels on all patch panel ports and 8p8c jacks and must match as-builts associated with that cable.

F. Fiber Optic Cable Testing
1. Testing device for fiber optic cables shall be a high quality OTDR (Optical Time-Domain Reflectometer) equipped with a printer. The printed data shall show, in addition to any summary information, the complete test trace and all relevant scale settings. The OTDR must have the capability to take measurements from bare fiber strands as well as ST or SC connector terminations.
2. All fiber optic cable shall be tested on the reel before installation to ensure that it meets the specifications outlined herein.
3. After installation, the Contractor shall test each intra-building fiber strand with a power meter in accordance with EIA 455-171 Method D procedures (bi-directional testing) at both 850 and 1300 nm. A form shall be completed for each cable showing data recorded for each strand including length, total segment (end to end) loss (dB) and connector losses (dB) at each end. In addition, the printed data strip for each strand shall be attached to the form. Patch cables shall also be tested.
4. Acceptable fiber optic cable and connector loss shall not exceed 1.5 dB. The Contractor is responsible for obtaining minimum loss in fiber connections and polishing per manufacturer specifications.

G. Acceptance of the Data Communications Cabling System shall be based on the results of testing, functionality, and the receipt of documentation. With regard to testing, all fiber segments and all workstation data cables must meet the criteria specified. With regard to functionality, the contractor must demonstrate to the Owner that 100 Base-T data signals can be successfully transmitted, bi-directionally, from the MDF and from some number of

individual data outlets. The number of outlet locations to be tested shall be determined by the Owner.

H. Coordinate with Architect and Owner's Information Systems Department the required SCS identification prior to construction. Exact nomenclature for identification shall be submitted in writing to the Architect for review prior to final identification.

I. Cable Drop Label Nomenclature:
   1. Each port shall be identified; verify exact nomenclature with Owner.
   2. Each port on the “front” or facing side of each patch panel shall be identified.
   3. Each patch panel or “blade” shall be identified on the “front” or facing side.
   4. In each rack, numbering shall begin the upper left patch panel (as viewed from the “front” of the patch panels), extending down vertically through each rack’s complement of patch panels, and sequencing to the upper patch panel in the next adjacent rack.
   5. All data cable jackets should be labeled at both terminations:
      a. Cable end at faceplate termination should be labeled to match faceplate designation.
      b. Cable end at IDF/patch panel termination should be labeled to match back port designation on patch panel.

3.7 WARRANTY

A. The Product Warranty shall cover the replacement or repair of defective product(s) and labor for the replacement or repair of such defective product(s).

B. A twenty (20) year extended product warranty and application assurance for this structured cabling system shall be provided as follows:
   1. The extended product warranty shall ensure against product defects, that all approved cabling components exceed the specifications of TIA/EIA 568 and ISO/IEC IS 11801, exceed the attenuation and NEXT requirements of TIA/EIA TSB 67 and ISO/IEC IS 11801 for cabling links/channels, that the installation shall exceed the loss and bandwidth requirements of TIA/EIA TSB 67 and ISO/IEC IS 11801 for fiber links/channels. The warranty shall apply to all passive SCS components.

C. The extended warranty application assurance shall cover the failure of the wiring system to support the application which it was designed to support by recognized standards or user forums that use the ITA/EIA 568 or ISO/IEC IS 11801 component and link / channel specifications for cabling, for a twenty (20) year period.

D. Upon successful completion of the installation and subsequent inspection, the customer shall be provided with a numbered certificate, from the manufacturing company, registering the installation.

END OF SECTION

SECTION 27 41 16.10

INTEGRATED AUDIO-VIDEO SYSTEMS FOR INSTRUCTIONAL SPACES

PART 1 – GENERAL

1.1 RELATED WORK

The following, in their entirety and as applicable, shall apply to this section. Including any associated drawings.

A. Conditions of the Contract
B. Division 1
C. Division 26
D. Division 27
E. Division 28

1.2 DESCRIPTION

A. Summary of Work:
   1. Provide a complete and tested integrated audio-video system in various spaces. The video display system shall include:
      a. Provide and install all cable and components designated on the project drawings and within this specification section to furnish a complete audio-video solution. Areas shall include, as applicable, but not be limited to the following:
         1) Classrooms
         2) Additional locations Shown on Drawings: As applicable, these spaces shall have a fully integrated audio-visual solution.
      b. Video displays and projectors shall be Owner Furnished and installed.
   2. The installation shall comply with all applicable codes and standards in effect at the job site and as indicated in the Drawings and Specifications.
   3. Reference project drawings for locations, quantities unless specified herein, and coordination with other trades.
   4. The drawings and specifications are to be considered conceptual in nature and are intended to establish system standards insofar as manufacturer type and system configuration. The contractor shall provide pricing of a complete engineered system based on the issued conceptual documentation. The engineered system is to be submitted to the project's consultant for review prior to installation.
   5. If there are any discrepancies between the drawings and specification or among themselves, the contractor shall request clarification prior to providing pricing for the scope of work. If a request is not issued and a response not provided via a posted addendum, the contractor shall provide pricing for the costliest scenario and obtain clarification during the project.

1.3 QUALITY ASSURANCE

A. Installer Qualifications:
   1. The contractor providing and installing the integrated audiovisual systems and associated infrastructure shall be an authorized dealer of the specified projector manufacturer and be capable of providing the manufacturer's maximum available product warranty.
   2. All individuals installing the audio-video system must be employees of the authorized dealer and at least 75% of the installing staff shall have undergone a training class given by the manufacturer. Current certification indicating the successful completion of the training course shall be available upon request at

the project and submitted in the contractor's product submittals.

3. The proposing contractor and the installing contractor must be the same company. No subcontractor to the proposing audio-video contractor will be allowed for any portion of the audio-video scope of work.
4. The System Installer shall meet all applicable regulations of the State and Department of Labor insofar as they apply to this type of system. The bidder shall be a firm normally employed in the audio-video industry and shall provide a reference list of ten (10) projects of equivalent size or larger and contact names confirming successful completion of projection system installations.
5. The bidder shall have an authorized service center, within 75-miles of the project's location, for the brand of equipment that is submitted for bid. The Owner, Architect, and Consultant reserves the right to perform an onsite inspection as they deem necessary.
6. The bidder must produce a letter from the manufacturer guaranteeing the delivery of all the equipment outlined in the specification herein.
7. The bidder shall have a full time local service personnel capable of servicing the projector system described herein.

B. Pre-Construction Meeting:
1. The successful Contractor shall attend a mandatory pre-construction meeting with individuals deemed necessary by the Owner's representative prior to the start of the work.
2. The contractor shall provide a mockup of the complete integrated audiovisual system solution for each of the typical spaces below before implanting the installation in multiple like rooms. Mock up shall include all products listed in part 2 of this specification. Coordinate with G.C., Architect, Consultant, and Owner for scheduling and location of mockup.
3. All proposing contractors must have ability to demonstrate a/v system being proposed and provide owner with completely installed system to evaluate performance and operation.

C. Acceptance:
1. The Owner's representative reserves the right to reject all or a portion of the work performed, either on technical or aesthetic grounds.

D. Warranty:
1. The selected system installer shall be factory authorized service center and shall provide an end-to-end performance warranty of not less than one (1) year. The proposer shall provide current certification documentation. The performance warranty shall be issued by the manufacturer and shall warrant that video projection system projectors have been tested to the district's approval. This end-to-end warranty shall cover the labor associated with removing/reinstalling any associated hardware or equipment as well as the replacement of all defective equipment or hardware.
2. The bidder shall also submit with the materials mentioned in section 1.5 submittals of this specification a written explanation outlining the terms and conditions of product warranty of all parts and service of the integrated a/v solutions.

1.4 REGULATORY REQUIREMENTS

A. Standards: All work shall be performed in accordance with the latest revisions of the following standards and codes:
1. Latest Local Codes and Amendments
2. National Electrical Code, current version

B. Other References:
1. TIA/EIA-568-A Commercial Building Telecommunications Wiring Standard
2. EIA/TIA-569 Commercial Building Standard for Telecommunication Pathways and Spaces.
3. TIA/EIA-606 The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
4. TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications.
5. EIA/TIA 455-A Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices and Other Fiber Optic Components.
6. TIA/EIA TSB 67 Transmission Performance Specification for Field Testing of Unshielded Twisted-Pair Cabling Systems.
7. TIA/EIA TSB 72 Centralized Optical Fiber Cabling Guidelines
8. ISO/IEC 1180 Generic Cabling Standard
9. EN 50173 Generic Cabling Standards for Customer Premises
10. ANSI/EIA/TIA 526-14 Optical Power Loss Measurements of Installed Multimode Fiber Cable Plan.

C. Governing Codes and Conflicts:
1. If the requirements of these specifications or the Project Drawings exceed those of the governing codes and regulations, then the requirements of these specifications and the Drawings shall govern. However, nothing in the Drawings or Specifications shall be construed to permit work not conforming to all governing codes and regulations.

1.5 ABBREVIATIONS

A. The following abbreviations are used in this document:

AV-1	Audiovisual input station / Presentation Station
CMP	Ceiling Mounted Projector
WMP	Wall Mounted Projector
LCD / FSD / LED	Flat Screen Display / TV / Monitor
IVD	Interactive Video Display

1.6 SUBMITTALS

A. Project Initiation: Within fourteen (14) days of Notice to Proceed, the projection system installer shall furnish the following in a single consolidated submittal:
1. Permits: The Contractor shall obtain all required permits and provide copies to the Owner/Architect/Engineer.
2. Product Literature: Complete manufacturer’s product literature for all, speakers, amplifiers, cable, cross-connect blocks, cable supports, cable labels, outlet devices, and other products to be used in the installation. In addition, whenever substitutions for recommended products are made, samples (when requested by the Owner/Designer) and the manufacturer’s supporting documentation demonstrating compatibility with other related products shall be included.
3. Construction Schedule: A time-scaled Construction Schedule, using PERT/CPM, indicating general project deadlines and specific dates relating to the installation of the cable distribution system.
4. Testing: Proposed Contractor test result forms, and a list of instrumentation to be used for systems testing.

5. The contractor shall provide a letter from the manufacturer stating that the dealer is an authorized service center.
6. The resume and contact information of the full time service personnel responsible for the installed projection system.
7. Specification Compliance: A letter shall be provided stating, by section and subsection, that the installer complies with the ENTIRE specification section. If the installer intends to deviate from any portion of the specifications, a detailed explanation of reason in which the installer would like to deviate shall be provided in addition to the specification compliance letter. No deviations shall be acceptable until they have been accepted by the project's technology consultant.
8. Certifications: The contractor shall submit all of the following certifications and the certifications must contain dates which are valid from the date of proposal and not expirer any sooner than 12 months after substantial completion of the project.
    a. One (1) individual, employed by the installing firm, shall possess and maintain throughout the course of the project, an Avixa Certified Technology Specialist – Design (CTS-D) certification.
    b. One (1) individual, employed by the installing firm, shall possess and maintain, an Avixa Certified Technology Specialist – Installer (CTS-I) certification. This certified individual will be required to onsite during any installation, modification, testing, configuration, and/or programming of any portion of the AV system
9. Provide specification with line by line acknowledgement of compliance.

B. Shop Drawings: Submit the following items, for Owner review and approval, within twenty-eight (28) days of notice to proceed:
    1. Proposed wiring and connectivity diagram of the proposed projection system including all faceplates and sound reinforcing equipment
    2. In addition to the wiring/connectivity diagram, the submitted drawings shall indicate the following, even if the following is expected to be provided by the project's electrical or general contractor:
        a. Location of wall penetrations (all penetrations shall be sleeved and contain protective bushings at both ends)
            b. Location of sleeved wall pass-thru
            c. Size of sleeve at each location installed
            d. Quantity of cable passing through each sleeve
        e. Location of drops in each room (quantity or labeling of drops are not required in the submittal plans. Labeling shall be provided in the closeout plans and quantities shall be as per the contract documents, addendums, and issued changes. Each drop shall be labeled for the type of outlet that it is)
        f. Conduit routing, size, quantity, and stub-up locations for all floor mounted outlets.
        c. Drawing Compliance: A letter shall be provided stating that the installer complies with the entire project drawing, including all general, keyed, and notes to contractor. If the installer intends to deviate from any portion of the specifications, a detailed explanation of reason in which the installer would like to deviate shall be provided in addition to the specification compliance letter.
        d. No deviations shall be acceptable until they have Been accepted by the project's technology Consultant.

C. Project Completion: As a condition for project acceptance, the Contractor shall submit the following for review and approval:
    1. Samples: Complete manufacturer's product literature and samples (if requested) for all pre-approved substitutions to the recommended products made during the course of the Project.

2. Inspection and Test Reports: During the course of the project, the Contractor shall maintain an adequate inspection system to ensure that the materials supplied and the work performed conform to Contract requirements. The contractor shall provide written documentation that indicates that materials acceptance testing was conducted as specified. The Contractor shall also provide documentation, which indicates that all cable termination testing was completed and that all irregularities were corrected prior to job completion.
3. Operating and Maintenance Instructions: Operating and maintenance instructions for all devices within the system. These instructions shall reflect any changes made during the course of construction and shall be provided to the Owner for their use on disc or USB drive with the project name and description (2 copies).
4. Provide schematic line diagram of system components as deployed in each installation.

PART 2 – PRODUCTS

2.1 GENERAL

All products listed in this section shall be provided and installed by the contractor unless otherwise noted below. The following list is not intended to be a complete list of required equipment or cables as the project is to be Turnkey and may require equipment beyond the depth of this list. It is the contractor's responsibility to ensure that they are providing a complete and functional system with their proposal

A. Installation: The cabling shall be installed per requirements of the manufacturer and the Project Documents utilizing materials meeting all applicable TIA/EIA standards. The Contractor is responsible for providing all incidental and/or miscellaneous hardware not explicitly specified below as required for a complete and operational system.

B. Materials: Materials shall be as listed or shall be approved equivalent products of other manufacturers meeting the intent and quality level of the TIA/EIA specifications. All approved equivalent products will be published by addendum ten days prior to proposal for Architect/Engineer to review.

C. Testing: All installed cabling shall be tested 100% good after installation by the Contractor.

D. Ratings: All products shall be new and brought to the job site in the original manufacturer's packaging. Electrical components (including innerduct) shall bear the Underwriter's Laboratories label. All communications cable shall bear flammability testing ratings as follows:

CM Communications Cable
CMP Plenum Rated Communications Cable
CMR Riser-Rated Communications Cable

E. Initial Cable Inspection: The Contractor shall inspect all cable prior to installation to verify that it is identified properly on the reel identification label, that it is of the proper gauge, containing the correct number of pairs, etc. Note any buckling of the jacket that would indicate possible problems. Damaged cable or any other components failing to meet specifications shall not be used in the installation.

F. Cable Lubricants: Lubricants specifically designed for installing communications cable may be used to reduce pulling tension as necessary when pulling cable into conduit.
1. Approved Products
a. Twisted-pair cable: Dyna-Blue

American Polywater

G. Fire Wall Sealant: Any penetration through firewalls (including those in sleeves) will be resealed with an Underwriter Laboratories (UL) approved sealant.
1. Approved Products
a. 3M or
b. Pre-approved equal

2.2 FLAT PANEL DISPLAY

A. Owner Furnished and Owner Installed

2.3 INTERACTIVE FLAT PANEL VIDEO DISPLAY

A. Owner Furnished and Owner Installed

2.4 VIDEO PROJECTORS

A. Owner Furnished, Owner Installed (excluding special venues)

2.5 STANDALONE AV SYSTEM CABLING AND COMPONENTS

A. Provide and install the following Cabling and components from all locations with a local audio video input to their associated video display or projection device
1. Cabling:
a) One (1) HDMI Cable, from AV input plate to the AV output plate.
1) For runs 25’ or less, provide C2G Product No. 425* (42529 = 25’ cable assembly)
2) For runs over 25’, provide C2G Product No. 413* (41373 = 100’ cable assembly)
3) For runs with limited raceway space, Provide Hall Research Product No. CHD-DE*
b) The (*), at the end of each product number above, shall be replaced with a numerical value depicting the length as required per location
2. Components:
a) Provide the following at each AV Input Wall Plate (AV-1, etc.):
1) One (1) HDMI Pass-Through, with Pigtails, Wall Plate, C2G Product No. 39870.

b) Provide the following at each AV Output Wall Plate associated with a video display (IVD, FSD, Monitor, or Digital Signage) and wall mounted projector (WMP) devices:
1) One (1) HDMI Pass-Through, with pigtails, Wall Plate, C2G Product No. 39870.

c) The (*), at the end of each product number above, shall be replaced with a numerical value depicting the finish and color. Contractor to match finish and color to the surrounding electrical devices.

2.6 AUDIO VISUAL PATCH CABLES

A. Provide and install the following Patch Cables
1. Provide the following at each AV Input Outlet:
a) One (1) 10’ HDMI Patch Cable, C2G Product No. 56784

2. Provide the following at each AV Output Outlet:

a) One (1) 6’ HDMI Patch Cable, C2G Product No. 56783

2.7 CABLE ROUTING/PATHWAY

A. Cable Support System: All audio-video cabling shall be installed and supported, using an approved cable support system, at 4’-0” intervals unless installed in conduit. Do not exceed manufacture recommendation for the quantity of cables supported in an individual support.

B. All cable bundles shall be grouped together using plenum rated Velcro for the entire run above and below the ceilings.

PART 3 – EXECUTION

3.1 GENERAL

A. Contractor is required to properly mount integrated A/V solutions and connect all ceiling video/audio cables to projector component inputs.

B. Contractor is required to thoroughly test and verify operation of all A/V inputs and video modes prior to project completion.

C. Contractor is required to focus and adjust projector to properly project image on viewing surface (screen or multimedia board depending on location).

D. Contractor shall provide owner with written verification test process and results once all projectors have been installed, tested, and placed in final condition.

E. Damage:
1. The Contractor shall replace or rework cables showing evidence of improper handling including stretches, kinks, short radius bends, over tightened bindings, loosely twisted and over-twisted pairs at terminals and cable sheath removed too far (over 1-1/2 inches).

E. The Contractor shall replace any damaged ceiling tiles that are broken during cable installation.

G. Clean Up:
1. All clean up activity related to work performed will be the responsibility of the Contractor and must be completed daily before leaving the facility.

3.2 DOCUMENTATION

A. Contractor shall provide owner with detailed serial number listing and associated graphical room number designation equipment was installed. Contractor shall use actual graphical package room numbers not architectural plan numbers from construction set.

3.3 STATION WIRING INSTALLATION

A. General:
1. All cable must be handled with care during installation so as not to change performance specifications. Factory twists of each individual pair must be maintained up to the connection points at both ends of all category 6 cable. There shall never be more than one and one-quarter inch of unsheathed enhanced Category6 UTP cable at either the wiring USB Transmitter or Receiver.

B. Exposed Cable:
   1. All cabling shall be installed inside walls or ceiling spaces whenever possible. Exposed station cable will only be run where indicated on the Drawings. Additional exposed cable runs will require Owner approval, and will only be allowed when no other options exist.

C. Placement: All cabling and associated hardware shall be placed so as to make efficient use of available space. All cabling and associated hardware shall be placed so as not to impair the Owner's efficient use of their full capacity.

D. Cable Routes:
   1. All cabling placed in ceiling areas must be in conduit, cable tray or PANDUIT® Corp. J-MOD™ modular cable support or equivalent. Cable supports shall be permanently anchored to building structure or substrates. Provide attachment hardware and anchors designed for the structure to which attached and that are suitably sized to carry the weight of the cables to be supported. Do not route cable through webbing of structural steel. Cabling must be supported in dedicated supports intended to support cabling as described in this section. Contractor shall adhere to the manufacturer's suggested fill ratio for each size cable support installed.
   2. Attaching cable to pipes or other mechanical items is not permitted. Communications cable shall be rerouted so as to provide a minimum of 18 inches spacing from light fixtures, sources of heat, power feeder conduits and EMI sources. Cabling shall not be attached to ceiling. Grid support wires. Cable runs shall be routed down the corridors; parallel or perpendicular to building structure. Multiple cables to be bundled together at and between each cable support installed.
   3. Contractor shall be responsible for coordinating with other trades on the project so that the installed cable pathway does not interfere with the installation of other systems to insure that mechanical ducts, pipes, conduits, or any other above ceiling systems are not putting unnecessary stress on any portion of the install audio-video cabling.

3.4 STATION HARDWARE

A. Flush mounted components: all component shall be inserted to a flush mounted faceplate unless designated otherwise.

3.5 FINAL TESTING REQUIREMENTS

A. Notification: The Owner and Engineer shall be notified one week prior to any testing so that the testing may be witnessed.

B. Inspection: Before requesting a final inspection, the Contractor shall perform a series of end-to-end installation performance tests. The Contractor shall submit for approval a proposal describing the test procedures, test result forms and timetable for all copper and fiber optic cabling.

C. Procedures: Trained personnel shall perform all testing. Acceptance of the test procedures discussed below is predicated on the Contractor's use of the recommended products and adherence to the inspection requirements and practices set forth. Acceptance of the completed installation will be evaluated in the context of each of these factors. Testing procedures shall consist of, but not me limited to the following:
   1. Input locations to be tested utilizing multiple types of source equipment. Equipment to include:
      a. Personal Computer (laptop)

b. Apple iMac
c. Apple Mac Mini
d. Google Chromebook
e. Additional devices may be required at the time of testing
f. contractor to provide devices on a single cart, to roll between inputs during testing.

2. Routing of video, from any source, to each projector and display simultaneously and independently.
3. Routing of audio, from any source, to each audio channel simultaneously and independently.
4. Control of the entire system from each installed A/V Control Panel
5. Additional test requirements may be required at the Owner and/or Consultant's request.

END OF SECTION

SECTION 27 50 15

EXPANSION OF EXISTING SCHOOL COMMUNICATION SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Test and expand the existing school communications system and clock/bell system. The complete system includes items such as wiring, clocks, handsets, expansion of the existing control console, and any new distribution equipment required to provide a complete and functional system.

B. Locate equipment to accommodate millwork, fixtures, marker boards and other room equipment at no additional cost to the Owner.

C. Return air plenum cable shall be used. Wherever cabling is run exposed or in inaccessible locations, conduit shall be used to cover and protect wiring.

D. Integrate the existing communications system with new or specified local sound reinforcement system.

1.2 QUALITY ASSURANCE

A. Provide the system by a company that has been designing and supplying similar systems for a period of 3 years. Provide, upon request by Owner or Architect/Engineer names and addresses of similar installations.

B. Provide central processing control console wiring connections by factory engineers or authorized factory trained personnel.

C. Installation by an authorized representative of the Communications Equipment Manufacturer. Include all components, elements, testing and acceptance procedures.

D. Authorized distributor of the equipment manufacturer shall have been actively engaged in the sale, installation and service of the type of system proposed for this project for a minimum of 10 years.

E. Any proposed installer who cannot show evidence of such qualifications will be rejected. The services of a technician provided and certified by the equipment manufacturer shall be provided to supervise the installation and tests of the system.

F. Furnish evidence there is an experienced and effective service organization that carriers a stock of repair parts for the system to be furnished.

1.3 WARRANTY

A. Warranty new equipment for a period of 1 year, from date of substantial completion.

B. Correct defects in material or workmanship with a minimum loss of operating time at no cost to Owner.

C. On site service.

1.4 SUBMITTAL

A. Submit shop drawings as specified.

B. Submittals include, and are limited to, marked product data on equipment and cables.

C. Submit wiring diagrams of new and existing system and scaled area plans indicating the approximate routing of conduits and cables, equipment locations, speakers, clocks, and accessories.

1.5 REFERENCES

A. National Electrical Code.

B. UL

C. Communication systems connected to a telephone utility company shall comply with the Federal Communications Commission rules Section 68 and the corresponding UL listing.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Bogen – Nyquist

2.2 SPEAKERS/HEAD-END

A. Ceiling speakers:
1. General Purpose Speaker: 8" speaker with 5 oz. magnet complete with line matching transformer. Program rating shall be 5 watts continuous. The speaker shall be a Quam System 12. 25/70V transformers shall have primary taps of 0.25, 0.5, 1, 2 and 5 watts. Tap speaker at 0.25 watt. White finish unless indicated otherwise.

B. Networked Amplifier – Bogen -NQ-A2060

PART 3 - EXECUTION

3.1 EXISTING COMMUNICATIONS AND CLOCK/BELL SYSTEM

A. Testing of existing systems:
1. Provide complete operational test of existing school communications and clock/bell systems. Verify operation of each communication device, control console, distribution equipment, clocks and associated accessories.
2. Provide a complete written report to the Architect, indicating any deficiencies of the existing system in relation to each component’s intended function. Provide the written report 14 days prior to any work related to the expansion of the existing system.
3. Testing of the existing system shall include all areas of the main campus, remote buildings and temporary buildings served by the existing system.

B. Expand the existing system to accommodate the specified functions.
1. Contractor shall verify the existing equipment.
2. New equipment shall be compatible with existing system.
3. Provide all speakers as shown, and a new networked amplifier to be installed in the newly established IDF.

3.2 INSTALLATION

A. General: Install new communication system components in accordance with the manufacturer's instructions.
   1. Terminate all field wiring on telephone punch blocks with quick disconnect amphenol plugs.
   2. Label cables and wiring logically, legibly, and permanently for ease of identification, using adhesive strip type labels.

B. Speaker Installation:
   1. Install new speakers types as indicated on the drawings. Installation at exposed structure or inaccessible ceilings shall include ¾-inch conduit to a 4-inch octagonal junction box above the corridor ceiling.
   2. Leave a 6 to 8" loop in each corridor ceiling junction box described above to facilitate splicing for the future intercom system.
   3. Speakers in high ambient noise areas (cafetorium, gymnasiums, etc.) Shall be tapped as required to overcome the ambient noise generated by the public.

C. Conduit Boxes and Cables
   1. Install conduit, fittings and boxes as specified in Division 26.
   2. Single system cables shall be grouped together in a common conduit of adequate capacity to facilitate the ease of installation and prevent conductor or insulation damage.
      a. In no case shall the conduit fill exceed 50% capacity.
      b. Do not group conductors or cables of different systems in a common conduit.
   3. Cable:
      a. Install cables as recommended by the system manufacturer. Conductor quantities specified are minimum required. Conductors to be installed shall be coordinated with the system equipment supplier.
      b. Cables installed on exposed surfaces, in inaccessible locations, or underground shall be installed in conduit.
      c. Cables installed above accessible, ceiling spaces may be installed without conduit. All cables not installed in conduit shall be plenum rated. Install cables that are not available plenum rated in conduit.
   4. Cables not installed in conduit shall be grouped and bundled and run to a central distribution junction box. Cable shall be bundled on a maximum of 2'-6" on center, hung in hangers, J-hooks or D-rings. Hangers, J-hooks or D-rings shall be secured to the structure at a maximum of 5' on center. Bundling and support shall be with plenum rated cable ties.
   5. Cables installed in hollow wall spaces shall be installed in conduit to an accessible location.
   6. Tag each circuit at each end and at each terminal with a separate tag indicating the area served.
   7. Color code wires in accordance with IPCEA standards.
   8. Terminate speaker cables in a junction box.
   9. Field verify size of existing outlet box to be reused. Provide device cover plates to fit existing single or double gang switch boxes.

3.3 INSTRUCTIONS

A. Provide two hours instruction to the operating personnel to ensure that no change in the existing systems operation has occurred.

3.4 GROUNDING OF EQUIPMENT

A. Racks and cabinets shall be grounded to the metallic structure of the building or to the building system power ground in accordance with NEC section 250. Securely bond equipment to the ground system through a minimum 14 gauge green insulated conductor.

B. Electronic systems shall be grounded to the building system ground, with a maximum resistance of 0.1 ohm. Systems ground shall be a driven ground rod, building steel, or other approved ground of the building power systems ground.

3.5 GRAPHIC FLOOR PLANS

A. Provide two (2) color coded floor plan detailed with actual room names, actual graphic room numbers as directed by the Owner, and adequate information to indicate group / zone / circuit information with non-fading floor plan media. Do not use architectural plan room names and numbers.

B. Each plan shall clearly relate the room numbers on the annunciator to the area description on the floor plan. All fire alarm devices located to correspond with the annunciator.

C. The floor plan shall be solvent welded in acrylic plastic.
1. Mount in an extruded aluminum frame.

D. Install graphic floor plans as directed by Architect / Owner prior to substantial completion. Each area or room designation shall be verified with the communication device during testing.

3.6 FINAL TESTING AND ACCEPTANCE

A. General
1. After completion of installation and start-up procedures commence a verification and testing sequence leading to final acceptance.
2. Submit for approval, a sample of the form on which the test will be reported.
   a. Identify project.
   b. Provide a list of all system devices, arrange in numerical order of point addresses.
      1) Show descriptor and location of each.
   c. Signatures of participants and observers.
   d. Results.
   e. Description of adjustment or corrections of defective components.
   f. Date.
3. Provide schedule of tests. Estimate dates of significant events.
   a. All testing shall be performed in the presences of the Owner / Engineer.
4. Test, calibrate and adjust each device in the system.
5. Verify operation of all specified functions.
6. Provide documentation of all tests and verifications as specified.

END OF SECTION

SECTION 28 01 00

ELECTRONIC SAFETY AND SECURITY OPERATING AND MAINTENANCE MANUALS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Compile Electronic Safety and Security (ESS) product data and related information appropriate for Owner's operation and maintenance of products furnished under Contract. Prepare ESS 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 5 copies of complete manual in final form.

1.2 ESS OPERATING AND MAINTENANCE MANUAL SUBMITTAL SCHEDULE

A. Thirty (30) days after receipt of reviewed submittals bearing the Architect/Engineer's stamp of acceptance (including resubmittals), submit for review 1 copy of the first draft of the ESS 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 Low Voltage Wire and Cable
   12. Schedule of ESS Equipment
   13. Schedule of ESS Field Devices
   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 (5) 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. Four complete manuals shall be delivered to the Owner.

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 ESS 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) Cable Plant Layout
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 which 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 data, engineering data and tests.
3) Complete nomenclature and commercial number of replaceable parts.
b. Operating procedures:
1) Start up, routine and normal operating instructions.
2) Regulation, control, stopping, shut down and emergency instructions.
3) Special operating instructions.
c. Maintenance procedures:
1) Routine operations
2) Guide to trouble-shooting.
3) Disassembly, repair and reassembly.
4) Adjusting and checking.
5) Routine service
d. Manufacturer's printed operating and maintenance instructions.
e. Original manufacturer's parts list, illustrations, assembly drawings and diagrams required for maintenance.
1) Items recommended to be stocked as spare parts.
f. Schedule of low voltage wire and cable
g. Schedule of ESS equipment
h. Schedule of ESS field devices
i. Each Contractor's coordination drawings.
1) As installed color coded wiring and cabling diagrams.
j. List of original manufacturer's spare parts and recommended quantities to be maintained in storage.
k. 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 28.
5. Provide certificates of compliance as specified in each related section.
6. Provide start up and testing 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 28 05 00

ELECTRONIC SAFETY AND SECURITY GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Except as modified in this Section, General Conditions, Supplementary Conditions, applicable provisions of Division 01 General Requirements, and other provisions and requirements of the Contract Documents apply to work of Division 28.

B. Applicable provisions of this section apply to all sections of Division 28.

C. The general provisions of the Contract and the requirements of the following Sections apply to the Work specified in this Section. See Division 26 for related general and specific requirements.

1.2 CODES AND STANDARDS

A. All equipment and work performed shall comply with all of the current and applicable Codes, Rules, Ordinances, Regulations and Standards (including those not specifically listed in this Specification) as interpreted and enforced by the authorities having jurisdiction including:
1. Americans with Disabilities Act (ADA)
2. Authorities Having Jurisdiction (AHJ) - Local
3. American National Standards Institute (ANSI)
4. American Society of Testing and Materials (ASTM) *Communications Cables - B694, B736, D4565, D4566, D4730, D4731, D4732*
5. Building Industry Consulting Services International (BICSI)
6. Code of Federal Regulations - Title 47
7. Electronics Industries Association (EIA) *Standard Test Procedures for Fiber Optic Fibers, Cables, Transducers, Connecting and Terminating Devices - EIA-455 Series*
8. Federal Communications Commission (FCC) - Communications Act and FCC Rules
9. Federal Information Processing Standards (FIPS) *Federal Building Standard for Telecommunications Pathways and Spaces - FIPS PUB 175, FIPS PUB 176*
10. The Insulated Cable Engineers Association (ICEA) *Communications Cable Stands - P-47-434, S-56-434, S-80-576, S84-608, S-85-625, S-86-634, S-87-640, S-89-648, S-90-661, S-98-688, S-99-689, S-100-685*
11. International Electro-technical Commission (IEC)
12. Institute of Electrical and Electronic Engineers (IEEE) *Local Area Networks/Metropolitan Networks Standards Collection - LAN/MAN 802 Series*
13. International Organization for Standardization (ISO) (ISO/IEC) *Premise Wiring Core and LAN/MAN Core Equivalents-11801, 8802, 14763-1*
14. International Telecommunication Union (ITU-T) *Telecommunications Standardization*
15. National Electrical Code (NEC) *National Electrical Code - NFPA 70*
16. National Electrical Contractor's Association (NECA) *Standards of Installation*
17. National Electrical Manufacturers Association (NEMA) *Performance Standard for Twisted Pair Premise Voice and Data Communications Cable-WC 63.1, WC 63.2, WC 66*
18. National Electrical Safety Code (NESC)
19. National Fire Protection Association (NFPA) - *National Fire Alarm Code NFPA 72, Life Safety Code NFPA 101*

20. Society of Cable Telecommunications Engineers (SCTE)
21. Local Accessibility Standards
22. Telecommunications Industries Association (TIA) *(ANSI/TIA/EIA) Wiring and Cabling Standards - 526, 568, 569, 570, 571, 598, 606, 607, 758, TSB 31-B, 63, 67, 72, 75 and 95*
23. Uniform Building Code (UBC)
24. Underwriters Laboratories, Inc. (U.L.) - *497A, 910, 1077, 1863, 1283, 1459, 1604, 1651, 1681, 1690, 1778, 1977*

B. 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.

C. 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.

D. Obtain all permits required.

1.3 SUMMARY

A. Provide complete and working ESS Systems including equipment, conduit, wiring, material, labor and training as described in this Specification and the Drawings. The ESS Systems Drawings and Specifications are the sole property of the Architect and are not to be duplicated, scanned, loaned or in any way made available to persons not designated as authorized by the Architect. All ESS Systems plans and specifications are to be returned to the Architect following completion of bid.

1.4 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.

1.5 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 rough-in drawings and wiring diagrams required for proper installation of the electrical work.

1. Make final connections to all ESS equipment indicated on the drawings, except as noted.

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.

1.6 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.

1.7 GUARANTEE

A. Guarantee work for a minimum of two years or as noted longer elsewhere 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.

1.8 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.

1.9 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.

1.10 ACCEPTABLE MANUFACTURERS

A. Manufacturers names and catalog number specified under sections of Division 28 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 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 complete design and performance data to the Architect. The Architect and Owner issue approvals of acceptable manufacturers as addenda to the Construction Proposal Documents.

1.11 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.

1.12 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. 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.

1.13 ABBREVIATIONS AND DEFINITIONS

Abbreviations:

A/V	Audio/Visual
AWG	American Wire Gauge
BCR	Building Communications Room
CMP	Communications Media Plenum
CMR	Communications Media Riser
dB	Decibel
EMI	Electromagnetic Interference
ER	Equipment Room
ESS	Electronic Safety and Security
FACP	Fire Alarm Control Panel
FCR	Floor Communications Room
Hz	Hertz
IDF	Intermediate Distribution Frame
Km	Kilometer
LCD	Liquid Crystal Display
LED	Light Emitting Diode
M	Micron
MDF	Main Distribution Frame
MHz	Megahertz
NEXT	Near-End Cross Talk
nm	Nano-meter
OFN	Optical Fiber Non-conductive
OFNP	Optical Fiber Non-conductive Plenum
OFNR	Optical Fiber Non-conductive Riser
OTDR	Optical Time Domain Reflectometer
TC	Telecommunications Closet *(Now referred to as TR)*
TR	Telecommunications Room *(A.K.A. TC - Telecommunication Closet)*
UTP	Unshielded Twisted Pair Wire

Definitions:

Low Voltage Wire - Wire or cable used for one or more systems that operate on 24 volts or less. Low Voltage Wire is used to install and interconnect one or more of the ESS Systems. Low Voltage Wire includes patch cords, jumpers and all portions of cable or wire used to make the ESS Systems operational or for system communications.

Electronic Safety and Security Systems - One or more of the following and associated equipment: Fire Detection/Alarm Systems, Intrusion Detection/Alarm Systems, Access Control Systems, Video Surveillance Systems,

1.14 QUALITY ASSURANCE

A. Equipment Standards:
1. System and all components shall be brand new stock from manufacturer.
2. All electronics shall be 100% solid state.
3. System and all components shall bear a UL Label.

B. Contractor Qualifications:
At the time of Proposal, the Contractor shall:
1. Have manufactured, supplied or installed at least three (3) other systems of similar size, complexity, and general operation as the systems described in these specifications. The Contractor shall furnish in writing to Architect proof of compliance with this paragraph at the time of proposal.
2. Hold all legally required Texas State Contractor's licenses necessary to accomplish the installation and activation of the described system at the facilities indicated. The Contractor shall submit copies of licenses to the Architect prior to the start of work
3. Hold all legally required state registrations to meet local requirements for submittal drawings.
4. Have a local office within fifty (50) miles of the project site staffed with factory trained technicians who have experience on systems of similar complexity and function as the systems described in these specifications. These technicians shall be fully capable of system engineering support, installation supervising, system start-up, and providing the Owner with training and service on both hardware and software for the systems specified.
5. Certify complete and total compliance with the provisions of these specifications by letter or submittal of the proposal response forms, signed by an officer of the corporation, or a principal if other ownership currently exists. In addition, the letter or forms shall include a complete listing of exceptions, if any.

1.15 SUBMITTALS

A. Provide SUBMITTALS according to Division 1 and the following.

B. Requirements:
1. Submit paragraph-by-paragraph specification review indicating compliance or deviation with explanation.
2. Submit proof that all system components and cables are U.L. Listed.
3. An equipment list with names of manufacturers, model numbers, and technical information on all equipment proposed. Clearly mark exact model number proposed to be installed.
4. Product technical information sheets for each principal components in the proposed system, including cable, wire, terminal marking, and wire marking material.
5. Certification from the manufacturer stating that the system Contractor is an authorized distributor or installer of the proposed system when such certifications exist.
6. A statement listing every technical and operational parameter wherein the submitted equipment varies from that which was originally specified. If the submitter fails to list a particular variance and his submittal is accepted, but is subsequently deemed to be unsatisfactory because of the unlisted variance, the

submitter shall replace or modify such equipment at once and without cost to the Owner.

1.16 EXAMINATION OF SITE

A. The Contractor shall have visited the site and familiarized himself with all existing conditions prior to submitting his proposal and shall be prepared to carry out the work within the existing limitations. Failure or neglect to do so shall not relieve the Contractor of his responsibilities not entitle him to additional compensation for work overlooked and not included in his proposal.

B. The Contractor shall confirm the availability of the proper power source for each piece of specified equipment, through site visits and Drawings as necessary. Where proper power does not exist, the Contractor shall provide the required power, circuits, outlets, conduits, and wire as specified under Division 26.

1.17 DATA ACCURACY

A. Absolute accuracy of information regarding existing conditions cannot be guaranteed. The Drawings and Specifications are for the assistance and guidance of the Contractor and exact locations, distances, elevations, etc., shall be governed by actual field conditions. Where variations from the contract documents are required, such variations shall be approved by the Architect / Owner.

1.18 SECURITY

A. The Contractor is responsible for complying with all of the Owner's and facility security's requirements to prevent theft or damage to equipment, tools and materials. If any deviation from facility security requirements is necessary, approval for such deviation shall be coordinated with the Owner.

B. The Contractor shall not disclose any confidential information of the Owner. The Contractor acknowledges that such action is highly injurious and can do damage to the Owner. The Contractor will agree to and comply with the standard policies and provisions of the Owner regarding outside Contractors and Consultants.

1.19 UTILITIES

A. It shall be the responsibility of the Contractor to provide all temporary connection and cables, lighting, light stands and power. The facilities shall be used in accordance with all applicable regulations regarding operations, safety and fire hazards of the governmental Authorities Having Jurisdiction, provided they are not used in a wasteful manner.

1.20 PERMITS

A. All permits required for the specified performance and completion of the work shall be secured by the Contractor. These permits shall be presented and reviewed at the initial project progress meeting.

1.21 NOTIFICATION

A. The Contractor shall not shut off any existing systems. The Contractor shall give the Owner at least ten (10) calendar day’s notice of any requirements to shut off or interference with existing alarm, regulating, computer or other service systems. The Owner will arrange and execute any shutdown. All work such as splicing, connections,

etc., necessary to establish or re-establish any system shall be completed by the Contractor in close coordination with the Owner.

1.22 INTERFERENCES WITH THE OWNER

A. Transportation and storage of materials at the facility, work involving the facility, and all other matters affecting the habitual use by the Owner of its buildings, shall be conducted so as to cause the least possible interference, and at times and in a manner acceptable to the Owner. The Contractor shall make every effort to delivery equipment per the schedule required by the project.

1.23 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 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 underslab cables installed, dimensioning exact location and elevation of such installations.

B. At conclusion of project, obtain without cost to the Owner, electronic AutoCAD 2012 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, reproducible and prints is a condition of final acceptance.
   1. 3 sets of electronic AutoCAD (2012 dwg) 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 or black-line prints of each contract as-built drawing.

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 AS-BUILT DRAWINGS.
   4. Clearly indicate: DOCUMENT PRODUCED BY:
   5. Indicate all changes to construction during construction. Indicate actual routing of all conduit and cables, etc that were deviated from construction drawings.
   6. Indicate exact location of all underground ESS 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 ESS equipment in building. Label panel schedules to indicate actual location.
   10. Exact location of all ESS equipment in and outside of the building.
   11. Location, size and routing of all ESS cables, conduits, equipment, etc. shall be accurately and neatly shown to dimension.
   12. Exact location of all roof mounted equipment, wall, roof and floor penetrations.
   13. Cloud all changes.

1.24 OPERATING TESTS

A. After all ESS 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.

1.25 WARRANTY

A. All equipment shall be covered for the full manufacturers warranty period and systems shall be warranted by the Contractor for a period of two years commencing with the filing date of substantial completion. The Warranty shall cover all costs for warranty service, including parts, labor, prompt field service, pick-up, transportation, delivery, reinstallation, and retesting. A contract for service shall cover the period starting with the first expected activation of each system and shall continue without interruption to cover the period to the end of the two-year warranty as defined above. The end of the warranty period shall be handled such that a smooth transition to a maintenance agreement with the Owner shall be achieved with no lapse in coverage.

B. Submit 3 copies of all warranties and guarantees for systems, equipment, devices and materials. These shall be included in the Operating and Maintenance Manuals.

1.26 BUILDING CONSTRUCTION

A. It shall be the responsibility of the sub-contractor to consult the Architectural and Engineering 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 piping, cables, pathways, raceways, and other items are placed in the walls, furred spaces, chases, etc., so that there shall be no delay in the job.

1.27 TEMPORARY FACILITIES

A. General: Refer to Division 01 for general requirements on temporary facilities.

B. Temporary Wiring: Temporary power and lighting for construction purposes shall be provided under Division 26. Installation of temporary power shall be in accordance with NEC Article 305.

C. Temporary facilities, wire, lights and devices are the property of this Contractor and shall be removed at the completion of the Contract.

1.28 EXTRA MATERIALS

A. Keys: Provide three (3) sets of all keys for system cabinets.

PART 2 - PRODUCTS

2.1 WORK INCLUDED:

A. All materials listed in PART 2 - PRODUCTS of this Division Sections and on the Drawings shall be provided by the Contractor unless specifically excluded or modified in other portions of this Specification or Addendums.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. This project has a critical path, which must be closely followed in order to meet the completion date. The Contractor shall review the proposed schedule at the Award of Contract meeting and be prepared to staff his work force according to the schedule constraints presented at that time.

B. Aesthetics are an important consideration in this installation. All components shall be installed so as to have aesthetically pleasing results as determined by the Owner and Architect. Actual locations of all visible components shall be coordinated in advance with the Owner and Architect.

C. Install, make fully operational and test the system as indicated on the Drawings and in the Specifications. Where information is not available the worst-case condition must be assumed to ensure a complete, functional system.

D. Any interfacing with other systems shall be the Contractor's responsibility under this contract, and the details, both logical and physical, of such interfaces shall be reflected in the Submittals and As-Built drawings.

E. If appropriate, interfaces with the Owner's Data Network or Telecommunications System shall be coordinated with the Owner and Architect.

F. All necessary back boards, back-boxes, pull-boxes, connectors, supports, conduit, cable and wire shall be furnished and installed to provide a complete and reliable system. Exact location of all backboards, boxes, conduit and wiring runs shall be presented to the Owner / Architect for approval in advance of any installation. Provide as required and as specified in Division 26.

G. Where required provide 120-VAC, 60 Hz power from nearest electrical panel through a junction box, to the system devices. Provide as required and as specified in Division 26.

H. Where required, install conduit, cable and wire parallel and square with building lines, including raised floor areas. Conduit fills shall not exceed 40%.

I. All equipment shall be mounted with sufficient clearance to minimize EMI as well as meet all applicable codes and facilitate observation and testing. Securely hand and/or fasten with appropriate fittings to ensure positive grounding, free of ground loops, throughout the entire system. Units shall be installed parallel and square to building lines.

J. Quiet and vibration-free operation of all equipment is a requirement of this installation. Properly adjust, repair, balance or replace any equipment producing objectionable (in the judgment of the Owner or Architect) noise or vibration in any of the occupied areas of any building and provide additional brackets and bracing if necessary. Any such additions or changes shall be at no additional cost to the Owner.

K. Installation shall comply with the CODES AND STANDARDS portion of this Section. Where more than one code or regulation if applicable, the more stringent shall apply.

L. Where new equipment is replacing old equipment, the Contractor is responsible for removing and disposing of the old equipment and doing whatever repair work is necessary as specified by the Owner / Architect.

M. Install firestopping, as specified in Division 26 for all penetrations in slabs and firewalls to meet code at the completion of work and prior to final testing demonstration to the Owner.

N. The installation shall be performed in a professional manner.

O. On a daily basis, clean up and deposit in appropriate containers all debris from work performed under the appropriate specification sections. Stack and organize all parts, tools and equipment when not being used.

P. Preparation, handling and installation shall be in accordance with the Manufacturer's written instructions and technical data appropriate to the product specified.

Q. All work shall conform to the National Electrical Contractor's Association "Standard of Installation" for general installation practice.

R. At the conclusion of the installation, all work areas, including all enclosures and boxes, shall be vacuumed and cleaned to remove all debris and grease.

3.2 COORDINATION WITH OWNER / ARCHITECT

A. Close coordination with the Owner / Architect is vital to achieve a complete, aesthetically pleasing job. The Contractor shall ensure that the Owner / Architect is kept fully apprized of job progress.

3.3 CUTTING, PAINTING, AND PATCHING

A. Structural members shall not be drilled, bored or notched in such a manner that shall impair their structural value. Cutting of holes in structural members, if required, shall be done with core drills and only with the specific approval of the Owner / Architect for each instance.

B. All walls that require cutting or repair during the installation process shall be returned to their original condition, including the matching of colors and finishes to the satisfaction of the Owner / Architect, and at no additional cost to the Owner.

3.4 WIRE AND CABLE

A. All low voltage cable shall be low smoke plenum rated, limited energy, with 300-volt insulation.

B. All wires in exposed areas shall run through conduit as specified in Division 26.

C. Provide conduits, cable trays, raceways, wireways, boxes and outlets as specified in Division 26.

D. After installation, and before termination, all wiring shall be checked and tested to insure there are no grounds, opens, or shorts on any conductors. In addition, all wires between buildings or underground and all coax cables shall have insulation tested with a megohmeter (megger) and a reading of greater than 20 megohms shall be required to successfully complete the test.

E. Run wires continuously from termination to termination without splices.

F. Wire and cable shall be supported in each equipment and terminal cabinet and in each terminal and pull box in vertical risers and horizontal runs with wire duct and strap-type supports. At any point where wire duct is required for good wire management, whether shown on elevations or not, install appropriate duct. Where terminal boards are used, wire ducts shall be supplied on both sides and at not rime shall wires cross over terminal boards. Arrange cables neatly to allow inspection, removal and replacement. Lace cables as required. Spot tie wire bundles with plastic cable ties and securely affix to panels. If screw type terminals are specified, terminal strip connections shall be locking, tongue style, pressure crimp, and solderless spade lug.

G. Visually inspect wire and cable for faulty insulation prior to installation. Protect cable ends at all times with acceptable end caps except during actual termination. At no time shall any coaxial cable be subjected to a bend less than a 6-inch radius. Protect wire and cable from kinks. Install 1 pull rope for all 2” or larger sized conduits.

H. Provide plastic bushings and strain relief material at all conduit exit points and where necessary, to avoid abrasion of wire and excess tension on wire and cable.

I. Cables above accessible ceilings shall not rest on ceiling tiles. Use Velcro tie wraps, J-hooks or D-rings to hold cables. Provide independent support for all cables. Support is to be from building structure (do not support from pipes or conduits). ESS cables shall not tie off on HVAC supports, all-thread, ceiling grid hanger wire or electrical / mechanical piping system.

J. Ground and bond equipment and circuits in accordance with NEC and Division 26.

3.5 IDENTIFICATION AND TAGGING

A. All cables, wires, wiring forms, terminal blocks and terminals shall be identified by labels, tags to other permanent markings in accordance with TIA/EIA-606. The markings shall clearly indicate the function, source, or destination of all cabling, wiring and terminals. All cables and wires shall be identified, utilizing heat-shrink, machine printed, polyolefin wire markers (Brady Type B-32 *or equal*). Hand written tags are not acceptable.

B. Should a situation arise where the wire tagging format as shown on the drawings cannot be used, a substitute format shall be submitted which complies with the intent to provide documentation that will permit end-to-end tracing of all ESS Systems wiring.

C. All panels shall be provided with permanently attached engraved lamacoid labels with identifying names and functions. All terminal points shall be appropriately labeled. Labels shall be consistent in form, color, and typeface throughout the system and all must contain the name of the system or subsystem as part of the label textual information. Design, color, font and layout shall be coordinated with, and approved by, the Owner.

D. 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.
   2. A black-white-black 3 layer laminated plastic engraved identifying nameplate shall be permanently secured to each wireway, terminal cabinet, and ESS cabinet or rack.
      a. Identifying nameplates shall have 1/2-inch high, engraved letters.

3. Permanent, waterproof, black markers shall be used to identify each ESS grid junction box, clearly indicating the type of system available at that junction box.
4. Pull Boxes: Field work each with a nameplate showing identity, and identifying equipment connected to it. Nameplates shall also indicate where pull box is fed from.

E. 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.

F. Warning Signs: Provide warning signs where there is hazardous exposure associated with access to or operation of ESS 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.

G. Wire and Cable Labeling: Provide wire markers on each conductor in all boxes, pull boxes, gutters, wireways. Identify with drop/circuit number.

H. Underground Warning Tape: Thomas and Betts or approved equal. Six-inch wide plastic tape, colored red or orange with suitable warning legend describing buried ESS lines. All underground 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 conduits.

3.6 CUTTING AND PATCHING

A. General: Comply with the requirements of Division 01 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.

3.7 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 ESS 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.

B. Time to be allocated for instructions.
1. Minimum of 12 hours dedicated instructor time
2. 4 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.

3.8 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.

3.9 HOUSEKEEPING PADS

A. Provide concrete equipment housekeeping pads under outdoor mounted ESS equipment.

B. Concrete and reinforcing steel shall be as specified in Division 03, or as indicated or noted.

C. Concrete pads:
1. 6-inches thick minimum indoors; 8-inches thick minimum outdoors, or as indicated on the drawings 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.

3.10 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.

3.11 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.

B. Proof of delivery of these items to the Owner shall be included in the Operating and Maintenance Manuals.

3.12 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.

3.13 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 location shown.
2. Provide minimum of two 4-ft. by 4-ft. sheets of plywood for each ESS location.

3.14 SITE MANAGEMENT RESPONSIBILITY

A. The Contractor shall provide an on-site Project Manager as defined in SUPERVISION OF WORK portion of this Section.

3.15 START-UP RESPONSIBILITY

A. The Contractor shall initiate System operation. The Contractor shall provide competent Start-Up personnel on each consecutive working day until all ESS Systems are functional and ready to start the acceptance test phase. If the Contractor, in the Owner / Architect’s judgment, is not demonstrating progress in solving any technical problems, the Contractor shall supply Manufacturer’s factory technical representation and diagnostic equipment at no cost to the Owner, until resolution of those defined problems. Where appropriate, the Contractor shall bring the Systems on-line in their basic state (i.e., alarm reporting, facility code access control, etc.) It is the responsibility of the Owner to provide the specific database information that will be utilized for initial system programming.

B. Properly ground each piece of electronic equipment prior to applying power. Properly ground all shielded wire shields to the appropriate earth ground at the hub end only, not at the remote or device end.

C. Use a start-up sequence that incrementally brings each portion of the system on-line in a logical order that incorporates checking individual elements before proceeding to

subsequent elements until the entire system is operational. The basic steps should include:

1. Establish ground planes at the equipment rooms and hub end of the systems as specified in Division 26.
2. Disconnect power, connect the first device, reconnect power, and verify operational correctness. Repeat until the entire system is verified and operational.

3.16 PREPARATION FOR ACCEPTANCE (SUBSTANTIAL COMPLETION)

A. All systems, equipment, and devices shall be in full and proper adjustment and operation, and properly labeled and identified.

B. All materials shall be neat, clean and unmarred, and parts securely attached.

C. All extra material as specified shall be delivered and stored at the premises as directed.

D. Test reports of each system and each system's components and As-Built Project Drawings shall be complete and available for inspection and delivery as directed by the Owner.

3.17 SYSTEM ACCEPTANCE REQUIREMENTS

A. Before final acceptance or work, the Contractor shall perform and/or deliver each of the following in the order stated.

B. The Contractor shall deliver three (3) composite "System Operations and Maintenance" manuals in three-ring binders, sized to hold the material below, plus 50% excess. Each manual shall contain in appropriately tabbed sections:

1. A statement of Guarantee including date of termination and the name and phone number of the persons to be called in the event of equipment failure.
2. A set of Operating procedures for the overall System that includes all required Owner activities, and that allows for the Owner operation of all attributes and facilities of the System.
3. A section for each specific type of equipment containing the vendor manuals, instruction sheets, and any related literature that cam in the original shipping container for that piece of equipment. Include all warranty cards.

C. Testing:

1. The Contractor shall perform all tests required by Division 28 and those submitted as part of this Section.
2. The Contractor shall activate all devices for proper system operation, including supervisory and trouble circuit tests. Similarly, audible alarms will not be activated except on a one-time, coordinated basis, to check the actual sounding devices.
3. A test report for each piece of equipment shall be prepared by the Contractor and submitted to the Owner. This report shall include a complete listing of every device, the date it was tested, by whom and the results. The final test reports shall indicate that every device tested successfully. Failure to completely test and document the tests will result in a delay of final testing and acceptance.

D. As-Built Drawings:

1. After completion of all the tests listed above, and prior to the final acceptance test, The Contractor shall submit the complete As-Built drawings as identified in PART 1 – PROJECT RECORD DRAWINGS.

2. The final As-Built Drawings shall consist on one set of reproducible prints, two (2) sets of Point-to-Point Detail Drawings, Equipment Schedules, and the complete detailed technical data that was shipped by the manufacturer with all installed equipment.

E. Final Acceptance Test: The Final Acceptance Test shall demonstrate the installed and activated System's performance and compliance with System Specifications. However, before this testing can begin the following must have received and reviewed by the Owner.
1. System Operations and Maintenance Manuals
2. System Test Reports
3. As-Built Drawings

3.18 NOTICE OF COMPLETION

A. When the Final System Acceptance Requirements described above including the Final Acceptance Test described above have been satisfactorily completed. The Owner / Architect shall issue a Letter of Completion to the Contractor indicating the date of such completion. The Notice of Completion shall be recorded by the Contractor upon receipt of the Owner / Architect completion letter. This date of record shall be the start of the warranty period.

END OF SECTION

SECTION 28 05 05

ELECTRONIC SAFETY AND SECURITY 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 exists the possibility that there are existing conditions and devices which 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 Contractors responsibility to visit the site and determine all of the existing conditions and to take these existing conditions into consideration when making and presenting a proposal to as 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 and equipment serve only abandoned facilities.

E. Demolition Drawings are based on casual field observation and existing record documents. Report discrepancies to Architect before disturbing existing installation.

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. 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.

C. 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.

D. Material or equipment salvaged for Owner's use shall be carefully handled and stored where directed by the Owner.

E. Materials and equipment not indicated to be removed or abandoned shall be reconnected to the new system.

F. Clean and repair existing materials and equipment that remain or are to be reused.

3.3 SEQUENCING AND SCHEDULING

A. Coordinate utility service outages with 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. Remove and replace existing conduit, wiring, outlets, devices, and appurtenances as occasioned by new or remodeled construction. Re-establish service to devices that may be interrupted by remodeled construction.

D. Disconnect communication 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.

E. Remove equipment, systems, conductors, wiring, raceways, etc. abandoned or not required for existing or new systems. Coordinate with Architect/Owner for salvage by Owner.

F. 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 24 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

G. Existing Security System: Maintain existing system in service. Disable system only to make switchovers and connections. Notify the Owner at least 24 hours before partially or completely disabling system. Minimize outage duration.

H. Existing Video Surveillance System: Maintain existing system in service. Disable system only to make switchovers and connections. Notify the Owner at least 24 hours before partially or completely disabling system. Minimize outage duration.

3.4 DEMOLITION AND EXTENSION OF EXISTING SAFETY AND SECURITY 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 and 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.

F. Disconnect and remove communication devices and equipment serving utilization equipment that has been removed.

G. Repair adjacent construction and finishes damaged during demolition and extension work.

H. Maintain access to existing communication installations that remain active. Modify installation or provide access panel as appropriate.

I. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

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.

D. Repairs, equipment replacements, and corrections to special systems due to damage caused by contractor:
   1. For each special 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.
   2. Corrective measures to the special systems to correct components of the special systems found damaged by the contractor shall be completed to the satisfaction of the Owner and Architect prior to acceptance of substantial completion at no additional cost to the Owner.

3.6 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 preformed 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. Security Access Control System
      b. Video Surveillance System
      c. Fire Alarm and Detection 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 special systems:
   1. Provide complete operational test 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 preformed 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. Security Access Control System
b. Video Surveillance System
c. Fire Alarm and Detection 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.

END OF SECTION

SECTION 28 05 07

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 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 relation to adjacent or critical features or work or products.

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: 1/4"=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 room containing ESS equipment and each rack with ESS equipment, submit plan and elevation drawings. Show:
1. Actual ESS equipment and components to be furnished.
2. NEC working space and NEC access to NEC working space.
3. Relationship to other equipment and components and openings, doors and obstructions
4. Rack location and dimensions

D. Identify field dimensions. Show relation to adjacent or critical features of work or products.

E. Verify location of ESS station devices and other work specified in this Division.

1. Coordinate with drawing details, site conditions and millwork shop drawings prior to installation.
2. Where required for clarification, submit shop drawings prior to rough-in and fabrication.

F. Submit shop drawings in plan, elevation and sections, showing outlets and other devices in casework, cabinetwork and built-in furniture.

1.4 PRODUCT DATA

A. 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.

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 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:)

1.5 MANUFACTURERS INSTRUCTIONS

A. Submit Manufacturer's instructions for storage, preparation, assembly, installation, start-up and adjusting.

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 four opaque reproductions.
2. Product Data: Submit the number of copies the contractor requires, plus those to 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 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

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 resubmittals under procedures specified for initial submittals.
   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.

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. 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.

1.12 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 Division 01.

PART 2 - PRODUCTS - NOT USED.

PART 3 - EXECUTION

3.1 SHOP DRAWINGS AND PRODUCT DATA

A. Submittals shall not be combined or bound together with any other material submittal.

B. Submit individually bound shop drawings and product data for the following when specified or provided:
   1. Low Voltage Wire
   2. Electronic Access Control and Intrusion Detection
   3. Electronic Surveillance
   4. Fire Detection and Alarm

3.2 COORDINATION DRAWINGS

A. Submit coordination drawings as specified.

END OF SECTION

SECTION 28 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.

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 / 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 a manufacturer’s qualified personnel to observe:
   1. Field conditions.
   2. Condition of installation.
   3. Quality of workmanship.
   4. Start-up of equipment.
   5. Testing and adjusting 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

PART 2 - PRODUCTS

2.1 REFERENCE APPLICABLE SPECIFICATION SECTIONS.

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.

3.2 MOCK-UPS

A. Mock up a typical classroom, science lab of each type, and computer lab with all wiring devices, cover plates, rough-in boxes, conduits, etc. provide all conductors from all wiring devices to above ceiling space to demonstrate conduit routing and conductor fill.

END OF SECTION

SECTION 28 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.

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 28 10 00

ELECTRONIC ACCESS CONTROL SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The contractor shall furnish and install a complete microprocessor based access control system as specified herein. The system shall include, but not be limited to, all control equipment, signal initiating and signaling devices, door hardware, conduit, wire, fittings, labor and all other accessories required to provide a fully functioning system.

1.2 CODES AND STANDARDS

A. The system shall comply with the applicable Codes and Standards as follows:
   1. National Fire Protection Association Standards:
      a. NFPA 70 National Electric Code
      b. NFPA 72 National Fire Alarm Code
      c. NFPA 101 Life Safety Code

B. Local & State Building Codes

C. Requirements of Local Authorities having Jurisdiction

D. Underwriters Laboratory Requirements and Listings for use in Security Alarm Systems.

E. Requirements of American Disabilities Act (Public law 101-336).

F. Texas Accessibility Standards (TAS)

G. State Fire Marshal.

H. Texas Insurance Code.

1.3 RELATED WORK

A. Division 08 – Door Hardware

1.4 DEFINITIONS

A. ACS – Access Control System

B. CSA – Client Software Application

C. DGM – Dynamic Graphical Maps

D. ALPR – License Plate Recognition

E. SDK – Software Development Kit

F. SMA – Software Maintenance Agreement

G. SSM – Server Software Module

H. UI – User Interface

I. USP – Unified Security Platform

J. USW – Unified Web Client

K. VMS – Video Management System

L. DVS – Digital Video Server

1.5 QUALITY ASSURANCE

A. Contractor Qualifications:
   1. The installing contractor shall be the authorized representative of the access control system manufacturer to sell, install, and service the proposed manufacturer's equipment. The installing contractor shall have represented the security alarm manufacturer's product for at least two years.
   2. The installing contractor shall be licensed by the State of Texas as a security services contractor to design, sell, install, and service security alarm systems.
   3. The installing contractor shall provide 24 hour, 365 day per year emergency service with factory trained service technicians.
   4. The installing contractor shall have personnel on their staff that has been actively engaged in the business of designing, selling, installing, and servicing security alarm systems for at least ten (10) years.

B. The system programmer shall have attended manufacturer training and obtained certification in OpenOptions.

C. Optionally, the system programmer shall have attended manufacturer training and obtained certification in OpenOptions.

D. The system programmer shall be a OpenOptions certified partner with the following level of qualification:

E. All Contractors shall submit to the Owner prior to starting any work the factory training certificates for all personnel that will be working on the access control system. No person is allowed to work on the system without proper manufacturer's certification

1.6 SUBMITTALS

A. The installing contractor and/or equipment supplier shall provide complete and detailed shop drawings and include:
   1. Control panel wiring and interconnection schematics.
   2. Complete point to point wiring diagrams.
   3. Riser diagrams.
   4. Complete floor plan drawings locating all system devices.
   5. Factory data sheets on each piece of equipment proposed.
   6. Detailed system operational description. Any specification differences and deviations shall be clearly noted and marked.
   7. Complete system bill of material.
   8. Line by line specification review stating compliance or deviation.

B. All submittal data will be in bound form with contractor's name, supplier's name, project name and state security license number adequately identified.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Head-End/Software
1. OpenOptions DNA Fusion

B. Controllers
1. OpenOptions

C. Card Readers
1. HID

D. Wiring
1. Belden
2. Windy City Wire
3. General Cable

2.2 PERFORMANCE REQUIREMENTS

A. Controllers:
1. OpenOptions NSC-100

B. Card Readers
1. Multi-Class
2. 50/75mA @ 12VDC
3. Wiegand interface
4. multiclass SE RP15
5. multiclass SE RP40

C. Wiring
01. Plenum rated
02. Minimum of 18 AWG

PART 3 - EXECUTION

3.1 GENERAL

A. The contractor shall have furnished and installed a complete microprocessor based access control system as specified herein. The system shall include, but not be limited to, all control equipment, power circuits, signal initiating and signaling devices, door hardware, conduit, wire, fittings, labor and all other accessories required to provide a fully functioning system.

3.2 HARDWARE INSTALLATION

A. General
1. Provide mock-up of a typical entry door, complete with conduit, outlet boxes, cables and access control devices prior to installation.
2. All security conduit as required for a complete installation of this system shall be provided as specified in Division 26.
3. Coordination with the Division 26 is the responsibility of the Security Contractor to ensure all conduit is in place for a complete installation.
4. All door hardware to be coordinated with Division 08, reference Division 08 for hardware requirements

B. Wiring/Conduit

1. All wiring shall be in accordance with the National Electrical Code, Local Codes, and article 760 of NFPA Standard 70. All wiring sizes shall conform to recommendations of the equipment manufacturer, and as indicated on the engineered shop drawings.
2. All wire shall be UL Listed CL2 for limited energy (300V) applications and shall be installed in conduit. Limited energy MPP wire may be run open in return air ceiling plenums provided such wire is UL Listed for such applications and is of the low smoke producing fluorocarbon type and complies with NEC Article 760 if so approved by the local authority having jurisdiction.
3. No AC wiring or any other wiring shall be run in the same conduit as security alarm wiring.
4. All wire shall be installed in an approved conduit/raceway system (except where permitted by NEC and the local authority having jurisdiction). Maximum conduit "fill" shall not exceed 40% per NEC.
5. Minimum conduit size shall be 3/4" EMT. Install conduit per engineered shop drawings.
6. Systems utilizing open wiring techniques with low smoke plenum cable shall provide conduit in all inaccessible locations, inside concealed walls, all mechanical/electrical rooms, or other areas where wiring might be exposed or subject to damage.
7. All vertical wiring and all main trunk/riser wiring shall be installed in a complete raceway/conduit system. All riser boxes shall be adequately sized for the number of conductors traversing the respective box as well as the number of terminations required.
8. All plenum wiring is to be installed parallel and perpendicular to the building structure. Install wiring tight up against structure for protection. Cable shall be bundled on a maximum of 2'-6" and secured to the structure at a maximum of 5' on center. Bundling and support shall be with plenum rated cable ties.
9. Contractor is required to provide all mapping and software configuration required to operate system as per manufacturer’s recommendations.
10. All wire not installed inside conduit or a designated cable tray system shall be installed in a dedicated j-hook style cable support system for the entire run of each cable. Including, but not limited to service loops
11. The cable support system shall be attached directly to the building steel at a serviceable height. If the building steel is not within 5’ of the finished ceiling, the contractor shall provide a dedicated threaded rod extending within 5’ of the finished ceiling and mount the support hook to the treaded rod.

C. System

1. Furnish and install one (1) card reader, controller, and license for each location shown on drawings. All door hardware wiring, and final terminations to be provided by system integrator. Reference Division 8, to ensure all necessary cabling is included.
2. Provide an additional four (4) hours per site of programming, coordinate final programming with district personnel.

3.3 TESTING

A. Submit a written test report from an authorized representative of the equipment manufacturer that the system has been 100% tested and approved. Final test shall be witnessed by Owner, Engineer, Electrical Contractor and performed by the equipment supplier. Final test report shall be received and acknowledged by the Owner prior to substantial completion.

B. Provide instruction as to proper use and operation of system, for the Owner's designated personnel.

3.4 WARRANTY

A. Contractor shall provide minimum of one (1) year warranty of workmanship and product. Must support (24) hour turn time to fix and/or replace any system issues or hardware.

B. The product shall perform in all material respects in accordance with the accompanying user manual, and the media on which the Software Product resides will be free from defects in materials and workmanship under normal use. Software defects are covered through Service Releases and Cumulative Updates which are available for a period of 1 year from the date of substantial completion.

END OF SECTION

SECTION 28 20 00

VIDEO SURVEILLANCE SYSTEM

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

A. Furnish and install IP closed-circuit television system including cameras, mounts, licensing, and system programming.

B. The contractor shall coordinate with other system vendors, where appropriate, to facilitate equipment installation, scheduling, protection of equipment and access to the project site in order to provide the Owner a substantially complete project in a timely manner.

C. Contractor is responsible for coordinating all electrical work required on this project for connection of servers, cameras, conduit, and power supplies. Contractor shall provide a complete solution to the owner and be responsible for the complete installation of the video security camera system. Any additional power requirements for power supplies and additional pathway conduits/sleeves are to be provided by the system installing contractor's licensed electrician or the project's electrical contractor.

D. Contractor will be required to meet with district security representative before any cabling is to be installed to walk the site and coordinate proposed camera locations and cable routing.

E. Data cabling for IP/PoE cameras shall be provided by Division 27 10 00.

F. Contractor shall provide a complete installation of camera including testing of all cameras. Testing and camera aiming must be conducted in conjunction with the Owner's Security personnel prior to installation.

G. Locate equipment to accommodate millwork, fixtures, marker boards and other room equipment at no additional cost to the Owner.

1.2 RELATED SECTIONS

A. Division 26 and Division 27

1.3 DEFINITIONS

A. ACS – Access Control System

B. CSA – Client Software Application

C. DGM – Dynamic Graphical Maps

D. DVS – Digital Video Server

E. LPR – License Plate Recognition

F. SDK – Software Development Kit

G. SMA – Software Maintenance Agreement

H. SSM – Server Software Module

I. UI – User Interface

J. VMS – Video Management System

1.4 QUALITY ASSURANCE

A. Installer Qualifications:
1. The contractor shall be licensed and shall meet all applicable regulations. The contractor shall be a firm normally employed in the security industry.
2. The contractor shall be certified by the manufacturing company in all aspects of design, installation and testing of the products described herein. Each contractor shall furnish with their submittal a letter from the manufacturer indicating they are a dealer in good standing.
3. The contractor must be certified by the manufacturer of the products, adhere to the engineering, installation and testing procedures and utilize the authorized manufacturer components and distribution channels.
4. The contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size. The contractor shall own and maintain tools and equipment necessary for successful installation and testing of video surveillance distribution systems and have personnel who are adequately trained in the use of such tools and equipment.
5. A resume of qualifications shall be submitted with the Contractor's proposal indicating the following:
   a. A list of five recently completed projects using the product proposed of similar type and size with contact names and telephone numbers for each.
   b. A list of test equipment proposed for use in verifying the installed integrity of metallic cable systems on this project.
   c. A technical resume of experience for the contractor's Project Manager and on-site installation supervisor who shall be assigned to this project.
   d. A list of technical product training attended by the contractor's personnel that shall install the video surveillance system shall be submitted.
   e. Any subcontractor who shall assist the video surveillance contractor in commissioning / programming of this work shall have the same training and certification as the video surveillance contractor.

B. It is acceptable for a non-certified contractor to furnish and install security cameras. Final licensing, and commissioning / programming shall be performed by VMS manufacturer certified contractor.

C. Contractor must be a current integrator of solution in the Houston/Galveston metropolitan area, have a permanent office located within 150 miles of the project, and be able to include information on current support staff to be able to service this client.

D. The Owner's representative reserves the right to reject all or a portion of the work performed, either on technical or aesthetic grounds.

E. Contractor shall schedule a pre-construction meeting with Owner / Engineer to review specific project requirements.

F. The system programmer shall have attended manufacturer training and obtained certification in Milestone xProtect Expert.

G. The system programmer shall be a Milestone certified partner with the following level of qualification: Expert

H. The system programmer shall submit proof of certifications.

1.5 REGULATORY REQUIREMENTS

A. Standards: All work shall be performed in accordance with the latest revisions of the following standards and codes:
1. Local Building Code
2. Local Electrical Code
3. NEC National Electrical Code

B. Other references:
1. TIA/EIA-568-A - Commercial Building Telecommunications Wiring Standard
2. EIA/TIA-569 - Commercial Building Standard for Telecommunications Pathways and Spaces.
3. TIA/EIA-606 - The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
4. TIA/EIA-607 - Commercial Building Grounding and Bonding Requirements for Telecommunications
5. TIA/EIA TSB 67 - Transmission Performance Specification for Field Testing of Unshielded Twisted-Pair Cabling Systems.
6. ISO/IEC 11801 - Generic Cabling Standard
7. EN 50173 - Generic Cabling Standards for Customer Premises

C. Governing Codes and Conflicts: If the requirements of these specifications or the Project Drawings exceed those of the governing codes, regulations, and manufacturer installation requirements, then the requirements of these specifications and the drawings shall govern. However, nothing in the drawings or specifications shall be construed to permit work not conforming to all governing codes, regulations, and manufacturer installation requirements.

1.6 SUBMITTALS

A. Contractor shall meet with Owner’s Security representative prior to submission of formal/final shop drawings to Engineer to allow the Owner and Engineer to review a preliminary draft copy of the submittal to verify compliance with the specifications and any detailed requirements of the project. The contractor shall then submit the final and formal submittal to Engineer for review. After the draft submittal has been reviewed by the Owner / Engineer, and formal shop drawings have been reviewed by Engineer and returned to the Contractor, the required pre-construction meeting shall take place with Owner / Engineer.

B. The video surveillance system installer shall furnish all CCTV system submittals in a single consolidated submittal.

C. Shop Drawings: Submit the following items, for Owner review and approval:
1. Samples: Complete manufacturer’s product literature and samples (if requested) for all pre-approved substitutions to the recommended products made during the course of the Project.
2. Permits: The Contractor shall obtain all required permits and provide copies to the Owner/Engineer
3. Product Literature: Complete manufacturer’s product literature for all electronics, cable, cable supports, cable labels, outlet devices, and other products to be used in the installation. In addition, whenever substitutions for recommended products

are made, samples (when requested by the Owner/Engineer) and the manufacturer's supporting documentation demonstrating compatibility with other related products shall be included.

4. Testing: Proposed Contractor test result forms, a list of instrumentation to be used for systems testing.
5. A complete point-to-point floor plan diagram indicating camera locations and all required cabling to connect systems.

D. Project Completion: As a condition for project acceptance, the Contractor shall submit the following for review and approval:

1. Inspection and Test Reports: During the course of the Project, the Contractor shall maintain an adequate inspection system to ensure that the materials supplied and the work performed, conform to contract requirements. The Contractor shall provide written documentation that indicates that materials acceptance testing was conducted as specified. The Contractor shall also provide documentation, which indicates that all cable termination testing was completed and that all irregularities were corrected prior to job completion.
2. Operating and Maintenance Manuals for all devices within the system. These instructions shall reflect any changes made during the course of construction, and shall be provided to the Owner, for their use, in a three-ring binder labeled with the project name and description.
3. All training sessions with district staff and training media shall be complete.
4. As-built Drawings shall include cable pathways, camera locations with correct labeling and MDF/IDF locations. The as-built drawings shall be prepared using AutoCad V. 2013 or later. Provide the Owner with electronic versions of the as-builts on CDs.

PART 2 – PRODUCTS

2.1 GENERAL

A. The Contractor is responsible for providing all incidental and/or miscellaneous hardware not explicitly specified below as required for a complete and operational system.

B. Materials shall be as listed or shall be approved equivalent products of other manufacturers meeting the intent and quality level of the specifications. All approved equivalent products shall be published by addendum ten days prior to proposal for Engineer review.

C. All equipment and materials used shall be standard components, regularly manufactured, regularly utilized in the manufacturer's system.

D. All systems and components shall have been thoroughly tested and proven in actual use.

E. All systems and components shall be provided with the availability of a toll free 24-hour technical support phone number from the manufacturer. The phone number shall allow for immediate technical assistance for either the dealer/installer or the end user at no charge.

F. All systems and components shall be provided with an explicit manufacturer warranty.

2.2 DATA CLOSET (MDF/IDF) TERMINATION HARDWARE

A. Security contractor is responsible to coordinate with data/voice cabling contractor on acquiring network connections. Contractor shall coordinate with District technology

department on acquiring any network configuration information such as IP numbers that will be required.

B. Structured Cabling Contractor is responsible to provide network cabling connection, either fiber or category 6, to Owner provided network equipment. This connection allows Cameras to be connected to Owner's local area network.

2.3 CABLE AND INSTALLATION

A. The data cabling to each camera location on this project shall be provided by Structured Cabling Contractor installing new infrastructure on site.

B. Provide all penetrations and all conduits as necessary for installation of CCTV installation.

C. All exterior penetrations require necessary weatherproofing to avoid moisture penetration.

D. All outdoor cable runs underground shall be rated for underground use.

E. Provide all power circuits required for the camera power supplies.

F. Contractor shall not run any power cabling for any security equipment on rack tray system due to EMI considerations. Contractor shall provide individual cabling support for all low voltage power cabling.

G. All cabling for entire project shall be installed at 5'-0" intervals in dedicated support system using supports such as j-hooks or saddle support systems. Cable supports shall be securely attached directly to building structure. Do not attach cabling or supports to ductwork, piping, grid hangers, conduit, or equipment.

2.4 CAMERAS

A. ACCEPTABLE MANUFACTURERS
1. Hanwha

B. Multi-Sensor Cameras: Hanwha PNM-9085RQZ
1. Mounting Hardware: SBP-390WMW2 Wall Mount Arm

C. Field of View Determination by the contractor as necessary for fixed camera locations shall be performed at no additional cost to provide the view desired by the owner. Contractor shall coordinate all final camera views and locations with owner for final approval.

D. Ceiling mounted cameras shall be installed with the weight of the camera being supported by the building structure. At no point should the weight of any camera be supported by the ceiling tile.

E. All cameras installed shall be focused at nighttime in black and white/low resolution mode to insure the best possible view.

2.5 VIDEO SERVER AND EQUIPMENT

A. Licensing: Coordinate with owner, for utilization of existing Milestone licenses.

B. Contractor Shall Provide 3-years of Care Plus.

2.6 PROGRAMMING

A. Coordinate programming of IP address of Owner provided wide area archiver. All cameras to be addressed, and brought into the existing system.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Cable Support:
1. All wire not installed inside conduit or a designated cable tray system shall be installed in a dedicated cable j-hook style support system for the entire run of each cable. Including, but not limited to service loops.
2. The cable support system shall be attached directly to the building steel at a serviceable height. If the building steel is not 5’ of the finished ceiling, the contractor shall provide a dedicated threaded rod extending within 5’ of the finished ceiling and mount the support hook to the treaded rod.
3. Cable support shall be installed at a maximum of 5' on center.
4. All cable installed shall be attached to the hook support system with plenum rated Velcro and a plenum rated Velcro tie shall be installed between each cable support to keep wires neatly bundled throughout the entire run. Tie wraps will only be allowed to be used inside the control panels as required to manage the wires within each type of panel.
5. Absolutely no cable, not installed in conduit, will be allowed to be attached directly to the building’s steel or supported in any other method than that stated above.
6. It is the responsibility of the installing contractor to coordinate with all other trades on the project to ensure that the pathway of this system does not interfere with the installation of the other trades and to prevent the installed product of other trades from putting strain on the installed wiring.
7. Do not route cable through webbing of structural steel.

B. Conduit / Raceway:
1. All wire shall be installed in an approved conduit/raceway system (except where permitted by NEC and the local authority having jurisdiction). Maximum conduit "fill" shall not exceed 40% per NEC.
2. Conduit and raceway system shall be installed as specified under the general electrical section of the specifications, and per NEC.
3. Minimum conduit size shall be 3/4" EMT. Install conduit per engineered shop drawings.
4. Systems utilizing open wiring techniques with low smoke plenum cable shall provide conduit in all inaccessible locations, inside concealed walls, all mechanical/electrical rooms, or other areas where wiring might be exposed or subject to damage.
5. All conduit ends shall have a protective bushing to prevent cable damage. Bushings must be installed prior to installing cable. Cutting bushing to install around installed cables will not be accepted.

C. Fire Wall Penetrations: The Contractor shall avoid penetration of fire rated walls and floors wherever possible. Contractor shall also seal all floor, ceiling and wall penetrations in fire or smoke barriers and in the wiring closet.

D. Wall Penetrations: Where penetrations are necessary, they shall be sleeved with metallic conduit and resealed with an Underwriter Laboratories (UL) approved sealant.

E. Install new roof mounted conduits on portable pipe supports – (low profile type), as manufactured by Portable Pipe Hangers or Advanced Support Products. Provide roof protection pads under each support. Coordinate location and routing with design

engineer prior to rough-in or installation of system.

F. Do not install wall mounted cameras into metal fascia. Ensure they are mounted into brick, and sealed top and sides (not bottom)

3.2 EQUIPMENT RACK CONFIGURATION

A. Cable Placement: Cable installation in the wiring closet must conform to the Project Drawings. All cabling shall be routed so as to avoid interference with any other service or system, operation, or maintenance location. Avoid crossing areas horizontally just above or below any riser conduit. Lay and dress cables to allow other cables to enter the conduit/riser without difficulty at a later time by maintaining a working distance from these openings.

B. Cable shall be routed as closely as possible to the ceiling, floor or corners to ensure that adequate wall or backboard space is available for current and future equipment. All cable runs within the wiring closet shall be horizontal or vertical within the constraints of minimum cable bending radii. Minimum bend radius shall be observed. Cables shall not be tie-wrapped to electrical conduit or other equipment.

C. All incoming cables shall be routed on the cable tray and neatly dressed down to the patch panels.

3.3 WIRING INSTALLATION

A. General:
1. All network cabling shall be provided and installed by the network cabling contractor. Cabling between wiring closet and camera locations shall be made as individual home runs. No intermediate splices may be installed or utilized between the wiring closet and the camera location.
2. All cable must be handled with care during installation so as not to change performance specifications.
3. Coordinate jack color with structured cabling specification.

B. Placement: All cabling and associated hardware shall be placed so as to make efficient use of available space. All cabling and associated hardware shall be placed so as not to impair the Owner’s efficient use of their full capacity.

3.4 ADDITIONAL REQUIREMENTS

A. Confirm mounting locations with Owner prior to installation.

B. Coordinate with network cabling contractor to ensure installation of cable service loops to all camera locations and future camera locations.

C. Provide final aiming, focus, and other camera configuration adjustments as directed by Owner.

D. Lens: Provide and install the following lens types for the exterior cameras, in addition to the lenses supplied with the camera:
1. 60^ 4.0mm
2. 38% 2.8mm
3. 2% 8mm

3.5 DOCUMENTATION

A. Labels: The Contractor shall label all outlets using permanent machine engraved labels approved by the Owner. Label patch panels in the wiring closet to match those on corresponding camera locations. The font shall be at least one-eighth inch (1/8”) in height, block. All labels shall correspond to as-built and to final test reports.

B. Contractor shall ensure complete typed labeling of all cameras with numbers that correspond to locations on video server. Labeling system shall correspond to the Owner’s labeling system. Verify with Owner. Provide tags (black letters on white labels, plastic coated) on all cables and outlets.

C. All cables shall be labeled at both ends with a machine label and all terminations shall be stenciled with a typed label for quick circuit identification. Labeling shall conform to TIA/EIA standard 606 and include interconnect cable identification numbers.

D. A floor plan, clearly labeled with all numbered camera locations, shall be included in the as-built plans.

3.6 CABLE TESTING - BY MANUFACTURER’S REQUIREMENTS

A. Notification: The Owner/Engineer/Consultant shall be notified one week prior to any testing so that the testing may be witnessed.

B. Final Acceptance: Before requesting a final acceptance, the Contractor shall perform a series of end-to-end installation performance tests. The Contractor shall submit for approval a proposal describing the test procedures, test result forms and time table for all copper and fiber optic cabling.

C. Procedures: Trained personnel shall perform all testing. Acceptance of the test procedures discussed below is predicated on the Contractor’s use of the recommended products and adherence to the inspection requirements and practices set forth. Acceptance of the completed installation shall be evaluated in the context of each of these factors.

D. Errors: When errors are found, the source of each error shall be determined, corrected and the cable retested. All defective components shall be replaced and retested. Retest results must be entered on the test results form. All corrections shall be made prior to final acceptance test.

3.7 INSPECTION

A. Conformance to the installation practices covered above is to be verified when completed. In some cases, the Owner/Engineer may observe before acceptance.

3.8 WARRANTY

A. The product shall perform in all material respects in accordance with the accompanying user manual, and the media on which the Software Product resides will be free from defects in materials and workmanship under normal use. Software defects are covered through Service Releases and Cumulative Updates which are available for a period of 1 year from the date of the software purchase.

3.9 DEPLOYMENT SERVICES AND SYSTEM COMMISSIONING

A. General Requirements

1. The contractor shall engage the services of the Milestone vendor to assist in the management of the deployment of the Milestone at the end-user site on the project.
2. The Milestone vendor services shall include Deployment Management and System Configuration and Commissioning.
3. Provide 4 hours of system programming.

3.10 MANUFACTURER END USER OPERATOR TRAINING

A. The contractor shall engage the services of the Milestone vendor to assist in the end user training of the Milestone at the end-user site for 4 hours of training.

END OF SECTION

SECTION 28 31 02

EXPANSION OF EXISTING FIRE DETECTION AND ALARM SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all detailed engineering, documentation, materials and devices, installation, calibration, software programming and check-out necessary for a complete and fully operational fire detection and alarm system in accordance with the full intent and meaning of the drawings and specifications including, but not limited to, the following:
   1. Supply, install and connect all hardware necessary to provide a complete and operational fire detection and alarm system.
   2. Supply, install and wire all field hardware, power supplies, power circuits, alarm initiating devices, audible and visual alarm devices, auxiliary control relays, signal initiating and signaling devices, conduits, wires, fittings and all accessories required for the system to perform as specified as required. Use and expand the existing fire alarm control panel.
   3. Supply, install, debug and test all software required to provide all software functions described in accordance with the full intent and meaning of the drawings and specifications.
   4. Coordinate the work specified under this Section with other trades and contractors to assure a complete and fully operational system.

B. The intent of fire detection and alarm system work is specified in this section and indicated on the drawings. The installing contractor shall design and provide a complete system, meeting the requirement of this section. The Contractor shall provide all fire alarm and initiation devices in new and renovated areas required for a complete system acceptable to all governing authorities. Provide proper spacing and coverage of all devices.

1.2 RELATED SECTIONS

A. Divisions 22 & 23

B. Fire Suppression Systems

C. Food Service

1.3 CODES / STANDARDS / REFERENCES (LATEST EDITIONS)

A. National Fire Protection Association (NFPA):
   1. NFPA 13 Systems, Installation
   2. NFPA 17 Dry Chemical Extinguishing Systems
   3. NFPA 70 National Electrical Code
   4. NFPA 72 National Fire Alarm Code.
   5. NFPA 80 Fire Doors and Fire Windows
   6. NFPA 90A Standard for the Installation of Air Conditioning and Ventilating Systems.
   7. NFPA 92A Smoke Control Systems
   8. NFPA 101 Life Safety code.
   9. NFPA 105 Smoke Control Door Assemblies
   10. NFPA 2001 Fire Extinguishing Systems, Clean Agent

B. UL: Underwriters Laboratories, Inc.
   1. 217 Single and Multiple Station Smoke Detectors.
   2. 268 Smoke Detectors for Fire Protective Signaling Services.
   3. 864 Control Units for Fire Protective Signaling Services.
   4 864 Transient protection
   5. 1480 Speakers for Fire Protective Signaling Systems
   6. UL Fire Protection Equipment Directory.
   7. UL Electrical Construction Materials Directory.

C. Factory Mutual P7825 Approval Guide

D. American National Standards Institute (ANSI).

E. National Electrical Manufacturer's Association (NEMA).

F. Institute of Electrical and Electronic Engineers (IEEE).

G. Electronic Industries Association (EIA-232-C): Interface between Data Terminal Equipment and Data Communication Equipment Employing Serial Binary Data Interchange.

H. Requirements of American Disabilities Act (Public Law 101-336).

I. Local Accessibility Standards, Codes, and Ordinances

J. State Fire Marshall or Requirements of Local Authorities having Jurisdiction

K. State Insurance Code.

L. National Building Code.

M. International Building Code.

N. Uniform Building Code.

O. Local & State Building Codes.

P. In addition the above requirements, comply with all local codes. Where discrepancies exist between codes, drawings or specifications, the more stringent requirement shall prevail. Installation shall be subject to approval, inspection and test of applicable regulatory agencies.

1.4 MANUFACTURER'S, PLANNER'S AND INSTALLER'S QUALIFICATIONS

A. The manufacturer shall regularly and presently produce, as the manufacturer's principle products, the equipment and material of the type and design specified for this project, and shall have manufactured the item for at least 5 years. All components of the system shall be UL compatible with the existing main fire alarm control panel. Manufacturer of all components shall match existing manufacturers of similar or same type components unless otherwise specified or noted on the drawings.

B. The installing contractor shall have been actively engaged in the business of designing, selling, installing, and servicing fire alarm systems for at least ten (10) years.

C. The entire Fire Detection and Alarm System shall be installed by a factory authorized representative of the existing main fire alarm control panel and certified by the

manufacturer to distribute, sell, and install the specified fire alarm and smoke detection system. Include all components, elements, and testing and acceptance procedures.

D. If the submitted system is being supplied by an authorized distributor of the equipment manufacturer, the distributor shall have been actively engaged in the sale, installation and service of the type of system proposed for this project for a minimum of 10 years.

E. Any proposed installer who cannot show evidence of such qualifications may be rejected. The services of a technician provided and certified by the equipment manufacturer shall be provided to supervise the installation and tests of the system.

F. Furnish evidence there is an experienced and effective service organization, which carries a stock of repair parts for the system to be furnished.

G. The installing contractor shall be licensed by the State Fire Marshall to design, sell, install, and service fire alarm systems as required by the State Insurance Code.

H. The installing contractor shall have on his staff a minimum of two (2) Fire Alarm Planning Superintendent (APS) licensed by the State Fire Marshall's office for such purpose and under whose supervision installation, final connections, and check out will take place as required by the State Insurance Code.

I. The APS shall be a certified NICET Level III state licensed fire alarm planner under whose supervision system design shall take place. In lieu of a NICET certified state licensed fire alarm planner, the contractor or supplier may provide design supervision by a registered professional engineer, who regularly engages in the design of fire alarm systems.

J. The installing contractor shall provide 24-hour, 365 days per year emergency service with factory trained, state licensed service technicians.

K. Material shall be new and in perfect condition when installed.

L. Electrical or electronic equipment provided under this Division which has been damaged, exposed to weather, or is, in the opinion of the Architect/Engineer otherwise unsuitable because of improper fabrication, storage, or installation, shall be removed and replaced with new equipment, at no additional cost to the owner.

1.5 COORDINATION

A. It shall be the responsibility of the installing contractor to coordinate all requirements surrounding installation of the fire alarm system with all other trades.

1.6 DEFINITIONS

A. General: Wherever mentioned in this specification or on the drawings, the equipment, devices and functions shall be defined as follows:
   1. Alarm Signal: A signal, which signifies a state of emergency requiring immediate action and immediate notification of the Fire Department. These are signals such as:
      a. The operation of a manual station.
      b. The operation of a fire suppression system switch.
   2. Pre-Alarm Signal: A signal, which indicates a detection device, has operated. These signals require and immediate response, but do not require immediate notification of the Fire Department.
   3. Supervisory Signal: A signal, which signifies the impairment of fire protection

system, which may prevent its normal operation.

4. Trouble Signal: A signal, which indicates that a fault, such as an open circuit or ground, has occurred in the system.
5. Alarm Zone: An alarm initiating device or combination of devices connected to a single alarm initiating device circuit.
6. Pre-Alarm Zone: A detector or group of detectors connected to a single detector circuit, which can send an alarm to the central control panel.
7. Supervision Zone: A supervisory signal initiating device or combination of such devices connected to a single supervisory signal circuit.
8. Communication Zone: A fire alarm indicating device or series of devices arranged to visually and/or audibly indicate a fire alarm signal.

1.7 SUBMITTALS

A. Before the shop drawings are submitted to Architect / Engineer, submit drawings to the Authority Having Jurisdiction for approval. All approvals shall be noted on the drawings or by letter from the Authority Having Jurisdiction. Submit copies of the Authority Having Jurisdiction approved shop drawings to the Architect for review.

B. Fire alarm submittal shall be bound and separate from all other submittals. The installing contractor and/or equipment supplier shall provide complete and detailed shop drawings and include:

1. Provide a complete written, item-by-item, line-by-line, specification review stating compliance or deviation in full description.
2. Complete point-to-point wiring diagrams of new equipment.
3. Complete floor plan drawings locating all new system devices and existing panels used for expansion.
4. Complete system bill of material.
5. Detailed system operational description. Any specification differences and deviations shall be clearly noted and marked.
6. Provide a complete description of system operation.
7. Manufacturer’s installation instruction.
8. Bound form with contractor's name, supplier's name, project name, state fire alarm license, Fire Alarm Planning Superintendent license and all Technician(s) license adequately identified.
9. Submittal sheets sequentially numbered with the format: sheet number of number total. For example: 1 of 3.
10. Complete set of manufacturer’s operating instructions, circuit diagrams and the information necessary for proper installation, operation and maintenance.
11. Field and factory wiring diagrams of all new systems and for typical devices showing all connections with all terminals and interconnections identified.
12. Complete schematic circuit diagrams for all new equipment, including panel modules.
13. Floor plan drawings including all existing main and new panel and device locations, conduit sizes between devices and panels; number, size and type of conductors between devices and panels; walls, doors and graphic room numbers; exact power requirements and conduit routing with the location of all junction boxes and exact locations of devices and equipment. Submit a floor plan drawing circuiting/zoning shall be identified on the drawings.
14. Complete wiring, routing, and schematic diagrams, software descriptions, and details required to demonstrate that the system has been coordinated and will function as a system.
15. Manufacturers catalog cut sheets shall be provide for each piece of equipment with the appropriate model or part number highlighted in cases where multiple model numbers or part numbers are shown.
16. Detailed list of all hardware components, which are included.

17. Installation details for each type of field mounted device installed under this contract.
18. Point-to-point termination schedules with cable identification numbers and terminal strip numbers.
19. New fire detection and alarm system's panel configuration complete with peripheral devices, batteries, power supplies, and interconnection diagrams.
20. Submit a riser diagram of trunk wiring and device-to-device wiring and device to fire alarm control panel wiring. Riser shall show:
    a. Conduit sizes and types.
    b. Number, size and type of conductors.
    c. Fire detection and alarm devices arranged in the required circuiting/zoning, as defined in the specifications and on the drawing.
    d. Battery calculations to show compliance with the requirements of the specifications for both alarm and supervisory mode.
21. Indicate visual alarm device candela setting required for coverage.
22. Sample of proposed graphic/text annunciation.

1.8 OPERATION AND MAINTENANCE MANUALS

A. Submit complete sets of operation and maintenance manuals. Manual, less as-builts, and sign-off sheets, shall be provided upon completion of the work. Approval of the manual will be required prior to substantial completion.

B. The Operation and Maintenance Manual shall consist of the following:
1. The manual shall include the names, addresses and telephone numbers of each Contractor installing products, and of the nearest service representative for each product. The manual shall have a Table of Contents and tab sheets. Update manuals to include modifications made during installation, checkout and acceptance. The manual shall include the sections described in the following paragraphs.
2. The Functional Design Section shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. Hardware and software functions, interfaces, and requirements shall be provided for system operating modes.
3. The Hardware Section shall describe equipment provided, including general description and specifications, installation and checkout procedure, electrical schematics and layout drawings. Alignment and calibration procedures, manufacturer's repair parts list indicating source of supply, interface definition, signal identification and wiring diagrams. Also, include a complete parts list of all components as well as a list of recommended spare parts. The spare parts list shall include, for each item, the manufacturer's name, the model of the part, and serial number, if appropriate, and a physical and electrical description of the part.
4. The Software Section shall describe programming and testing, starting with a system overview and proceeding to a detailed description of each software module, to instruct the user on programming or reprogramming any portion of the system and other information necessary to enable proper system usage.
5. The Operation Section shall provide instructions for operation of the system, including system start-up procedures, use of system and applications software, alarm presentation (where applicable), failure and recovery procedures, preventive maintenance schedule, parameter schedules and sequence definition, and system access requirements.
6. The Maintenance Section shall provide descriptions of maintenance for equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.
7. The Shop Drawings section shall include copies of all approved shop drawings and submittal materials updated to "AS BUILT".

1.9 AS-BUILT DRAWINGS

A. Prepare and submit detailed “As-Built” drawings. The drawings shall include certified test of the system, testing and acceptance sign-off sheets, and other items specified elsewhere to be performed after initial submission of operation and maintenance manuals, complete wiring diagrams showing connections between all devices and equipment, both factory and field wired. Include a riser diagram and drawings showing the as built location of all devices and equipment. The drawings shall show the system as installed, including all deviations from both the project drawings and the approved shop drawings. The drawings shall be prepared on uniform sized sheets, the same size as the project drawings. The plan drawings shall be 11x17 inch and inserted in the specified Operations and Maintenance Manuals. Provide electronic copies in PDF and Autocad.dwg format.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturers acceptable contingent upon Products’ compliance with the specifications:
1. Match Existing main fire alarm panel manufacturer.

2.2 SYSTEM DESCRIPTION

A. System shall be a fully functional fire detection and alarm system, tested and left in first class operating condition. Voice evacuation systems where required or specified shall have voice alarm notification wherever audible notification is required.

B. The system shall provide communication with initiating and control devices individually. All of these devices shall be individually annunciated at the fire alarm control panel. Annunciation shall include the following conditions for each point:
1. Alarm
2. Trouble.
3. Open
4. Short
5. Device missing/failed.

C. System circuits shall be wired as follows: Initiating device circuit (IDCs) shall be Style B, indicating appliance circuit (IACs) shall be Style Y, and signal line circuit (SLCs) shall be Style 4 as describe in NFPA 72.

D. The system shall contain independently supervised initiating device circuits. The alarm activation of any initiation circuit shall not prevent the subsequent alarm operation of any other initiation circuit.

E. There shall be supervisory service initiation device circuits for connection of all sprinkler water flow switches and valves. Device activation shall cause a general alarm at the fire alarm control panel. Each flow and tamper switch shall have an individual address.

F. There shall be independently supervised and independently fused indicating appliance circuits for all alarm signaling devices. Disarrangement conditions of any circuit shall not affect the operation of other circuits.

G. Auxiliary manual controls shall be supervised so that an “off normal” position of any switch shall cause an “off normal” system trouble.

H. The incoming power to the system shall be supervised so that any power failure must be audibly and visually indicated at the fire alarm control panel. A green “power on” LED shall be displayed continuously while incoming power is present at the building fire alarm control panel.

I. The system batteries shall be supervised so that a low battery condition or disconnection of the battery shall be audibly and visually indicated at the building fire alarm control panel.

J. The system modules shall be electrically supervised for module placement. Should a module become disconnected, the system trouble indicator shall illuminate and the audible trouble signal shall sound.

K. The system shall have provisions for disabling and enabling all circuits individually for maintenance or testing purposes.

L. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 120 VAC power in a normal or supervisory mode for a period of 24 hours with 20 minutes of alarm operation at the end of this period as a minimum. The system shall automatically transfer to the standby batteries upon power failure. All battery charging and recharging operations shall be automatic. If batteries are fully discharged, the charger shall recharge them back to full charge in four hours.

M. All external circuits requiring system operating power shall be 24 VDC and shall be individually fused at the respective fire alarm control panel.

N. All addressable devices shall have the capability of being disabled or enabled individually from the fire alarm control panel.

O. A maximum of 90 addressable devices shall be multi-dropped from a single pair of wires. Systems that require factory reprogramming to add or delete devices within the capability of the designed system are unacceptable. Expansion of the designed system shall be accomplished by factory reprogramming.

P. The communication format to the addressable devices shall be a completely digital poll/response protocol to allow t-tapping of the circuit wiring. A high degree of communication reliability must be obtained by using parity data bit error checking routines for address codes and check sum routines for the data transmission portion of the protocol.

Q. Each addressable device must be uniquely identified by an address code. The system must verify that proper type device is in place and matches the desired software configuration. All remote or external panels shall have an individual address for monitoring.

R. Wiring type, distances, survivability, and wiring configuration types shall be approved by the equipment manufacturer. The system shall allow a line distance of up to 2,500 feet to the furthest addressable device on a Style Y circuit. Fire alarm cable shall have an outer jacket insulation color of red. Minimum wire size shall be #18 AWG.

S. Each panel extender shall have an individual address.

2.3 FIRE ALARM CONTROL PANEL (FACP)

A. Expand existing to remain.

B. The fire alarm control panel shall be left with 25% spare initiating point and battery capacity for future use.

C. New power supplies (if required) shall provide all control panel and peripheral power needs with filtered power as well as unregulated 24VDC power for external audio-visual devices. The audio-visual power shall be increased as needed by adding additional modular expansion power supplies. All power supplies shall be designed to meet UL and NFPA requirements for POWER LIMITED operation on all external signaling lines, including initiating circuits and indicating circuits. Design the system power supplies and power trunk wiring for all annunciation devices required, and to add a minimum of two (2) 110cd visual devices in the future. Individual circuit design loading shall not exceed 70% of power supply and system wiring capacity when including the additional spare capacity for the 110cd visual devices
   1. Input power shall be 120VAC 60Hz. The power supply shall provide internal supervised batteries and automatic charger. The power supply shall provide positive and negative ground fault supervision, battery/charger fail condition, and AC power fail indicators. The power supply shall also provide supervision of modular expansion power supplies as may be required.
   2. Surge protection shall be integral to the control panels.
   3. Each power supply shall be monitored and have an individual address.

2.4 DIGITAL FIRE ALARM COMMUNICATOR

A. Existing to remain.

2.5 EMERGENCY VOICE ALARM COMMUNICATION SYSTEM

A. Expand existing to remain.

B. Compatible and UL listed with existing fire alarm system.

2.6 NEW FIELD DEVICES WHERE REQUIRED

A. All devices shall be supervised for trouble conditions. The fire alarm control panel shall be capable of displaying the type of trouble condition (open, short, device missing/failed). Should a device fail, it shall not hinder the operation of other system devices.

B. Visual Signals
   1. Strobe lights shall be low profile and operate on 24 VDC. The strobe light shall be capable of producing 75 candela on axis to comply with ADA and UL 1638 requirements, and 15, 30, or 110 candela to comply with UL 1971 requirements. Visual signals in common areas of illumination shall have synchronized flash. Provide white with red letters.
   2. All wall mounted strobe units installed in student’s toilets, gymnasiums, corridors, student locker/dressing rooms, kitchen preparation and serving areas, vocational shops, athletic/drill team training rooms, student toilets/restrooms, cafeterias, and commons areas, shall have a protective cover, STI Stopper #STI1221E Series. Provide enviro kit for locations where dampness, water or dust is present.

C. Combination Alarm Signal and High Intensity Visual Signals
   1. Strobe lights shall operate on 24 VDC. The strobe light shall be capable of producing 75 candela on axis to comply with ADA requirements, and 15, 30 or 110 candela to comply with UL 1971 requirements. Visual signals in common areas of illumination shall have synchronized flash. Each unit shall provide a Code 3 Temporal tone. The horn shall be capable of an output of 95dB at 10', and intensity adjusted accordingly for the area of coverage. Electronic Mini-

Sounder or horn set on low setting shall be provided in interior rooms 900 square feet or less. Mini-sounder shall not be used in any corridors, mechanical electrical rooms and similar large spaces and areas of high ambient noise level. Provide white with red letters.

2. All wall mounted combination units installed in student toilets, gymnasiums, corridors, student locker/dressing rooms, kitchens, preparation and serving area, vocational shops, athletic/drill team training rooms, student toilets/restrooms, cafeterias, and commons areas, shall have a protective cover, STI Stopper #STI1220E Series. Provide enviro kit for locations where dampness, water or dust is present.
3. The audible emergency alarms shall produce a sound that exceeds the prevailing sound level in the room or space by at least 15 dba or shall exceed any maximum sound level with a duration of 60 seconds by 5 dba, whichever is louder. Sound levels for alarm signals shall not exceed 110 dba at the minimum hearing distance from the audible appliance.

D. Exterior Audible Signal:
1. Semi-flush mounted, molded of high impact red thermoplastic and listed for weatherproof locations.

E. Combination Voice Signal and High Intensity Visual Signals (where indicated or required by local AHJ):
1. Strobe lights shall operate on 24 VDC. The strobe light shall be capable of producing 75 candela on axis to comply with ADA requirements, and 15, 30 or 110 candela to comply with UL 1971 requirements. Visual signals in common areas of illumination shall have synchronized flash.
2. All combination units installed in student toilets, gymnasiums, corridors, student locker / dressing rooms, kitchens, vocational shops, athletic / drill team training rooms, cafeterias, commons areas, shall have a protective cover, STI Stopper #STI1220E Series. Provide enviro kit for locations where dampness, water or dust is present.
3. The visual signal lens housing shall be white with red lettered FIRE or as approved by Architect. The speaker and visual signal shall be mounted to a common white speaker baffle. The visual signal shall flash at a rate of minimum of 1 Hz and maximum of 3 Hz, and shall use a xenon strobe type lamp or other high intensity long life light source. The lamp intensity shall be a minimum of 75 candela.
4. The speaker shall be UL 1480 compatible with the control equipment. Unit shall operate within a temperature range of 150°F to -30°F. High output speakers, UL minimum 87dB at 10 feet with speaker taps of .33.66/1.25/2.5 watts. Standard output speakers, UL 75-81 dB at 10 feet with speaker taps of .5/1/1.75/2.75 watts. Capacitor for line supervision.

F. Ceiling mounted recessed mounted speakers (where indicated or required by local AHJ) shall be UL 1480 compatible with the control equipment. Unit shall operate within a temperature range of 150°F to -30°F. UL minimum 78-87 dB at 10 feet with speaker taps of .25, .5/1.0/2.0 watts. Round, white baffle or 2x2 lay-in grid with UL enclosure, tile bridge supports when recessed in lay-in ceiling tiles (where indicated or required by local AHJ) and capacitor for line supervision.

G. Surface mounted speakers (where indicated or required by local AHJ) shall be UL 1480 compatible with the control equipment. Unit shall operate within a temperature range of 150°F to -30°F UL minimum 100 dB at 15 watts at 10 feet. Speaker taps via 7-position selector switch, 25-vol., .48/.94/1.8/7.5/15 watts. Fully enclosed wiring terminals. Capacitor for line supervision.

H. Manual Pull Station: Addressable pull stations shall contain electronics that communicate the station's status (alarm, normal) to the control panel over two wires which also provide power to the pull station. They shall be manufactured from high impact red Lexan with white lettering. Station shall mechanically latch upon operation and remain so until manually reset by opening with a key common to all system locks. Pull stations shall be double action without glass rods. The front of the station shall be hinged to a back plate assembly and shall be opened with a key to reset the station. The key shall be common with the control panels. The addressable manual station shall have address setting programmed electronically and automatically from the fire alarm control panel. Manual stations shall be designed for semi-flush (surface) mounting on standard electrical box. All pull stations units shall have a protective cover, STI Stopper II #STI-1130 surface mounted cover with local alarm horn. Provide STI, Weather Stopper II #STI3150 for locations where dampness, water or dust is present.

I. Intelligent Multi-Criteria Photoelectric Smoke Detectors
1. The intelligent multi-criteria detection device shall include the ability to combine the signal of the thermal sensor with the signal of the photoelectric signal in an effort to react hastily in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a false alarm condition by examining the characteristics of the thermal and smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomena.
2. The detectors shall use the photoelectric principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the ANALOG level of smoke density. The detector shall provide automatic sensitivity "drift" compensation. The detector shall also provide a "maintenance alert" feature whereby the detector shall initiate a trouble condition should the unit's sensitivity approach the outside limits of the normal sensitivity window.
3. The detectors shall provide address setting means electronically and automatically at the control panel.
4. The detectors shall provide operational status and alarm state LED. Under normal conditions, the LED shall flash, indicating the detector is operational and in regular communication with the control panel. An output connection shall also be provided in the base for connecting an external remote alarm LED.
5. The detector shall be semi-flush ceiling mounted and be provided with modular detector head with twist lock base. No radioactive material shall be used.
6. Voltage and RF transient suppression techniques shall be employed as well as smoke signal verification circuit and an insect screen.

J. Intelligent Photoelectric Smoke Detectors
1. The detectors shall use the photoelectric principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the ANALOG level of smoke density. The detector shall provide automatic sensitivity "drift" compensation. The detector shall also provide a "maintenance alert" feature whereby the detector shall initiate a trouble condition should the unit's sensitivity approach the outside limits of the normal sensitivity window.
2. The detectors shall provide address setting means electronically and automatically at the control panel.
3. The detectors shall provide operational status and alarm state LED. Under normal conditions, the LED shall flash, indicating the detector is operational and in regular communication with the control panel. An output connection shall also be provided in the base for connecting an external remote alarm LED.
4. The detector shall be semi-flush ceiling mounted and be provided with modular detector head with twist lock base. No radioactive material shall be used.
5. Voltage and RF transient suppression techniques shall be employed as well as smoke signal verification circuit and an insect screen.

K. Duct photoelectric smoke detectors:
1. Detectors shall be analog addressable type.
2. To minimize nuisance alarms, detectors shall have an insect screen and be designed to ignore invisible airborne particles or smoke densities that are below the factory set alarm point. No radioactive material shall be used.
3. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the control panel.
4. Voltage and RF transient suppression techniques shall be employed as well as smoke signal verification circuit and an insect screen.
5. Remote alarm/power LED indicator with test switch shall be provided. Unit shall be wall or ceiling mounted in readily visible and accessible area near the location of detector; exact location of unit to be approved by the Architect/Engineer.
6. Detectors shall operate on the same principles and exhibit the same basic characteristics as area type photoelectric smoke sensors. The detector shall operate in air velocities of 300 FPM to 4,000 FPM. Each detector shall interface directly to the system SLC loop without the requirement of interface zone modules.
7. The unit shall consist of a clear molded plastic enclosure (or remote mounted LED status indicator shall be provided next to the smoke detector) with integral conduit knockouts to provide visual viewing of detector/sensor for monitoring sensor operation and chamber condition. The duct housing shall be provided with gasket seals to insure proper seating of the housing to the associated ductwork. Each unit's sampling tubes shall extend the width of the duct and be provided with porosity filters to reduce sensor/chamber contamination.
8. The detectors shall provide alarm and power status indication by LED. Under normal conditions, the LED shall flash, indicating the detector is operational and in regular communication with the control panel. Steady illumination of the LED shall indicate that the control panel has detected and verified an alarm condition. An output connection shall also be provided in the base for connecting an external remote alarm LED.
9. The detectors shall provide address setting means electronically and automatically from the control panel.

L. Intelligent Thermal Detectors
1. The detectors shall use dual electronic thermostats to measure temperature levels in its chamber and shall, on command from the control panel, send data to the panel representing the analog temperature level.
2. The detectors shall provide address setting means electronically and automatically at the control panel.
3. The detectors shall provide operational status and alarm state LED. Under normal conditions, the LED shall flash, indicating the detector is operational and in regular communication with the control panel. An output connection shall also be provided in the base for connecting an external remote alarm LED.
4. The detector shall be semi-flush ceiling mounted and be provided with modular detector head with twist lock base.
5. Thermal Detectors shall be combination rate-of-rise and fixed temperature- rated at 135°F for areas where ambient temperatures do not exceed 100°F and shall be 200°F for areas where ambient temperatures exceed 100°F but not 150°F. The fixed temperature element shall consist of a fusible alloy retainer and actuator shaft. Detectors shall have a smooth ceiling rating of 2,500 square feet. Detectors shall be located as shown on the drawings and where required by local code authority.
6. Provide fixed temperature 190°F detector in kitchen and kiln room in lieu of combination rate-of-rise / fixed-temperature type.

M. Auxiliary AHU Relays: Air Products model MR-101C relays shall be provided for HVAC

and AHU control and interface. Relays shall be heavy-duty type with contacts rated up to 10 amps at 120V AC, 60 HZ. Relays shall be provided with NEMA I dust cover assembly and be provided with DPDT contacts as well as activated LED indicator.

N. Voltage sensing relays: Addressable control modules for voltage sensing relay interface shall be FCM-1.

O. Monitor Module:
1. Addressable monitor modules shall be provided where required to interface to contact alarm devices. The monitor module shall be used to connect a supervised zone of conventional initiating devices to an intelligent SLC loop.
2. The monitor module shall provide address setting means electronically and automatically at the control panel. A status/alarm LED shall be provided which shall indicate that the monitor module is operational and in regular communication with the control panel, and indicate detection of an alarm condition.

P. Control Module
1. Control/relay modules shall be provided where required to provide audible alarm interface and/or relay control interface. The control module shall be used to connect a supervised zone of conventional indicating devices to an intelligent loop. The zone may be wired class A or class B - field selected. The control module may be optionally wired as dry contact (form C) relay.
2. The control module shall provide address setting means electronically and automatically at the control panel. A status/alarm LED shall be provided which shall indicate that the control module is operational and in regular communication with the control panel and indicate when the device is actuated via the fire alarm control panel.

Q. Auxiliary Interface Points: All auxiliary input points (kitchen hoods, water flow, tamper switches, fire extinguishing systems etc.) shall be connected as required, and addressed as a separate initiating point of annunciation at the fire alarm panel and any remote annunciator as required.

R. Water flow switches / Valve supervisory switches shall be provided and installed by the fire protection contractor and connected by the fire alarm contractor. Wiring of these field devices to the fire alarm system shall be the responsibility of the fire alarm contractor. It is the responsibility of this contractor to ensure the proper function of the system. Each fire protection zone (flow switch) and (Valve switch) shall be addressed electronically and automatically at the control panel as a separate point of annunciation at the fire alarm panel. Coordinate exact location with fire protection contractor and civil drawings.

S. Beam detectors:
1. Microprocessor based beam detectors, consisting of a separate transmitter and matching receiver.
2. Coverage up to 350 ft. X 60 ft.
3. LED status indicators for normal (green), alarm (red), and trouble (yellow).
4. The detectors shall provide address setting means electronically and automatically at the control panel.

2.7 MAGNETIC DOOR HOLDERS, AUTOMATIC FIRE DOORS / SHUTTERS, AND SECURITY GRILLES AND INTERIOR SPACE CONTROLLED ACCESS EGRESS DOORS WITH AUTOMATIC EMERGENCY EGRESS ELECTRIC LOCK EMERGENCY RELEASE

A. Magnetic fire door hold open devices, interface for automatic roll down fire doors/shutters, and interface for security grilles and controlled access egress doors with emergency

egress shall be provided. Coordinate with Division 8 and Architectural Drawings for exact location.

B. The operation of any alarm in the fire alarm system shall cause the following:
1. Release of the magnetic fire door holding devices, permitting the fire doors to be closed by the door closer.
2. Permit the automatic roll down fire doors/shutters to close automatically.
3. Permit the security grilles with emergency egress to open automatically.
4. Unlock the electrically controlled access doors in all interior spaces.

C. The magnetic door holders, automatic roll down fire doors/shutters, security grilles, and interior electrically controlled access doors with emergency egress, shall be associated with two smoke detectors located on the ceiling with one on either side of the fire door/shutter, security grille opening, or interior egress path electrically controlled door. The operation of either of these detectors shall also cause the magnetic holder to release the fire door, the automatic fire door/shutter to close, and the security grille with emergency egress to open.

D. The operation of smoke detectors associated with a magnetic door holder, automatic roll down fire door, security grille, or electrically controlled access door shall transmit a pre-alarm signal to the fire alarm panel.

2.8 REMOTE PAGING UNIT

A. Remote all-call paging unit or to activate one of the pre-recorded messages over the speaker circuits.

2.9 REMOTE ALPHANUMERIC DISPLAY ANNUNCIATORS

A. (Where indicated or required by Local Authority Having Jurisdiction) Remote alpha-numeric annunciator(s) to annunciate all system events and duplicate the displayed status at the main FACP. The annunciator(s) shall be an 80-character display similar to the main FACP and operate via the system RS485 or RS232 serial output terminal from the main FACP. The unit shall operate from FACP 24VDC power and function during system power failure while the system resides on standby batteries. The remote annunciator(s) shall include:
1. Integral time/date clock
2. System reset
3. System silence
4. System acknowledge
5. Display/step switch
6. Integral trouble buzzer
7. LCD contrast adjust
8. Fire Drill Operation

B. Annunciator shall upon command display the first system alarm, last alarm, and system alarm count. The following primary controls shall be visible through a front access panel:
1. 80 character alphanumeric display, LCD, LED, or gas plasma
2. Individual red system alarm LED
3. Individual yellow supervisory service LED
4. Individual yellow trouble LED
5. Green “POWER ON” LED
6. Alarm acknowledge key
7. Trouble acknowledge key
8. Alarm silence key
9. System reset key

10. LED test

PART 3 - EXECUTION

3.1 EXPANSION OF EXISTING SYSTEM

A. Testing of existing systems:
1. Provide complete operational test of existing fire alarm system prior to any demolition or construction. Verify operation of each device, control panel, distribution equipment and associated accessories.
2. Provide a complete written report to the Architect, indicating any deficiencies of the existing system in relation to each component's intended function. In addition, provide deficiencies of the existing system with regard to current Code, ADA, and Local Accessibility Standards requirements. Provide the written report 14 days prior to any work related to the expansion of the existing system.
3. Testing of the existing system shall include all areas and all buildings served by the existing system.

B. Expand the existing system in all expansion or renovation areas to include requirement specified and as required by the local authority having jurisdiction. Verify compatibility of new equipment with existing system.

C. Provide smoke detectors in the following locations in addition or renovated areas:
1. All paths of egress and adjoining spaces within the same envelope including but not limited to: corridors, hallways, stairs, lobbies, and elevator landings.
2. At each electrical room, telecommunications/data room, elevator machine room, kiln room, and mechanical room not subject to un-treated or un-filtered outside air.
3. At each computer lab/room.
4. At each library or book storage room.
5. At each storage room, stock room, or warehouse space.
6. At each pre-K and kindergarten classrooms.
7. At nurse's area/clinic and patient care/cot areas.
8. At each special needs, life skills, adaptive behavior, developmental classrooms or similar designated areas without food preparation or cooking equipment.
9. At each student toilet/restroom. Provide STI protective covers. Do not locate over plumbing fixtures or near partitions.
10. Provide duct smoke detectors in all air handling units and outside air units with air volumes of 2,000 cfm or larger.

D. Provide heat/thermal detectors in the following locations in addition or renovated areas:
1. At each mechanical room subject to un-treated or un-filtered outside air.
2. At each janitor's closets and laundry rooms.
3. At each commercial kitchen and adjoining storage rooms; at each food preparation area.
4. At each employee break room.
5. At each vocational shop.
6. At each science, physics, chemistry, or biology classroom and their associated preparation and storage rooms.
7. At each special needs, life skills, adaptive behavior, developmental classrooms or similar designated areas with food preparation or cooking equipment.

E. Provide manual pull stations in addition or renovated areas at each exterior exit and at each exit from all floors.

F. Provide weatherproof exterior audio/visual alarm devices mounted on the building at the

following locations:
1. Main entry.
2. Courtyards or outdoor assembly areas adjacent to the building.
3. Mechanical yards adjacent to the building.
4. Covered playgrounds or covered assembly areas adjacent to the building.

G. Provide beam type detectors at the following locations when appropriate:
1. Atriums.
2. High ceiling corridors where maintenance of spot type detectors may be difficult.
3. Areas with skylights.

H. Provide audio and visual alarm devices in all areas normally occupied by students or minors.

I. Provide carbon monoxide detection and smoke detection devices in all areas designated as day-care for minors.

3.2 GENERAL REQUIREMENTS

A. Installation shall include the delivery, storage, setting in place, fastening to the building structure, interconnection of the system components, alignment, adjustment and all other work, whether or not expressly specified, which is necessary to result in a tested and operational system.

B. All installation practices shall be in accordance with, but not limited to, the specifications and drawings. Installation shall be performed in accordance with the applicable standards, requirements and recommendations of the National Electrical Code and any authorities having jurisdiction. Proper protection against corrosion shall be provided on all electrical equipment in accordance with the requirements of the National Electrical Code. The installation shall conform to all manufacturers' recommendations.

C. All equipment shall be firmly secured in place unless requirements of portability dictate otherwise. Fastenings and support shall be adequate to support their loads with a safety factor of at least three.

D. All boxes, equipment, etc., shall be plumb and square. The contractor must take such precautions as are necessary to prevent and guard against electrostatic hum, to supply adequate ventilation, and to install the equipment to provide reasonable safety for the operator.

E. In the installation of equipment and cables, coordinate with Architectural drawings for possible conflicts with millwork, casework, marker boards, furniture, lockers, etc., and notify the architect of any discrepancies. Verify modifications before proceeding with installation.

F. Mount end-of-line resistor for each box circuit in backbox located at the last manual alarm station or automatic initiating device in a circuit. Mark device accordingly in the field.

G. Contractor shall submit on completion of system verification, a point-by-point check list indicating the date and time of each item inspected and issue a certificate confirming that the inspection has been completed and the system is installed and functioning in accordance with the Specifications prior to date of substantial completion.

H. Provide remote alphanumeric display annunciators as required by the Local Authority Having Jurisdiction and/or where indicated on the drawings.

I. Provide remote paging units adjacent to each remote alphanumeric display communicator for voice alarm system.

J. Alarm devices shall be ceiling mounted unless indicated specifically otherwise. Alarm devices in Mechanical, Electrical, Communications, IDF / MDF Rooms and Central Plant shall be wall mounted and coordinated with other equipment, piping and ductwork.

K. Detectors shall be installed per NFPA 90A and be listed with the fire alarm control panel.

L. Power for magnetic door holders should be provided from the nearest receptacle circuit wired through fire alarm relay.

M. Smoke detectors shall be mounted to a 4-inch octagon box with hanger bar or with box secured to building structure.

N. Provide power via 120-volt, 20-Amp dedicated circuits with lock-on provisions at the respective circuit breaker for each new main fire alarm control panel, each new panel extender and each new remote power supply at no additional cost to the Owner. The complete fire alarm system shall be powered under emergency power when emergency life safety power is available at the project site. When emergency life safety power is not available at the project site, power shall originate from the nearest available 120-volt panel, or as indicated.

3.3 CABLE AND BOXES INSTALLATION

A. All circuits shall be protected to avoid interruption of service due to short-circuiting or other conditions, which might adversely affect the connected devices. Each individual signaling circuit shall be classified as a circuit pair.

B. All cabling in racks, cabinets and junction boxes shall be neatly strapped, dressed and adequately supported. Cable installation shall conform to good engineering practices and to the standards of the National Electrical Code.

C. Cables shall be terminated with the proper connector required for the associated operation of the equipment to which it is connected. Screw terminal blocks shall be furnished for all cables, which interface with racks, cabinets, consoles or equipment modules.

D. All cables within a rack, console or junction box shall be grouped according to the signals being carried to reduce signal contamination.

E. Where shielded conductors enter a panel or enclosure, and where power wiring exists, provision shall be made to provide physical isolation of signal and power conductors.

F. Supply and install all fittings and accessories whether or not they are specified, required for proper, safe and reliable operation of the system.

G. All wire shall be installed in an approved conduit/raceway system (except where permitted by NEC and the local authority having jurisdiction). Maximum conduit fill shall not exceed 40%.

H. Minimum conduit size shall be 3/4" EMT with insulated bushings. Install conduit per engineered shop drawings.

I. Systems utilizing open wiring techniques with low smoke plenum cable shall provide conduit in all inaccessible locations, inside concealed walls, all mechanical/electrical

rooms, or other areas where wiring might be exposed to view and or subject to damage.

J. All vertical wiring and all main trunk/riser wiring shall be installed in a complete raceway/conduit system. All riser boxes shall be adequately sized for the number of conductors transversing the respective box as well as the number of terminations required.

K. All junction boxes containing fire alarm wiring are to be painted red.

L. All plenum wiring is to be installed parallel and perpendicular to the building structure. Cable shall be bundled with cable ties on a maximum of 2'-6". Install cables in D-ring hangers secured to the structure at a maximum of 5' on center. Cable shall not lie on ceiling grid or ceiling tiles, light fixtures, piping, ductwork or foreign equipment.

M. The system ground is to be connected to the local ground bus. Under no conditions shall the AC neutral either in a power panel or in receptacle outlets be used for a reference ground.

N. All wiring shall be in accordance with NFPA 72, the National Electrical Code, and Local Codes. All wiring sizes shall conform to recommendations of the equipment manufacturer, and as indicated on the engineered shop drawings.

O. All wire shall be UL Listed FPL for limited energy (300V) and fire alarm applications and shall be installed in conduit. Limited energy FPLP or MPP wire may be run open in return air ceiling plenums provided such wire is UL Listed for such applications and is of the low smoke producing fluorocarbon type and complies with NEC Article 760 and approved by the local authority having jurisdiction.

P. No other wiring shall be run in the same conduit as fire alarm wiring.

Q. All fire alarm wiring to be red. All fire alarm circuits shall be identified at each termination and at each 25 feet between terminations.

R. Copper wiring leaving or entering main building shall be protected on both ends with surge suppression; otherwise use fiber-optic cabling.

3.4 ALARM SYSTEM SEQUENCE OF OPERATION

A. General:
1. All fire alarm circuits shall be electrically supervised.
2. Automatic response functions shall be accomplished by the first device initiated. Alarm functions resulting from initiation by the first device shall not be altered by subsequent alarms. An alarm signal shall be the highest priority. A pre-alarm signal shall have second priority and supervisory or trouble signals shall have third and fourth level priority. Signals of a higher level priority shall take precedence over signals of lower priority even though the lower priority condition occurred first.

B. Fire alarm operating sequences shall be as follows:
1. Activation of any automatic detector, manual station, or sprinkler flow switch shall cause the location of alarm to be identified in an audible and visual manner at the building fire alarm control panel (FACP), and shall initiate the following events:
a. The system common alarm LED on the CPU Module shall flash. The internal audible trouble device shall sound. Acknowledging the alarm condition shall silence the audible trouble device and revert the flashing common alarm LED to a steady state.

b. The 80-character display shall indicate all applicable information associated with the alarm condition including: zone, device type, device location, and time of alarm. Location and zoning messages shall be custom field programmed to respective premises.
c. Any remote or local annunciator LED's associated with the alarm point shall be illuminated as herein specified.
d. The remote signaling connection shall be activated relaying the alarm signal to an approved central station (central station connection and service provided by Owner). Point ID and descriptor must be sent and received.
e. All automatic events programmed to the alarm point shall be executed and the associated indicating devices and/or outputs activated.
f. Activate all audible/visual alarm devices. Where prerecorded voice announcement is required or specified, the prerecorded announcement shall be preceded with attention tone(s), followed by the approved prerecorded announcement and continue in a cycle until the system is reset. Manual voice announcement shall interrupt the prerecorded cycle and the prerecorded cycle shall resume automatically after three minutes.
g. De-activate all HVAC systems.
h. De-energize the kitchen hood supply/exhaust fans as required by local authority having jurisdiction.
i. Close all related smoke dampers.
j. Close all related smoke/fire dampers.
k. Release all magnetic door hold open devices.
l. Open all security grilles with emergency egress.
m. Activate to close all related fire and smoke doors and shutters.
n. Activate signaling connection to the elevator as required by the local authority having jurisdiction.
o. Signal the building automation system and security system, and Owner’s security/police personnel as directed by Owner/Architect. The audible alarms shall be inhibited from being silenced for a period of 3 minutes after commencing operation unless alarm is acknowledged and appropriate action has been taken.
p. Release the electric strike, unlocking, but not unlatching, locked doors controlled by an access control system. Release Counter Shutters and hold-open devices on all fire and smoke doors.
q. Activate automatic recall operation of elevators as required by local authority having jurisdiction.
r. Record all events on the system printer when an existing printer is part of the system.

2. Activation of duct mounted smoke detector on the HVAC equipment, or a smoke detector mounted in the return/supply air stream of any fan shall shut down all units as required by NFPA. The activation of one of these detectors shall initiate the Alarm Sequence of Operation.
3. Activation of a control valve supervisory switch shall initiate the following events:
   a. The activation of any sprinkler valve supervisory (tamper) switch shall activate the system supervisory service audible signal and illuminate the LED at the building fire alarm control panel (FACP). Differentiation between valve tamper activation and opens and/or grounds on the initiation circuit wiring shall be provided.
   b. Activation of a sprinkler system control valve supervisory switch shall not prevent the events listed under Article 3.4.
   c. Restoring the valve to the normal position shall cause the supervisory service audible signal to pulse, indicating the restoration to normal position. The supervisory service reset key shall be provided to silence the audible signal.

4. Activation of the smoke detector and heat detector in the elevator machine room and at top of elevator shaft shall cause the elevators' controllers to be tripped by way of the shut trip breaker, and shall also initiate the events listed under Article 3.4.
5. Any subsequent fire alarm shall reactivate the alarm indicating appliances and activate the respective control sequences described above.
6. Upon reset of the fire alarm control panel, HVAC units shall be capable of being started, and resume normal operation.

C. Activation of the manual evacuation pull station shall operate the alarm indicating appliances without causing other control circuits to be activated. However, should true alarm occur, all alarm functions should occur as described.

D. ALARM VERIFICATION shall be field programmed for each respective detector. Global verification will not be acceptable. The verification sequence is activated after a "check" procedure and the panel will wait a field programmable delay period (0-50 seconds) then proceed to re-sample the detector for continued presence of smoke. If the alarm condition still exists or a non-verified device is actuated during the verification period, the system will then initiate all alarm sequences specified herein. The system shall incorporate the ability to log in memory the number of verification events that have occurred for each selected device.

3.5 EQUIPMENT IDENTIFICATION

A. Each new panel or equipment enclosure shall be provided with a permanently engraved or embossed or silkscreen identification tag. The tag shall include the following information:
1. Name of manufacturer.
2. Manufacturer's equipment description.
3. Serial number and model number.
4. Voltage and current rating.

3.6 SPARE PARTS AND TOOLS

A. Interchangeable Parts: All spare parts furnished shall be directly interchangeable with the corresponding components of the installed system. Spare parts shall be packaged and identified by nameplate, tagging, or stamping. Spare parts shall be delivered to the site in unopened cartons for storage as directed by the Owner.

B. Spare Parts: Provide minimum of one, or 5% of renovation area total, whichever is greater unless noted otherwise.
1. Spare shut down modules
2. Spare detectors of each type in the system
3. Spare alarm indicating devices of each type in the system
4. Spare manual pull stations
5. Spare protective covers of each type in the system.
6. Spare relays/controls required for connection to smoke and fire/smoke dampers
7. Devices listed above are to be installed as directed by Architect/Engineer or local code authorities at no additional cost to the Owner. Unused spare parts are to be parts for Owner's cabinet.
8. Provide one telescopic pole for each type of area detector located above 12 feet AFF to facilitate removal and installation of detector head.

C. Provide two copies of the final software programmed into the fire alarm system.

D. Parts list: Furnish a list, in duplicate, of all other parts and accessories the manufacturer

of the system recommends to be stocked for maintenance.

3.7 KEYS

A. Keys and locks for all equipment shall be identical to the existing building master key for the fire alarm system.

3.8 SMOKE DAMPERS AND FIRE/SMOKE DAMPERS

A. Smoke dampers and combination fire/smoke dampers shall be controlled by an automatic alarm initiating device. Smoke dampers installed to isolate the air handling system shall be arranged to close automatically when the system is in alarm.

B. Coordinate motor operator voltage with supplier.

C. Open all dampers prior to starting air handling equipment.

D. Provide 120V power from nearest general purpose 20A receptacle circuit as required, or as noted otherwise.

3.9 GRAPHIC FLOOR PLANS

A. Provide updated color coded floor plan detailed with actual room names, actual graphic room numbers as directed by the Owner and adequate information to direct people to the fire alarm devices in alarm and to exits with non-fading floor plan media. Do not use architectural plan room names and numbers.

B. Each plan shall clearly relate the room numbers on the annunciator to the area description on the floor plan. All fire alarm devices located to correspond with the annunciator.

C. The floor plan shall be solvent welded in acrylic plastic.
1. Mount in an extruded aluminum frame next to the main fire alarm control panel.

D. Install graphic floor plans as directed by Architect/Owner prior to substantial completion. Each area or room designation shall be verified with the fire alarm device during testing.

3.10 ADDITIONAL REQUIREMENTS

A. Coordinate with Owner for appropriate off-site monitoring service and communication technology to be used. Provide all necessary programming for interfacing with the Owner’s on-site and off-site remote signaling receiving station, including programming of descriptors and addresses at the receiving station.

B. The contractor is to ensure all areas of the renovation and new construction are covered with visual and audio alarm devices for occupant notification of a fire alarm including remote portable or temporary buildings.

C. Coordinate door hold devices with door and door hardware.

D. Provide interface with and coordinate shunt-trip circuit breakers and control devices with kitchen hood fire control systems (where new kitchen hood fire control systems are provided) and elevator equipment (where new elevators are provided).

E. Alarm circuit power supplies and circuiting shall be designed and installed to accept an additional five (2) 110cd visual devices for future expansion. The initial design shall not

exceed 70% of the rated power supply and circuit capability with the two additional 110cd devices installed.

F. Provide programming or re-programming of all hot keys as directed by Owner including, but not limited to, fire drill, AHU shutdown bypass, horn/strobe disable, elevator test.

3.11 COMMISSIONING THE SYSTEM

A. The installing contractor shall be responsible for verifying that each new or relocated component of the system is fully operational and in conformity with the specifications. He shall also be responsible for insuring that all elements function together as a system in accordance with the specifications.

B. A state licensed and factory trained technical representative of the manufacturer with NICET Level 3 minimum certification shall supervise the final control panel connections and testing of the system. Upon completion of the acceptance tests, the owner and/or his representatives shall be instructed in the proper operation of the system.

C. The installing contractor shall functionally test each and every device in the entire system for proper operation and response. Any new or relocated items located within the construction or renovation area found not properly installed or non-functioning shall be replaced or repaired and retested. The final test indicating a fully functional fire alarm system shall be recorded; electronic Excel and printed copy submitted to the Architect, Engineer and Owner.

D. The installing contractor shall provide a complete written report and printout of the functional test of the entire system after all existing deficiencies of the existing system have been corrected by the Owner, or as directed by the Owner. The test report shall be signed and dated by the licensed fire alarm superintendent responsible for supervising the final system test and checkout. This test shall be completed and accepted by the Owner prior to testing for the local Fire Marshall.

E. The installing contractor's fire alarm superintendent shall test the entire system in the presence of the local authorities having jurisdiction. The contractor shall be responsible for making any changes, adjustments, or corrections, as may be required by the local authorities. The Contractor shall affix his certification label and installation certificate to the interior of the main fire alarm control panel.

F. The testing and acceptance shall be performed within 30 days after the fire alarm installation is completed. The test shall be performed by a minimum of two qualified fire alarm system technicians acceptable to the authority having jurisdiction. The test which is a comprehensive 100 percent inspection and test of all fire alarm system equipment shall include the following:
   1. Fire alarm control equipment: a visual and functional test of the fire alarm control and auxiliary control equipment.
   2. A visual inspection shall be conducted to establish that all electrical connections and equipment, as required, are properly installed and operating.
   3. A functional fault simulation test shall be conducted on all relevant field wiring terminations to ensure that wiring is properly supervised as required.
   4. Indicators shall be tested to ensure proper function and operation.
   5. Control panel auxiliary functions shall be functionally tested to verify proper operation.
   6. Control panel supervisory and alarm current readings shall be taken to verify that the control panel has the appropriate power supplies and standby batteries to operate the system as required. A three-minute general alarm stress test, both under AC power and standby power, shall be conducted to further ensure

complete operation of the system.

7. Fire alarm peripheral devices; All fire alarm peripheral devices shall be functionally tested and the location and testing information recorded for each device.
8. Manual initiating devices:
   a. Each manual fire alarm station shall be functionally tested for alarm operation.
   b. Each manual fire alarm station shall be functionally tested for proper wiring supervision.
9. Automatic initiating devices:
   a. Each automatic initiating device shall be activated in accordance with manufacturer's instructions to ensure proper operation.
   b. Each automatic initiating device shall be functionally tested for proper wiring supervision.
   c. Each automatic initiating device shall be inspected to ensure proper placement and mounting as required by specifications.
10. Alarm signaling devices:
   a. Each alarm signaling device shall be tested and decibel reading taken at 10' from the device and recorded to ensure proper operation. Each area's voice alarm signaling devices shall be tested for intelligibility.
   b. Each alarm signaling device shall be functionally tested for proper wiring supervision.
   c. Decibel reading shall be taken to ensure that the alarm signal level can be clearly heard in all areas of the facility.
   d. All visual alarm indicators shall be functionally tested to ensure proper operation and that they are clearly visible.
11. Elevators: Each elevator shall be tested and automatic recall function verified.
12. Reporting: Upon completion of the initial verification audit, a report shall be sent to the Architect/Engineer indicating that all fire alarm equipment has been tested and is in 100 percent operation. The report shall also contain the audit testing information as to the location and operational status of each peripheral device. The 100 percent audit shall be performed by a factory-trained representative. The report shall include the voice intelligibility performance in each area and indicate compliance with NFPA and local AHJ requirements.

G. It is the intent of these specifications and of the Architect/Engineer that a continued program of system maintenance will be provided by the Owner in compliance with NFPA 72. It is mandatory that the installing Contractor provide such services and make available these services to the Owner upon completion of the project.

H. Upon completion of installation and full acceptance testing, submit NFPA 72 certificate of compliance that the total fire alarm system, including any subsystems, is fully functional and that the components are UL listed for function intended.

3.12 SUBSTANTIAL COMPLETION

A. Final acceptance of the FIRE ALARM SYSTEM by the owner, local code authorities and Occupancy Permit has been issued.

B. All fire alarm system shop drawings, operating and maintenance manuals, maps and as-built drawings shall be submitted to and accepted by the Architect / Owner prior to date of substantial completion.

3.13 WARRANTY

A. All new fire alarm devices, new panels, new equipment and new accessories, including

labor and material, shall be free from defects in workmanship and materials, under normal use and service, for a period of one year from the date of substantial completion. Any equipment or workmanship shown to be defective shall be repaired, replaced or adjusted during normal working hours at no cost to the owner within 4-hour notification.

B. Repair services and replacement parts for the system to be furnished under this Contract shall be available for a period of ten years after the date of final acceptance. Service during the warranty period shall be provided within four hours after notification and all repairs shall be corrected within 24 hours after notification throughout the warranty specified in this section.

C. The installing contractor shall provide 24 hour, 365 days per year emergency service with factory trained, state licensed service technicians.

D. The equipment manufacturer shall be represented by a local service organization and the name of such shall be furnished to the Owner, Architect, and Engineer.

E. Provide a certified fire alarm test of the complete system at the end of the warranty period and correct any and all items located in the area of renovation to bring the system to an approved status at no cost to the Owner. Clean all smoke detectors and replace all defective parts within the area of renovation at no cost to the Owner.

F. Guarantee labor, materials, and equipment provided under this contract against all defects for a period of one year after the date of final acceptance and receipt and approval of “As-Built” drawings and schematics of all equipment.

END OF SECTION