Salt Lake City
Department of Airports

SALT LAKE CITY INTERNATIONAL AIRPORT

PROJECT MANUAL FOR

PUMP HOUSE 5 RENOVATIONS

PROJECT NO. 54 1019 1763

ENGINEERING DIVISION

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SECTION 221410 - PLUMBING PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Water Piping.

B. Testing.

1.2 RELATED REQUIREMENTS

A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these documents.

B. Section 230500 - Basic Mechanical Requirements.

1.3 RELATED SECTIONS

A. Section 230529 - Basic Mechanical Materials and Methods.

B. Section 230540 - Mechanical Sound and Vibration Control.

C. Section 230548 - Mechanical Seismic Control.

D. Section 230700 - Mechanical Insulation.

E. Section 221411 - Disinfecting Water Supply System.

1.4 SUBMITTALS

A. Submit Product Data for the following items under provisions of the General Conditions of the Contract:

1. Water Piping, Fittings, and Joints.

PART 2 - PRODUCTS

2.1 WATER PIPE, TUBE, FITTINGS AND JOINTS

A. Interior Buried:

1. Provide type K annealed (soft) copper water tube conforming to ASTM B-88 with 95% tin 5% antimony solder joints using wrought fittings. No joints below grade. Provide continuous tube for all buried tubing using tube bends in lieu of fittings. Exterior tube may be coupled where requirements are in excess of standard mill lengths by using wrought pressure couplings with stops and silver solder brazed Joints. Lengths coupled in this manner, where necessary and acceptable to the Engineer, will meet the intent of the no fitting requirement of this Specification. Interior buried tube shall meet the same criteria and requirements.

B. Interior Tube Supported by Hangers and Clamps:

1. Provide ASTM B88 Type L hard drawn copper tube for all water distribution piping inside building/structure, with wrought copper fittings and couplers up to 6", cast brass or bronze fittings and couplers for sizes 6" and larger. Joints shall be 95-5 Class SnSb solder or Victaulic CTS roll-grooved couplers and fittings for 3” and larger tube.

PART 3 - EXECUTION

3.1 WATER TUBE, FITTINGS AND JOINTS

A. General:

1. All copper tube and fittings shall be reamed and buffed prior to soldering or brazing.
2. The use of lead solder of any class, for joint make-up or back-up for finishing is prohibited.
3. Refer and conform to the Copper Development Association instructions for proper preparation and actual installation practice for all soldered and brazed joints.
4. Support water tube in accordance with Section 230529.
5. Pull tee (T-drill) fittings are forbidden.

3.2 CLEANING

A. Remove temporary coverings and protection of adjacent work areas.

B. Repair or replace damaged installed products.

C. Clean installed products in accordance with manufacturer’s instructions prior to owner’s acceptance.

D. Remove construction debris from project site and legally dispose of debris.

3.3 PROTECTION

A. Protect installed work from damage due to subsequent construction activity on the site.

3.4 PROHIBITED PIPE ROUTING

A. Plumbing piping, regardless of contents (water, sewer, vent, etc.) shall not be routed through or above the following locations:

1. Electrical panel rooms
2. Electrical switch gear rooms
3. Electrical transformer rooms
4. Elevator shafts
5. Elevator equipment rooms
6. Data Centers
7. File Server Rooms / MDF / IDF

B. Should there be a conflict with the plans and the above paragraph, notify the Engineer immediately for corrective action prior to starting work.

3.5 TESTING

A. Schedule of Testing:

Service	Allowable Test Methods H_2O	CA	N_2	V	Minimum Test Pressure (psig)	Minimum Test Period (minutes)	Allowable Pressure Variance (psig)
1. Potable Water Pipe Valves & Fittings	X	X			125 100	60 60	-0- +1/2

B. Testing connections for hydrostatic tests shall be made at the base of the system, CA, N2 and vacuum testing can be made from connections anywhere in the system tested.

C. In the event that tests fail, use a standard soap and brush inspection using "Trouble Bubble" Liquid high density soap as manufactured by Jersey Meter Co., Patterson N.J. Formula ST-1. After source of failure is discovered, correct and retest system. Repeat procedure until system sustains required testing successfully.

D. Testing contractor shall give at least 16 working hours notice to the General Contractor/Construction Manager so that arrangements for witnessing tests can be made. The General Contractor/Construction Manager shall witness and SIGN the required test form.

E. All joints, valves, fittings and piping accessory items shall be exposed to view during tests whether pipe is above or below ground. "Closed in" or "Buried" piping shall be re-exposed during testing.

F. Proper restraining of piping and test plugs shall be accomplished prior to test.

END OF SECTION 221410

SECTION 221411 - DISINFECTING WATER SUPPLY SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Disinfection of Domestic Water Supply System.

1.2 RELATED WORK

A. Requirements: Provide Disinfecting Water Supply System in accordance with the Contract Documents.

B. Section 230500 - Basic Mechanical Requirements.

C. Section 221410 - Plumbing Piping.

1.3 DEFINITIONS

A. Disinfectant residual means the quantity of disinfectant in treated water.

B. pH factor means the measure of alkalinity and acidity in water.

C. ppm means parts per million.

1.4 CONTRACTOR'S QUALIFICATIONS

A. Water Treatment Contractor: At least three years experience performing work specified herein.

B. Bacteriological Laboratory: Certified by Serving Water Board or District and be in compliance with the State and U.S. Safe Drinking Water Act.

1.5 REGULATORY AGENCY REQUIREMENTS

A. Comply with requirements of Local and State Regulations.

1.6 SUBMITTALS

A. Submit for review and acceptance the following items under provisions of the General Conditions of the Contract:

1. Water treatment contractor's evidence of experience.
2. Bacteriological laboratory's evidence of certification.

B. Submit printed data for the following items under provisions of Operating and Maintenance Data paragraph in Section 230500:

1. Disinfection Report:

a. Include the following:

Date issued.

Project name and location.

Treatment Contractor's name, address, and phone number.

Type and form of disinfectant used.

Time and date of disinfectant injection start.

Time and date of disinfectant injection completion.

Test locations.

Initial and 24 hour disinfectant residuals in ppm for each outlet tested.

Time and date of flushing start.

Time and date of flushing completion.

Disinfectant residual after flushing in ppm for each outlet tested.

2. Bacteriological Report:

a. Include the following:

Date issued.

Project name and location.

Laboratory's name, certification number, address and phone number.

Time and date of water sample collection.

Name of person collecting samples.

Test locations.

Time and date of laboratory test start.

Coliform bacteria test results for each Outlet tested. Certification that water conforms or fails to conform to bacterial standards of State and Federal Safe Drinking Water Act.

Bacteriologist's signature.

1.7 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Protect against damage and discoloration.

B. Maintain caution labels on hazardous materials.

C. Maintain storage room dry and with temperatures as uniform as possible between 60 deg.F and 80 deg.F.

D. Do not store Caustic Soda directly on floor colder than 55 deg.F.

1.8 PROTECTING WORK OF OTHER TRADES

A. Provide necessary signs, barricades, and notices to prevent any person from accidentally consuming water or disturbing system being treated.

B. Protect against damage and discoloration caused by work of this Section.

PART 2 - PRODUCTS

2.1 DISINFECTANT

A. Free chlorine; liquid, powder, tablet, or gas.

2.2 ALKALI

A. Caustic Soda or Soda Ash.

2.3 ACID

A. Hydrochloric type.

PART 3 - EXECUTION

3.1 EXISTING CONDITIONS

A. Prior to starting work, verify that Domestic Water System is completed, flushed and clean.

B. Prior to starting work, notify Construction Manager/General Contractor of any defects requiring correction.

C. Do not start work until conditions are satisfactory.

3.2 PREPARATION OF WATER FOR TREATMENT

A. Verify pH factor of water to be treated.

B. If pH factor is less than 7.4, introduce sufficient alkali during disinfectant injection to produce 7.4 to 7.6 pH level.

C. If pH factor is greater than 7.6, introduce sufficient acid during disinfectant injection to lower pH to 7.4 to 7.6 level.

3.3 SYSTEM TREATMENT

A. Inject disinfectant throughout system to obtain 50 to 80 ppm residual.

B. Starting at outlet closest to water sources, bleed water from each outlet until water produces odor of disinfectant. Repeat process at each outlet throughout system.

C. Test for disinfectant residual at each of the following locations:

1. Ends of piping runs.
2. Remote outlets. (Ends of each multiple fixture branch line)
3. Tanks and domestic water heaters.
4. At least 15% of outlets on each floor as directed by Architect/Engineer.

D. Maintain disinfectant in system for 24 hours.

E. If resultant disinfectant residual test is less than 25 ppm, repeat System Treatment.

3.4 FLUSHING

A. Flush disinfectant from entire system; permit no more than residual rate of supplied incoming water.

3.5 BACTERIOLOGICAL TEST

A. Instruct Bacteriological Laboratory to take water samples no sooner than 24 hours after flushing system.

B. Take water samples at each of the following locations:

1. Where water enters system.
2. Ends of piping runs.
3. Remote outlets.
4. Tanks.
5. At least 10% of outlets on each floor other than those used for testing disinfectant residual, where directed by Architect/Engineer, but in no case less than 2 outlets per floor.

C. Analyze Water Samples in accordance with Standard Methods for the examination of Water & Waste Water, published by American Water Works Assoc., 6666 W. Quincy Ave., Denver, CO 80235.

D. If Bacteriological Test proves water quality to be unacceptable, repeat System Treatment.

3.6 PRODUCT CLEANING & REPAIRING

A. Including work of other trades, clean, repair and touch-up, or replace when directed, products which have been soiled, discolored, or damaged by work of this Section.

B. Remove debris from Project Site upon work completion or sooner, if directed.

END OF SECTION 221411

SECTION 230080 - SELECTIVE MECHANICAL DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Demolition and removal of selected portions of building or mechanical systems.

B. Related Sections include the following:

1. Section 221410 – Plumbing Piping
2. Section 230500 - Basic Mechanical Requirements
3. Section 230529 - Basic Mechanical Materials and Methods
4. Section 232113 – HVAC Piping and Specialties
5. Section 233300 - Ductwork and Accessories

1.3 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and reinstalled.

B. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed or removed and reinstalled.

1.4 SUBMITTALS

A. Schedule of Selective Demolition Activities: Indicate the following:

1. Detailed sequence of removal work, with starting and ending dates for each activity.
2. Interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Use of elevator and stairs.
5. Means of protection for items to remain and items in path of waste removal from building.

1.5 PROJECT CONDITIONS

A. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
   1. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Owner will remove hazardous materials under a separate contract.

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

C. Utility Service: Maintain existing utilities in service and protect them against damage during selective demolition operations.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

B. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Engineer.

3.2 UTILITY SERVICES AND MECHANICAL SYSTEMS

A. Existing Services/Systems: Maintain all services and systems and protect them against damage during selective demolition operations.

3.3 PREPARATION

A. 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.

   1. Comply with requirements for access and protection specified in Section 015000 - Temporary Facilities and Controls.

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people.

   1. Comply with requirements of Section 017419 - Temporary Facilities and Controls.

3.4 SELECTIVE DEMOLITION, GENERAL

A. General: Remove existing mechanical systems only to the extent required and as indicated. Use methods required to complete the Work within limitations of governing regulations.

B. Existing Items to Remain: Protect construction to remain against damage and soiling during selective demolition.

3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC SYSTEMS

A. Piping includes: Pipe, fittings, valves, accessories, hangers and insulation.

1. Where existing piping is to be removed:

a. Piping shall be drained, disconnected, removed and capped at an active main.
b. Piping not to remain in use shall be removed completely.

2. Where existing piping is to be relocated:

a. Piping shall be drained, disconnected and removed as shown.
b. Hangers may remain if they are to be reused for reinstallation.
c. Piping shall be stored for reinstallation.

B. Where piping or ductwork to be removed is concealed in construction it may be abandoned in place if capped at both ends and approved by the Owner and the Architect.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Except for items or materials indicated to be reused, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage.

B. Burning: Do not burn demolished materials.

C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

3.7 CUTTING AND PATCHING

A. All necessary cutting and patching shall be done by the Contractor.

END OF SECTION 230080

SECTION 230500 - BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Basic requirements common to the work in general of Division 22/23 and other Divisions and Sections of the Specification where referenced.

B. Provide, unless specified otherwise, all labor, materials and equipment necessary for completely finished and operational mechanical systems described and specified under Division 22 and other Sections of this Division 23.

C. Provide all minor incidental items such as offsets, fittings, and accessories required as part of the work even though not specified or indicated.

D. Inspection: Inspect work preceding or interfacing with work of Division 22/23 and report any known or observed defects that affect the Work to the Construction Manager/General Contractor. Do not proceed with the work until defects are corrected.

E. Existing Utilities: Are indicated as accurately as possible on the Drawings. Close openings and repair damage in acceptable manner to utilities encountered. This Contractor shall be responsible for field surveying all aspects of existing conditions prior to bid date. Change orders will not be issued for a failure to review existing conditions which affect Division 22/23 work.

1.2 RELATED WORK

A. Requirements: Provide Basic Requirements in accordance with the Contract Documents.

1.3 REFERENCES

A. General:

1. For products or workmanship specified by association, trade, or Federal Standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
2. The date of the standard is that in effect at the date of the Contract Documents, except when a specific date is specified.
3. When required by individual Specification sections, obtain copy of standard. Maintain copy at job site during work until substantial completion.

B. Schedule of Referenced Organizations: The following is a list of the acronyms of organizations referenced in these Specifications:

ADC — Air Diffusion Council
1000 E. Woodfield Rd.
Schaumburg, IL 60173
www.flexibleduct.org

AGA	American Gas Association 400 No. Capitol St. N.W. Washington, DC 20001 www.aga.org
AMCA	Air Movement and Control Association 30 West University Drive Arlington Heights, IL 60004 www.amca.org
ANSI	American National Standards Institute 1819 L Street N.W. Washington, DC 20036 www.ansi.org
ARI	Air Conditioning and Refrigeration Institute 4301 No. Fairfax Drive. Arlington, VA 22203 www.ari.org
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers 1791 Tullie Circle, N.E. Atlanta, GA 30329 www.ashrae.org
ASME	American Society of Mechanical Engineers Three Park Avenue New York, NY 10016 www.asme.org
ASPE	American Society of Plumbing Engineers 8614 W. Catalpa Ave. Chicago, IL 60656 www.aspe.org
ASSE	American Society of Sanitary Engineering 901 Canterbury Westlake, OH 44145 www.asse-plumbing.org
ASTM	American Society for Testing and Materials 100 Barr Harbor Dr. West Conshohoeken, PA 19428 www.astm.org
AWS	American Welding Society 550 N.W. LeJeune Rd. Miami, FL 33126 www.aws.org
AWWA	American Water Works Association 6666 West Quincy Avenue Denver, CO 80235 www.awwa.org

CDA	Copper Development Association 260 Madison Avenue New York, NY 10016 www.copper.org
CISPI	Cast Iron Soil Pipe Institute 5959 Shallow Ford Rd., Suite 419 Chattanooga, TN 37421 www.cispi.org
CS	Commercial Standard of NBS (U.S. Dept. of Commerce, National Institute of Standards and Technology) Government Printing Office Washington, D.C. 20402
CTI	Cooling Technology Institute 530 Wells Fargo Drive Houston, TX 77090 www.cti.org
ICC	International Code Council 5203 Leesburg Pike, Suite 600 Falls Church, VA 22041 www.intlcode.org
IAPMO	International Association of Plumbing and Mechanical Officials 20001 E. Walnut Drive South Walnut, CA 91789 www.iapmo.org
NEBB	National Environmental Balancing Bureau 8575 Grovemont Circle Gaithersburg, MD 20877 www.nebb.org
NEC	National Electric Code (of NFPA)
NEMA	National Electric Manufacturer's Association 1300 N. 17th Street Rosslyn, VA 22209 www.nema.org
NFPA	National Fire Protection Association One Batterymarch Park P.O. Box 9101 Quincey, MA 02269 www.nfpa.org
NSF	NSF International 789 No. Dixboro Rd. Ann Arbor, MI 48113 www.nsf.gov

OSHA	Occupational Safety Health Administration (U.S. Dept. of Labor) Government Printing Office Washington, D.C. 20402 www.osha.gov
PDI	Plumbing and Drainage Institute 45 Brystal Drive South Easton, MA 02375 www.pdionline.org
SMACNA	Sheet Metal and Air Conditioning Contractor's National Association 4201 Lafayette Center Drive Chantilly, VA 20151 www.smacna.org
UL	Underwriters Laboratories, Inc. 333 Pfingston Rd. Northbrook, IL 60062 www.ul.com

1.4 DEFINITIONS

A. Specification Language Explanation: These Specifications are of abbreviated, simplified or streamlined type and include incomplete sentences. Omissions of words of phrases such as "the Contractor shall", "in conformity therewith", "shall be", "as noted on the drawings", "a", "the", are intentional. Supply when "NOTE" occurs on Drawings. Supply words "shall be" or "shall" by inference when colon is used with sentences or phrases. Supply words "on the Drawings" by inference when "as indicated" is used with sentences or phrases. Singular words will be interpreted as plural and plural words will be interpreted as singular where applicable and where full context of the Contract Documents so indicates.

B. Furnish: Except as otherwise defined in greater detail, term "furnish" is used to mean supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, etc., as applicable in each instance.

C. Install: Except as otherwise defined in greater detail, term "install" is used to describe operations at Project site including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations, as applicable in each instance.

D. Provide: Except as otherwise defined in greater detail, term "provide" means furnish and install, complete and ready for intended use, as applicable in each instance.

E. Indicated: The term "Indicated" is a cross-reference to graphics, notes or schedules on Drawings, to other paragraphs or schedules in the Specifications, and to similar means of recording requirements in contract documents. Where terms such as "shown", "noted", "scheduled", and "specified" are used in lieu of "indicated", it is for purpose of helping reader locate cross-reference, and no limitation of location is intended except as specifically noted.

F. General Contractor: The term "General Contractor" used in Division 23 and elsewhere in the Contract Documents means the party with whom the Owner has executed the Owner-Contractor Agreement.

G. Approved Equal: Except as otherwise defined in greater detail, term "approved equal" means that any materials, equipment, work procedures and techniques shall be either addressed on the drawing, specifications or addendum by manufacturer or by detailed material description. When brand names are referenced it implies that only the manufacturers listed are approved. All approved material, equipment, work procedures, and techniques will be noted in the specifications, drawings, or by addendum prior to bid date. Items not approved in this manner will not be considered.

1.5 QUALITY ASSURANCE

A. Quality Control:

1. Materials and apparatus required for the work to be new and of first-class quality; to be furnished, delivered, erected, connected and finished in every detail; and to be so selected and arranged so as to fit properly into the building spaces. Where no specific kind or quality of material is given, a first-class standard article shall be furnished.
2. Furnish the services of an experienced superintendent, who will be constantly in charge of the installation of the work, together with all skilled workmen, fitters, metal workers, certified welders, plumbers, millwrights, sprinkler fitters, drain layers, helpers, and labor required to unload, transfer, erect, connect, adjust, start, operate and test for each system.
3. Unless otherwise specifically indicated, equipment and materials to be installed in accordance with the recommendations of the manufacturer. This includes the performance of tests as recommended by the manufacturer.

B. Proof of Performance:

1. Division 23 Contractor shall provide proof of performance certification of all Mechanical Equipment and Systems to demonstrate that all Mechanical Equipment and Systems are operating to the intent of the design. This proof of performance shall include, but shall not be limited to, actual demonstration of all temperature/pressure control loops, operation of all heating/cooling equipment and other required tests upon request by the Engineer or Owner. A signed certificate from the piping, sheet metal, control, and balancing subcontractors stating that they have personally checked the operation of all equipment and control loops and that everything under their subcontract is operating as specified. These certificates shall be furnished to the 230593 Contractor for inclusion in the Operation and Maintenance Manual.

1.6 REGULATORY REQUIREMENTS

A. Execute work per Underwriters, Public Utility, Local and State Codes, Ordinances and applicable regulations. Obtain and pay for required permits, inspections, and certificates. Notify Architect of items not meeting said requirements.

B. Comply with editions of all applicable codes, ordinances and regulations in effect at the time of bid opening including but not necessarily limited to the following:

International Mechanical Code
International Plumbing Code
International Fuel Gas Code
International Energy Conservation Code
State Department of Health Requirements
State Energy Code
National Fire Protection Association Standards
International Fire Code
International Building Code
National Electrical Code NFPA-70
State Boiler Code
Jurisdictional County Health Department
Jurisdictional City Wastewater Management Division or District
Jurisdictional City Water Department
Jurisdictional Water Conservation Standards

C. If discrepancies occur between the Contract Documents and any applicable codes, ordinances, acts, or standards, the most stringent requirements shall apply.

D. Where hourly fire ratings are indicated or required, provide components and assemblies meeting requirements of the IBC, and listed by Underwriters Laboratories, Inc.

1.7 SUBMITTALS

A. Submit Samples, Shop Drawings and Product Data as required by various Sections of Division 23 in accordance with The General Conditions of the Contract. The Contractor agrees that these Submittals processed by the Engineer are not Change Orders; that the purpose of these Submittals by the Contractor is to demonstrate to the Engineer that the Contractor understands the design concept, that he demonstrates his understanding by indicating which equipment and material he intends to furnish and install and by detailing the fabrication and installation methods he intends to use. Contractor further agrees that if deviations, discrepancies, or conflicts between these Submittals and the Contract Documents in the form of design drawings and specifications are discovered either prior to or after these Submittals are processed by the Engineer, the Design Drawings and Specifications shall control and shall be followed.

B. The submittals shall be submitted in a single package with all mechanical equipment for the project enclosed. The submittal shall be in the form of a single PDF file in which all equipment has been electronically bookmarked and all bookmarks have been identified using the equipment tags used on the drawings. Individual PDF files for separate pieces of equipment or specification sections will not be accepted.

C. Test Reports: Submit certified test reports as required by various Sections of Division 23 showing compliance in accordance with General Conditions of the Contract. Signed copies shall be included in the Operation and Maintenance Manual.

D. Operating Instructions and Maintenance Data: Prepare and submit printed operating instructions and maintenance data in accordance with Operating and Maintenance Data paragraph in this Section.

E. Submittals will be reviewed and marked as follows:

1. No Exceptions Taken: No action required.
2. Make Corrections Noted: Correct the submittals per notes by engineer and submit new copies of submittal to contractor for project records. Do not resubmit to engineer.
3. Rejected: Equipment as submitted does not meet requirements of contract documents. Revise and/or clarify per comments and resubmit to engineer.
4. Submittal Not Requested: Submittal not required per specification. Submittal returned with no review.

F. Note that the submittal review process does not relieve Contractor of responsibility for ensuring that submitted items satisfy all requirements of the Contract Documents.

G. Site Condition and Coordination:

1. Before any ductwork is fabricated or equipment installed and before running and/or fabricating any lines of piping or ductwork, the Contractor shall provide Architect and Engineer ¼" scale drawings of all mechanical rooms and main access walkways coordinated with all trades with submitted equipment and verify all other areas to assure himself that they can be run and installed as contemplated in cooperation with Contractors of other Divisions of the Work and the physical constraints of the Structural and Architectural Work and maintain access walkways are clear for maintenance.

1.8 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Substitutions and Prior Approvals: Substitutions and prior approvals will be acceptable only when the proposed substitute has been submitted to the Engineer and approved through an addendum or change order. Request for prior approval shall be submitted a minimum of 10 calendar days prior to bid.

B. Some materials and equipment are specified by manufacturer and catalog numbers. The manufacturer and catalog numbers are used to establish a degree of quality and style for such equipment and material.

C. NOTE: When alternate or substitute materials and equipment are used Division 23 Contractor shall be responsible for engineering/redesign costs, space requirements, configurations, performance, changes in bases, supports, structural members and openings in structure, electrical changes and other apparatus and trades that may be affected by their use. Notification of General Contractor and other affected subcontractors shall be the responsibility of the Division 23 Contractor.

1.9 PROJECT RECORD DOCUMENTS

A. General: Comply with Division 1.

B. Job Site Documents: Maintain at the job site, one record copy of the following:

1. Drawings
2. Specifications
3. Addenda
4. Reviewed Product Submittals and Shop Drawings

5. Field Test Records

Do not use record documents for construction purposes. Maintain documents in clean, dry legible condition, apart from documents used for construction.

C. Record Information: Label each document "Record Document". Mark information with red ink. Keep each record current. Do not permanently conceal any work until required information is recorded.

D. Record following information on Drawings:

1. Horizontal and vertical location of underground utilities to be dimensioned from column lines.
2. Dimensioned location of internal utilities and appurtenances concealed in construction.
3. Field changes of dimension and detail.
4. Changes by change order or field order.
5. Details not on original contract drawings.
6. Manufacturer, trade name, catalog number and supplier of each product and item of equipment actually installed shall be indicated on equipment schedules.

E. Record the following information on Specifications:

1. Changes by change order or field order.
2. Other matters not originally specified.

F. Shop Drawings: Maintain shop drawings as record documents recording changes made after review as specified for drawings above.

G. Submittal: At completion of project, deliver record documents to Owner's representative and transmit a copy of signed receipt from Owner to the Engineer.

1.10 OPERATING AND MAINTENANCE DATA

A. The "Operating and Maintenance Manual" (O & M) is a bound compilation of descriptive drawings and data which identify equipment installed at the project site and detail the procedures and parts required to maintain and repair the equipment. Copies of final reviewed submittals shall be included for all equipment items.

B. These are to be submitted for approval to the Project Manager. Five electronic versions of the manuals are required, as described in Paragraph I below.

C. Organization of the manuals shall follow the recommendations in ASHRAE Guideline current edition.

D. EPages are to be standard 8-1/2" x 11" sheets, or 11" x 17" folded to fit the 8-1/2" x 11" sizes.

E. The manual shall include the following:

1. Alphabetical list of all system components including the name, address, and 24-hour phone number of the company responsible for servicing each item during the first year's operation.

2. Operating instructions for complete system, including emergency procedures for fire or failure of major equipment and procedures for normal starting/operating/shutdown and long-term shutdown
3. Maintenance instructions, including valves, valve tag and other identified equipment lists, proper lubricants and lubricating instructions for each piece of equipment and necessary cleaning/replacing/adjusting schedules.
4. All test reports and proof of performance certificates.
5. Manufacturer's data and instruction sheets for each piece of equipment, marked to indicate the plan symbol, model, number, and options installed for each item of equipment furnished and installed on the project. These data sheet shall be accompanied by reviewed submittals that had no exceptions taken to them. Provide original printed material in each book, faxes are NOT acceptable. The serial numbers of each item of equipment installed are to be listed with the model numbers and plan symbols.

    a. Installation instructions.
    b. Drawings and specifications (final shop drawings).
    c. Complete parts lists, and a source of supply for each piece of equipment, marked with model, size, and plan symbol.
    d. A copy of the reviewed submittals for each piece of equipment, with any/all corrections identified during the submittal process made to the final submittal documents.
    e. Performance curves and capacity data, marked with model number, size, and plan code.
    f. Complete “as-builts” wiring and temperature control diagrams. (Shop drawings are not acceptable).
    g. Lubrication and other preventative maintenance data.
    h. Equipment warranties.
    i. The final balance report.

6. Design Intent Document furnished by Engineer.
7. Include a Table of Contents and tabbed index dividers.

F. In addition to the maintenance manual, and keyed to it, the equipment shall be identified and tagged as specified on drawings. Insert a copy of the Equipment List or Equipment Schedules in manual.

1. Identify all starters, disconnect switches, and manually operated controls, except integral equipment switches. Label with permanently applied, legible markers corresponding to operating instructions in the "Maintenance Manual".
2. Tag all valves per requirements in Section 230529.
3. Provide a typed tag list or schedule laminated or mounted under plexiglass in the equipment room stating valve ID number, location, service or function of each tagged item, and normal valve position. Insert a copy of tag list in each "Maintenance Manual". Also provide one copy of the list in a plastic closure as manufactured by Seton Name Plant Company, New Haven, Conn; or approved equal. The plastic closure shall include two holes punched at the top, with a brass or nickel grommet in each hole, and an 8” long length of nickel plated bead chain run through the holes, allowing the list to be hung from a wall peg.
4. Provide a reduced scale drawing of each floor indicating the location of each manual and automatic valve in every HVAC and plumbing piping system and include valve position number and normal valve position (normally open/normally closed) as per Specification Section 230529. Mount all drawings under plexiglass or laminate and mount on equipment room wall.

G. Division 230593 Contractor shall be responsible for scheduling instructional meetings for maintenance personnel on the proper operation and maintenance of all mechanical systems, using the maintenance manual as a guide. These meetings must be scheduled through the Architect, Construction Manager/General Contractor and far enough in advance so that all necessary personnel can be adequately notified.

1. Submit training certificate to Owner's Representatives at end of training and have certificate signed to indicate adequate training has been received.

H. Operating and Maintenance Data documents must be provided in digital format as follows:

1. Provide O&Ms in an intuitive format on a CD-ROM or DVD. Electronic manual preparation shall be under the direction of an individual or organization that has demonstrated expertise in the preparation of a comprehensive and complete electronic operation and maintenance manual. Qualifications shall be submitted for approval. One source of procurement used on past projects is Emanuals by Scanitall in Sandy, UT (tel. 801-619-2082). This is the responsibility of the Division 21/22/23 contractor.
2. A single CD or DVD to be authored with the latest edition of Adobe Acrobat, and be in a "non-protected" network accessible format.
3. All information on the CD-ROM or DVD shall be printable on 8.5"x11" or 11"x17"plain paper.
4. Capture images using OCR technology such that the user can key word search for information.
5. Provide a hypertext alphabetical index of all equipment and building products. All hypertext shall be blue in color.
6. Provide 3 copies of the O&M CD-ROM or DVD.

1.11 DELIVERY, STORAGE AND HANDLING

A. General: Deliver and store materials and equipment in manufacturer's unopened containers fully identified with manufacturer's name, trade name, type, class, grade, size and color.

B. Protection: Store materials and equipment off the ground and under cover, protected from damage. Maintain caution labels on hazardous materials.

C. Large Items: Make arrangements with other contractors on the job for introduction into the building of equipment too large to pass through finished openings.

D. Handling of Materials: Materials shall be handled, sorted and distributed using appropriate handling methods to protect all materials from damage. Dented, rusted, corroded or otherwise damaged materials shall be removed from the project site. Lined ductwork on which the liner becomes wet shall be removed from the project site. Determination of materials deemed unusable or inappropriate for installation shall be made by the Architect/Engineer.

1.12 PROJECT CONDITIONS AND ASBESTOS HAZARD

A. Accessibility:

1. Division 23 Contractor shall be responsible for the sufficiency of the size of shafts and chases and the adequate clearance in double partitions and hung ceilings for proper installation of his work. He shall cooperate with Contractors of other Divisions of the Work whose work is in the same space and shall advise the Construction Manager/General Contractor of his requirements. Such spaces and clearances shall, however, be kept to the minimum size required.
2. Division 23 Contractor shall locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment shall include (but not be limited to) valves, shock arrestors, traps, cleanouts, motors, controllers, switchgear, filters, VAV boxes, control valves, balancing valves, and drain points. If required for better accessibility, furnish access doors for this purpose. Minor deviations from Drawings may be allowed to provide for better accessibility. Any changes shall be approved by the Architect/Construction Manager/General Contractor prior to making the change.
3. Division 23 Contractor shall provide the Construction Manager/General Contractor with the exact locations of access doors for each concealed valve, damper, or other device requiring service. Locations of these doors shall be submitted in sufficient time to be installed in the normal course of work.

B. Fabrication:

1. Before any ductwork is fabricated and before running and/or fabricating any lines of piping or ductwork, the Contractor shall assure himself that they can be run as contemplated in cooperation with Contractors of other Divisions of the Work and the physical constraints of the Structural and Architectural Work.

C. Freeze Protection:

1. Do not run lines in outside walls, or locations where freezing may occur. Piping next to outside walls shall be in furred spaces with insulation between the piping and the outside wall. Insulation of piping shall not be considered freeze protection. Buried pipe shall be installed minimum 6” below frost depth, unless noted otherwise in the documents.

D. Scaffolding, Rigging and Hoisting:

1. Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises of any equipment and apparatus furnished; remove same from premises when no longer required.

E. If Contractor during the course of work observes or suspects the existence of asbestos in the structure or building, Contractor shall promptly notify Owner and Architect/Engineer. Owner shall consult with Architect/Engineer regarding removal or encapsulation of the asbestos material and Contractor shall not perform any work pertinent to the asbestos material prior to receipt of special instructions from Owner through the Architect/Engineer.

1.13 COORDINATION

A. General: Coordinate and order the progress of mechanical work to conform to the progress of the work of the other trades. Complete the entire installation as soon as the condition of the building will permit.

B. Coordination with Electrical Work: Section 230529.

C. Utility Interruptions: Coordinate mechanical utility interruptions with the Owner and the Utility Company. Plan work so that duration of the interruption is kept to a minimum.

D. Cutting and Patching: Section 230529.

E. Drawings and Specifications: The Mechanical Drawings indicate the general design and arrangement of lines, equipment, systems, etc. Information shown is diagrammatic in character and does not necessarily indicate every required offset, fitting, etc. Do not scale the Drawings for dimensions. Take dimensions, measurements, locations, levels, etc., from the Architectural Drawings and equipment to be furnished.

F. Each Division 22/23 subcontractor shall coordinate with all other contractors to make certain that any of his equipment, piping or ductwork which is mounted on isolators or flexibly connected does not become "grounded" by another contractors work (e.g. walls, ceiling, etc.).

G. Coordinate with all subcontractors to maintain adequate access to all equipment for maintenance and for future replacement of equipment.

H. Discrepancies: Examine Drawings and Specifications for other parts of the work, and if any discrepancies occur between the plans for the work of this Division and the plans for the work of others, report such discrepancies to the Construction Manager/General Contractor and obtain written instructions for any changes necessary.

I. Order of Precedence: The precedence of mechanical construction documents are as follows:

1. Addenda and modifications to the Drawings and Specifications take precedence over the original Drawings and Specifications.
2. Should there be a conflict within the Specifications or within Drawings of the same scale, or between the Specifications and the Drawings, the more stringent or higher quality requirements shall apply.
3. In the Drawings, the precedence shall be Drawings of larger scale over those of smaller scale, figured dimensions over scaled dimensions and noted materials over graphic indications.
4. Should there be a conflict in dimensions or locations between Mechanical Drawings and Architectural Drawings, the Architectural Drawings shall have precedence.

1.14 START-UP PROCEDURES

A. Before start-up, each piece of equipment comprising a part of the system shall be checked for proper lubrication, drive rotation, belt tension, proper control sequence, and any other condition which may cause damage to equipment or endanger personnel.

B. Insure that all control systems are fully operational in automatic mode. Individually test each control loop to make certain it is operating as intended and is communicating properly with other devices.

C. If systems are not to continue in use following the start-up procedures, steps should be taken to insure against accidental operation or operation by unauthorized personnel. Provide padlocks on disconnect switches where applicable.

D. Factory personnel shall be notified as appropriate to start systems requiring their services.

E. Notify engineer at least 2 weeks prior to the scheduled start-up date of all major mechanical equipment and systems.

1.15 SCHEDULE OF TESTING

A. Provide testing in accordance with the General Conditions of the Contract.

B. A schedule of testing shall be drawn up by the Division 23 Contractor in such a manner that it will show areas tested, test pressure, length of test, date, time and signature of testing personnel.

C. All testing must be performed in the presence of the Architect's/Construction Manager's/General Contractor's representative; his signature for verification of the test must appear on the schedule.

D. All testing must be performed in accord with the procedures set forth in Division 23 and other Sections of the Specifications where referenced. At completion of testing, the completed schedule shall then be submitted in triplicate to the Architect and a copy shall be forwarded to the 230593 Contractor for inclusion in Operation and Maintenance Manual.

E. Make all specified tests on piping, ductwork and related systems as specified in this specification.

F. Make sure operational and performance tests are made on seasonal equipment.

G. Complete all tests required by Code Authorities, such as smoke detection, life safety, fire protection and health codes.

H. After test runs have been completed and systems have been demonstrated to be satisfactory and ready for permanent operation, all permanent pipeline strainers and filters shall be cleaned, air filters cleaned or replaced, settings on pressure relief valves properly adjusted, valve and pump packings properly adjusted, belt tensions adjusted, drive guards secured in place, lubrication checked and replenished if required.

1.16 CLEANING AND FINISHING

A. Provide cleaning in accordance with the General Conditions of the Contract and Division 1.

B. Cleaning shall include but not be limited to removing grease, dirt, dust, stains, labels, fingerprints and other foreign materials from sight-exposed piping, ductwork, equipment, fixtures and other such items installed under Division 23 of the work. If finishes have been damaged, refinish to original condition and leave everything in proper working order and of intended appearance.

1.17 WARRANTIES

A. Warranty: Provide a written warranty to the Owner covering the entire mechanical work to be free from defective materials, equipment and workmanship for a period of one year after Date of Acceptance. During this period provide labor and materials as required to repair or replace defects. Provide certificates for such items of equipment which have warranties in excess of one year. Submit to the Construction Manager/General Contractor for delivery to the Architect. Include a copy of all warranties in the Operation and Maintenance Manual.

B. This warranty will be superseded by the terms of any specific equipment warranties or warranty modifications resulting from use of equipment for construction heat or ventilation.

C. All refrigeration compressors shall have a (4) four year extended warranty from the manufacturer of the equipment in addition to the standard one-year warranty.

1.18 PROJECT CLOSEOUT

A. Project Observation Reports:

At or near the completion of the construction phase of this project, the Engineer will generate one or more Project Observation Reports for the owner. These reports will list the items of construction observed by the Engineer which are not in compliance with the Contract Documents.

The Mechanical Contractor and/or subcontractors shall certify completion of each listed item in writing and forward copies to the Architect, Engineer and General Contractor. The Engineer will not recommend the payment of retainage until this compliance certification has been received.

Each item on the Project Observation Report shall have a signature/date in the margin of the report indicating completion of that item.

1.19 CERTIFICATES AND KEYS

A. Certificates: Upon completion of the work, deliver to the Construction Manager/General Contractor one copy of Certificate of Final Inspection.

B. Keys: Upon completion of work, submit keys for mechanical equipment, panels, etc. to the Construction Manager/General Contractor.

END OF SECTION 230500

SECTION 230529 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED WORK

A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these documents.

B. Work furnished but not installed by this Contractor:

1. Access doors in accordance with paragraph 2.3 in this Section 230529.

1.2 SYSTEM DESCRIPTION

A. The work includes, but is not limited to the following:

Materials and methods common to the work in general of Division 23 and other Divisions and Sections of the Specifications where referenced.

1.3 QUALITY ASSURANCE

A. Welder Qualifications: Welding shall be performed by an ASME Certified welder with current certificate in accordance with ANSI B31.1 for shop and project site welding of piping work. Welder Qualifications:

1. Each welder shall have passed a qualification test within the past 6 months.
2. The test shall be in accordance with the ASME Boiler and Pressure Vessel Code, Section IX, "Welding Qualifications", ASME Section VIII, and ANSI 313.
3. The test report shall certify that the welder is qualified to weld the material to be used at the job site.
4. The Contractor shall submit three copies of each welder's qualification test report to the Project Manager for approval prior to commencing the work. No welder shall be used on the project until so certified.

1.4 REFERENCES

A. Reference Standards: Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations of the following:

1. For electrical equipment and products, comply with applicable National Electrical Manufacturers Association (NEMA) Standards, and refer to NEMA Standards for definitions of terminology herein.
2. Comply with National Electrical Code (NEC) NFPA-70 for electrical installation requirements.
3. Certified Pipe Welding Bureau (NCPWB) and American National Standards Institute (ANSI) Code Numbers B31.2, & B31.9 as applicable for welding requirements.
4. Comply with American National Standards Institute (ANSI A13) for identification of piping systems.

5. Comply with American National Standards Institute (ANSIB31.1) Code for Pressure Piping.

1.5 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings and Product Data for the following items in accordance with the General Conditions of the Contract:

1. Legend and color of piping and equipment identification.
2. Proposed access door sizes and locations

B. Operating Instructions and Maintenance Data: Submit printed Operating Instructions and Maintenance Data for the following items in accordance with Operating and Maintenance Data Paragraph in Section 230500.

1. Motors.
2. Starters.

C. Certificates: Before proceeding with the Work, submit to the Architect/Construction Manager/General Contractor, two copies of Certification that the welding work will be done according to ANSI B31.1 by welders who have been tested and whose qualification test sheets are available, attesting to their ability to weld in accordance with the Standard Procedure Specifications as established by the National Certified Pipe Welding Bureau.

PART 2 - PRODUCTS

2.1 MOTORS

A. General: Furnish motors necessary to operate mechanical equipment.

B. Motor Characteristics: Comply with the following requirements:

1. Variable Speed Drive Compatibility: All motors which are powered through a variable frequency drive shall conform to NEMA MG-1, Part 31 for inverter duty and shall be capable of continuous operation at 20% of nominal speed and shall meet the requirements of the Variable Frequency Drive specification in Section 230810 or Division 26 as applicable.
2. Altitude Deration: Motors to be furnished to maintain specified rated service factor at altitude of project.
3. NEMA Temperature Rating: Rated for 40 deg.C environment for continuous duty at full load, Class B motor temperature rise. Motors for use with variable frequency drives shall be Class F insulated.
4. Starting Capability: Provide each motor capable of making starts as frequently as indicated by the automatic control system.
5. Phases and Current Characteristics: Provide squirrel-cage induction polyphase motors for 3/4 horsepower and larger, and provide capacitor-start single-phase motors for 1/2 horsepower and smaller. One-sixth horsepower and smaller may, at equipment manufacturer's option, be split-phase type. Coordinate current characteristics with power specified in Division 26 and with individual equipment requirements specified in other Sections of Division 23. Provide two separate windings on polyphase two speed motors. Do not purchase motors until power characteristics available at locations of motors have been confirmed, and until rotation directions have been confirmed.

6. Power Factor: All motors rated greater than 1000 watts shall have a Power Factor of not less than 95% under rated load conditions. The 95% PF may be obtained by design of the motor or by providing a capacitor. Capacitors, if provided to obtain the 95% PF, must be switched with the motor. If the motor draws less than 1000 watts at full load, it is excluded from the 95% power factor requirement.
7. Service Factor: 1.15 for polyphase motors and 1.35 for single-phase motors. Motors shall be selected such that the brake horsepower requirement is not within the service factor at design load.
8. Efficiency: All motors shall be premium efficiency type in accordance with the current State Energy Code, except where a higher efficiency is noted on drawings.
9. Motor Construction: Provide Design "B" motors for general purpose continuous duty and Design "C" motors where required for high starting torque such as the low speed motor on fans with a two-motor drive arrangement. Small motors that are part of packaged equipment may be manufacturer's standard motors meeting Energy Code requirements for efficiency.

    a. Bearings: Ball or roller bearings with inner and outer shaft seals: regreasable; except permanently sealed where motor is normally inaccessible for regular maintenance. Where belt drives and other drives produce lateral or axial thrust in the motor, provide bearings designed to resist the thrust loading. Refer to individual sections of Division 23 for fractional horsepower light-duty motorized equipment where sleeve-type bearings are permitted.
    b. Enclosure Type: Except as otherwise indicated, provide open drip-proof motors for indoor use where satisfactorily housed 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.
    c. Overload Protection: Provide built-in thermal overload protection for each leg of each phase and, where indicated, provide internal sensing device suitable for signaling and stopping the motor at the starter. Thermal overload protectors shall be sized to accommodate the altitude of installation.
    d. Name Plate: Provide metal nameplate on each motor, indicating full identification of manufacturer, ratings, characteristics, construction, NEMA efficiency, power factor, special features and similar information.
    e. Motor Connections: Provide conduit connection boxes.
    f. Motors shall not exceed 80dbA rating when running their full speed and power range.

2.2 STARTERS

A. General: Furnish starters and contactors necessary to operate mechanical equipment motors. **Starter manufacturer shall be the same brand for ALL motors furnished under Division 23.**

B. Motor Starter Characteristics: Comply with NEMA standards and NEC. Furnish Type I general purpose enclosures with padlock ears, and with frames and supports for mounting on wall, floor or panel as required. Furnish the type and size of starter recommended by the motor manufacturer and equipment manufacturer for the applicable protection and start-up condition; refer to individual equipment sections for basic load requirements. All starters shall be by the same manufacturer. Only manufacturers approved by Division 26 will be accepted. All starters shall comply with Division 26 requirements.

C. Manual Control:

1. Furnish maintained-contact push buttons and pilot lights, properly arranged for single-speed or multi-speed operation as indicated.
2. Furnish manual switch and pilot light for motors 1/3 horsepower and smaller, except where interlock or automatic operation is indicated.

D. Automatic Control:

1. Furnish magnetic starters for motors 1/2 horsepower and larger and for smaller motors where interlock or automatic operation is indicated. Include the following:

a. Maximum number of auxiliary contacts available: three or more.
b. "Hand-Off-Automatic" switches in starter cover.
c. Interlocks, pneumatic switches and similar devices as required for coordination with the control requirement specified in Section 230900-Electronic Controls.
d. Built-in 120 volt control circuit transformer, fused from line side, where service exceeds 240 volts.

1) Control circuit conductors to be protected in accord with the National Electrical Code.

e. Trip-free thermal overload relays, each phase.
f. Externally operated manual reset except on refrigeration compressors which shall have automatic reset. Automatic reset shall be limited to three attempts. If motor fails to start after three attempts, manual reset shall be required.
g. Undervoltage release or protection.
h. Phase failure/phase reversal protection on all legs.

E. Weather Protection: Provide weather-proof mounting of magnetic starters for equipment outside of the building.

2.3 ACCESS DOORS

A. Furnish steel access doors, minimum size required for normal service use or as sized on drawings as manufactured by Inryco/Milcor, where shown on mechanical or architectural drawings, and where required for access to valves, shock absorbers, dampers, mechanical equipment or appurtenances.

B. Standard Doors:

1. Frames: 16 ga. steel.
2. Panels: 14 ga. steel.

3. Finish: Chemically bonded prime coat of baked enamel.
4. Hinge: Concealed spring hinges openable to 175 degree; removable pins. Provide number of hinges as recommended by manufacturer for size of door.
5. Locking Devices: Flush steel, screwdriver operated, cam type locks. All access doors below 8'-0" in public areas shall be key-operated cylinder lock with two keys. Same key shall open all access doors.
6. Style of doors shall be appropriate for architectural finish at door location. Furnish masonry anchors where required.

C. Fire Rated Doors:

1. Frames: 16 ga. steel.
2. Panels: Sandwich type, 20 ga. steel sheets, manufacturer's standard insulated core.
3. Finish: Chemically bonded prime coat of baked enamel.
4. Hinge: Continuous type, steel with stainless steel pin.
5. Closer: Automatic closing mechanism.
6. Locking Devices: Self-latching, key-operated cylinder lock with two keys; interior, latch release mechanism.
7. Style of doors shall be appropriate for architectural finish at door location.
8. Fire rated doors shall have components and assemblies meeting requirements of the American Insurance Association, Factory Mutual Insurance Association and listed by Underwriters Laboratories, Inc.

D. Exact location of access doors shall be as directed by Mechanical Contractor and approved by the Architect. Coordinate with General Contractor and Architect.

2.4 VALVES

A. General:

1. Provide valves as specified herein and as indicated on the Drawings complete with accessories and attachments as required and appropriate for the pressure/temperature of system.
2. Supply valves for proper pressure ratings determined by the system working pressures at point of use and of proper types for systems and functions indicated.
3. Steam and Condensate System Isolation Valves: Use steam rated ball valves on pipe sizes 2” and smaller. Use gate valves on pipes larger than 2”. Use globe valves on manual bypass lines.
4. Provide like type valves of one manufacturer only unless specified otherwise.
5. Plainly and permanently mark valves with manufacturer's name or trademark, pressure rating, both Cold Working Pressure (CWP) and Steam Working Pressure (SWP), as applicable and flow direction when required to prevent improper installation.
6. Mark valves requiring approval by Underwriter's Laboratories (UL) or Factory Mutual Engineering Division (FM) with appropriate markings cast into the valve body.
7. Provide extended necks as appropriate for insulation.

B. Manufacturers:

1. The following manufacturers are acceptable providing the product to be considered is equivalent in every respect to the nomenclature provided by the specified make and model.

a. Bronze Valves: Powell, Milwaukee, Crane, Hammond, Nibco.
b. Iron Body Valves: Powell, Milwaukee, Traverse City, Kennedy, Iowa, American, Nibco.
c. U.L., F.M. Approved or Listed Valves: Nibco, Demco, Pratt, Kennedy, Mission, Milwaukee, Hammond.
d. Ball Valves: Hammond, Watts, Jamesbury, Worcester, Milwaukee, Apollo, Powell, Dynaquip, Nibco, Spirax Sarco, FNW.
e. Butterfly Valves: Milwaukee, Hammond, Centerline, DeZurik, Fisher, Victaulic, Keystone, Posi-Seal, TEC, Flowseal, Nibco, IFC, FNW, Bray, EBRO.
f. Lubricated Plug Valves: Homestead, Nordstrom, Powell.
g. Non-Lubricated Eccentric Plug Valves: DeZurik.
h. Stop and Drain and Drain Valves: Milwaukee, Hammond, Prier, Nibco or United Brass.
i. Gas Cock: Peter Healy or Crane.
j. Check Valves: Nibco, IFC, DFT, Crane.

C. Valve Schedule:

1. Standard Bronze Valves - 150 SWP/300 CWP, per ASTM B61/B62. No brass materials will be accepted.

a. Check, Gate, and globe with union bonnet and rising stem.
b. Sizes 1/8 through 2 inches.
c. Schedule:

Plan Code:	G.V.	GL.V.	C.V. *	L.C.V. *
Valve Type:	Gate	Globe	Swing	Lift
Make:	Nibco	Nibco	Nibco	CRANE
Straight Threaded:	T-134	T-235Y	T-433Y	366E
Straight Soldered:	S-134	S-235Y	S-433Y	--
Angle Threaded:	--	T-335Y	--	--
Angle Soldered:	--	--	--	--

* Pressure drop across check valves shall not exceed 1 psi at design flow.

2. Standard Bronze Valves - 300 SWP/600 CWP, per ASTM B61/B62, no brass materials will be accepted.

a. Gate, globe and check.
b. Sizes 1/8 through 2 inches.

c. Schedule:

Plan Code	G.V.	GL.V.	C.V. *	L.C.V. *
Valve Type:	Gate	Globe	Swing	Lift
Make:	Nibco	Nibco	Nibco	Crane
Straight Threaded:	T-174-A	T-275-Y	T-473-Y	
Straight Soldered:	--	--	--	366E
Angle Threaded:	--	T-375-Y	--	--
Angle Soldered:	--	--	--	--

* Pressure drop across check valves shall not exceed 1 psi at design flow.

3. Standard Iron Body Valves - 125 SWP/200 CWP.

a. Gate, globe and check.
b. Sizes 2-1/2 through 12 inches.
c. Schedule:

Plan Code:	G.V.	OS&Y	GL.V.	C.V. *	W.C.V. *	N.S.C.V. *
Valve Type:	Gate	Gate	Globe	Swing	Weighted	Non Slam
Make:	Nibco	Nibco	Nibco	Nibco	Nibco	CRANE
Straight Threaded:	T-619	T-617-0	--	T-918-B	--	--
Straight Flanged:	F-619	F-617-0	F-718B	F-918-B	F-918BLW	223
Angle Threaded:	----	----	--		----	----
Angle Threaded:	----	----	F-818B	----	----	----

* Pressure drop across check valves shall not exceed 1 psi at design flow.

4. Standard Iron Body Valves - 150 SWP/300 CWP.

a. Gate, globe and check.
b. Sizes 2 through 12 inches.
c. Schedule:

Plan Code:	G.V.	OS&Y	GL.V.	C.V.	N.S.C.V.
Valve Type:	Gate	Gate	Globe	Swing *	Non Slam *
Make:	Nibco	Nibco	Nibco	Nibco	Crane
Straight Threaded:	--	--	--	--	--
Straight Flanged:	F-669	F-667-0	F-768B	F-968B	223
Angle Threaded:	--	--	--	--	--
Angle Flanged:	--	--	F-868B	--	

* Pressure drop across check valves shall not exceed 1 psi at design flow.

5. Standard Iron Body Valves - 250 SWP/500 CWP.

a. Gate, globe and check.
b. Sizes 2 through 12 inches.

c. Schedule:

Plan Code:	G.V.	OS&Y	GL.V.	C.V.	N.S.C.V.
Valve Type:	Gate	Gate	Globe	Swing *	Non Slam *
Make:	Nibco	Nibco	Nibco	Nibco	Crane
Straight Threaded:	--	--	--	--	--
Straight Flanged:	F-669	F-667-0	F-768B	F-968B	223
Angle Threaded:	--	--	--	--	--
Angle Flanged:	--	--	F-868B	--	--

* Pressure drop across check valves shall not exceed 1 psi at design flow.

6. UL and FM Approved Valves.

a. Gate, check and butterfly.
b. Sizes all.
c. Schedule:

Plan Code:	OS&Y	C.V.	W.V.C.	BF.V	D.V.
Valve Type:	Gate	Swing	Wafer	BTFY	Drain
Make:	Nibco	Nibco	Nibco	Demco	Nibco
Straight Threaded:	T-104-0	T-413W	--	--	T-211Y
Straight Flanged:	F-607-0	F-908-W	--	--	--
Wafer:	--	--	KW-900-W	NE-H	--

7. UL and FM Approved Valves - 175 Pound Water.

a. Post indicator with indicator post.
b. Sizes 4 through 12 inches.
c. Schedule:

Plan Code:	P.I.V.	P.I.V.B.F.
Valve Type:	Gate	BTFY
Make:	Nibco	Demco
Straight Flanged:	F-609	NE-H (Wafer)
Mechanical Joint:	M-609	--
Indicator Post Vertical:	NIP-1	Stem extension and gear operator with post indicator U.L. Listed only.
Indicator Post through Wall:	NIP-2	--

8. Underground Valves - 175 Pound Water, American Water Works Association (AWWA).

a. Gate valves with service boxes.
b. Sizes (see schedule).

c. Schedule:

Plan Code:	GV & SB	GV & SB
Size/Inches:	3/4 thru 2	2 thru 16
Valve Type:	Oriseal	Gate
Make:	Mueller	Mueller
Model:	H-15201	A-2380-22 or 2380-18
Service Box:	H-10396-86	H-10357
Base:	H-10396-7-8-9 or H-10400	No. 6 Oval
Key:	Stationary rod attached.	A-24610 Furnish one each box.

9. Ball Valve:

a. Blowout proof stem.
b. Full port type with appropriate seals and seat, as specified.
c. Bronze bodies per ASTM B61/B62 or ASTM B-584. No brass material will be accepted.
d. Stainless steel bodies per ASTM A-351, Grade CF3M.
e. Schedule:

Plan Code:	B.V.	B.V.	H.V.	S.B.V.
Service:	Balancing	In line control and isolation	Refrigeration	Steam and Steam Condensate
Pressure:	150 SWP/300 CWP	150 SWP/300 CWP	500 CWP	150 SWP
Sizes/Inches:	1/4 thru 2-1/2	1/4 thru 3"	3/8" thru 2 1/8"	½” thru 2”
Make:	Nibco	Nibco	Nibco	Nibco
Straight Threaded:	T-580-70-66	T-585-70-66	--	T-595-Y-S6R-66
Straight Solder End:	S580-70	S585-70	S595-Y-66	--
Actuator:	Lever with memory stop	Lever	Lever	Lever
Port:	Standard	Full	Full	full

* Steam ball valve includes a three-piece body, seals rated for steam operating temperatures up to 400°F.

10. Butterfly Valves:

a. Schedule; standard 150 psi with 150 psi ANSI companion flanges for use where system pressures cannot exceed 200 psig shut off (static) pressure.

Plan Code:	BFV	
Style:	Lugged	
Pressure Rating ANSI Class:	150 minimum	
Body:	ASTM A126 Cast Iron or ASTM A395 Ductile Iron	
Disc:	Aluminum Bronze	
Stem:	316 Stainless	17-4 PH Stainless or 18-8 Stainless
Seat:	EPDM (-40 deg.F to 250 deg.F)	
Actuator:	2" thru 5" Infinite position lever with memory stop. 6" thru 24" Self-locking worm gear with adjustable limit stops, and position indicator. Provide chain wheel and chain where indicated by contract documents.	
Make:	Keystone	
Size:	2"-12"”	14”-36
Model:	222	AR2

b. Schedule: High performance 300 psi with 300 psi ANSI companion flanges for use where system pressures are more than 200 psig but cannot exceed 700 psig shut-off (static) pressure.

Plan Code:	BFV	
Style:	Lug	
Pressure Rating ANSI Class:	300 minimum	
Body:	Carbon steel ASTM A-216	
Disc:	316 stainless steel ASTM A-216	
Stem:	Stainless steel ASTM A564 Type 630 (17-4PH)	
Seat:	Virgin TFE	
Actuator:	3" and 4": Rachet handle with lock. 6 and over: Worm gear with lock.	
Make:	Flowseal (Mark Controls Corp.)	
Size:	3" and 4"	6" and over
Model:	XX-3L-121TTH-L	XX-3L-121TTH-2

11. Stop Check Valve:

    a. Schedule:

Plan Code:	S.C.V.
Pressure:	250 SWP/500 CWP
Size/Inches:	2-1/2 thru 10"
Make:	Crane
Straight Flanged:	28E
Angle Flanged:	30E

12. Eccentric Plug Valve:

    a. Schedule:

Plan Code:	E.P.V.	E.P.V.
Pressure:	175 lb. CWP	175 lb. CWP
Size/Inches:	1/2 thru 3	4 thru 8
Make:	DeZurik	DeZurik
Model:	400	100
Actuator:	483-487	159 w/Memory Stop
Ends:	Threaded	Flanged

13. Gas Valves:

    a. Gas cock and lubricated plug.
    b. Schedule:

Plan Code:	G.C.K.	L.P.V.	L.P.V.	G.B.V.
Pressure:	100 PSI Air	200 lb. CWP	200 lb. CWP	250 PSI LP-Gas
Size/Inches:	1/2 thru 1	1/2 thru 3	4 thru 12	1/4" thru 3"
Make:	Peter Healy	Walworth	Walworth	Apollo
Model:	1500-F	1700	1707-F	80-100
Actuator:	None	E-2	Wrench as required	1/4 turn
Ends:	Threaded	Threaded	Flanged	Threaded

14. Specialty Valves:

    a. Petcock, stop and drain, drain, needle.

b. Schedule:

Plan Code:	PTK	S&D.V.	D.V.	N.V.
Type:	Petcock	Gate	Ball	Needle
Pressure:	250 LB.	125 LB.	125 LB.	200 LB.
Size/Inches:	1/8	1/2 and ¾	3/4	1/8 thru 3/4
Make:	Powell	Nibco	Apollo	Jenkins
Model:	922	76 or 726	78-104	743G
Ends:	Threaded	Threaded or Soldered	Threaded and Hose End Adaptor	Threaded

2.5 PIPE HANGERS, SUPPORTS, AND ACCESSORIES PROTECTION

A. General:

1. Provide hangers, rods, clamps, brackets, attachments, inserts, bracing, nuts, coach screws, eye bolts, clips, plates, and washers as required for appropriate installation for building structure provided.
2. All hangers and accessories shall be manufactured by one manufacturer for compatibility of all components.
3. All hangers, attachments, and accessories shall be provided with a certified manufacturer's safety factor of five (5).
4. All hangers, attachments and accessories shall comply with the following:

   a. Safety factor of 5 (actual load vs. ultimate load).
   b. National Fire Protection Association (NFPA) (except as amended by provisions of this Specification for minimums) and as applicable.
   c. Factory Mutual Engineering Division (FM) as applicable.
   d. Manufacturers Standardization Society (MSS).

5. Support and positioning of piping shall be by means of engineered methods that comply with IAPMO PS 42-96.

B. Material:

1. Hangers in contact with steel, iron, cast or ductile iron shall be hot dipped galvanized or cold galvanized with "Galvilite by ZRC" cold galvanized compound only to a thickness of not less than 3.0 mil (.003 inches). "Galvilite by ZRC Worldwide, Marshfield, MA. Tel: (800) 831-3275, www.zrcworldwide.com" or equal.
2. Hangers in contact with copper piping shall be copper clad or provided with heavy density felt (20 oz.) pad permanently attached to the hanger and placed so as to prevent direct contact between pipe and hanger. Felt shall be mildew and moisture rot-proof. Heavy polyvinyl chloride coating on hanger, 5 mil thickness minimum will be acceptable in lieu of felt.
3. Hangers in contact with "plastic" or "glass" piping shall be galvanized in accordance with Sub-paragraph B-1, above and padded in accordance with Sub-paragraph B-2, above.

4. Hangers for insulated piping shall be sized to accommodate the insulation. Provide with insulation shields or insulation saddles* as applicable and appropriate and in accordance with the following schedule:

Nominal Pipe or Tubing Size	Shield Length	Shield Gauge Thickness	Material
½" thru 3"	12"	18	Galvanized
4"	12"	16	Galvanized
5"	15"	16	Galvanized
6"	18"	16	Galvanized
8"	24"	--	B-line (B3160-3165)
over 8"	36"	--	B-line (B3160-3165)

* Insulation inserts between piping and shield shall be furnished by 230700 Contractor for appropriate pipe size and insulation thickness for all insulated piping requiring a vapor barrier.

5. Provide swivel ring hangers similar and equivalent to B-Line B-3170, 3170CT, and 3170C for pipe sizes 1/2" thru 8".
6. Clevis type hangers may, at the Contractors option, be provided when similar and equivalent to B-Line B-3100, and 3100C.
7. Roller type hangers shall be used on all steam piping 4" and larger and when appropriate shall be equivalent to B-Line B-3110 black steel with cast iron roller. Provide insulation saddles for all roll-type hangers, B-Line B3160-3165. Calcium silicate inserts, in conjunction with insulation saddles shall be provided on all steam piping.
8. Beam and bar joist clamps shall be appropriate for attachment locations, top beam, bottom beam, etc., and provided with retainer rods, clips or straps as required.
9. Hanger spacing and minimum rod sizes shall be based on the applicable Mechanical and Plumbing Codes for the type of piping installed.
10. Riser clamps shall be provided on all vertical risers at each floor and shall conform to materials and protective coatings or pads as specified in Paragraph B of this Article 2.05. Clamps shall be similar and equivalent to B-Line B-3131 and B-3148.
11. Provide concrete inserts where required in flat slab construction similar and equivalent to B-Line B-22-1 Series 2000 lbs. per foot load capacity and spaced per hanger spacing schedule (sub-paragraph B-9 above) provide all accessories and nuts required.
12. Trapeze hangers shall be constructed of channel similar and equivalent to B-Line Series B-11 thru B-72 as appropriate complete with pipe clamps, nuts, rollers etc., as required. Channel to bear 5 times actual weight of all piping on trapeze system with minimum deflection. (.01 inch maximum). At a minimum, install pipe clamps on every other trapeze hanger, and where required to comply with seismic restraint design.
13. Wall brackets shall be fabricated "knee" brackets conforming to requirements of sub-paragraph B-12 above and made up with B-Line Series B-11 thru B-72 channel. Angle clips may be used in wood joist construction when similar and equivalent to B-Line B-3060 or 3061.

14. Hangers attached to wood construction shall be attached by use of eye bolts, coach screws or lag bolts when load bearing ratings maintain a safety factory of 5.
15. All other means of support i.e., special construction, pipe stands, earthquake bracing, sway bracing, etc., shall be provided as required and in conformance with jurisdictional authority and these Contract Documents, submit all special or required support and bracing systems for review by the Architect/Engineer prior to installing any item.
16. All vertical refrigeration suction and hot gas, and all steam piping shall be provided with insulation shields and calcium silicate inserts at each support location.
17. All piping systems exposed to motorized traffic shall be fully protected by installation of concrete-filled pipe bollards. Bollards shall be cleaned and painted as directed by the Owner.
18. For plenum applications use pipe supports that meet ASTM E-84 25/50 standards.

C. Acceptable Manufacturers:

1. Manufacturers acceptable to this Specification are as follows, all other manufacturers must submit for acceptance.

a. B-Line
b. Fee & Mason
c. Grinnell
d. Hubbard Enterprises/HOLDRITE
e. P.H.D.
f. Michigan
g. Tolco
h. MAPA
i. Hilti

2.6 IDENTIFICATION MATERIALS FOR PIPING AND EQUIPMENT

A. Materials for identification shall be as follows:

1. Metal Tags: Round brass discs, minimum 1-1/2" diameter with edges ground smooth. Each tag shall be punched and provided with brass chains for installation.
2. Engraved Nameplates: Fabricate from plastic sheet stock of sufficient thickness to allow engraved lettering in contrasting color. Attach nameplates to equipment with screws.

3. Painted Stencils: Of size and color per ANSI A13.1 using clean cut letters and oil base paint. Paint material shall comply with Architectural Painting Specifications. See Part 3 for legend and size for Stencils.

***** OR *****

3. Pressure Sensitive Markers: Brady Type 350 flexible vinyl film identification markers and tape, with legend, size and color coding per ANSI A13.1. or approved equal.

***** OR *****

3. Semi-rigid Plastic Identification Pipe Markers: Section Setmark with legend, size and color coding per ANSI A13.1 Direction of flow arrows are to be included on each marker, unless otherwise specified.

   a. Setmark Type Snap-Around markers to be used on diameters 3/4" thru 5".
   b. Setmark Type Strap-Around markers to be used on diameters 6" or larger.

Insulation or Pipe Diameter	Length of Color Field	Size of Letters
3/4" to 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
over 10"	32"	3-1/2"
Ductwork and Equipment	NA	2-1/2"

2.7 DIELECTRIC PIPE FITTINGS AND ISOLATORS

A. Manufacturer: Epco Sales Inc., Victaulic.

B. Schedule: (complete unions)

Model:	FX	GX
Sizes:	½" thru 2"	2" thru 12"
Maximum Pressure:	250 psi	175 psi
Maximum Temp.:	210 deg. F	210 deg. F
Epconite Gasket:	#2	#2
Ends:	FPT x Solder	FPT x Solder
Type:	Union	Flanged Union

C. Schedule: (companion flanges)

Model:	X	W	H
Sizes:	1-1/2" - 10"	1-1/2" - 12"	1-1/2" - 12"
Maximum Pressure:	175 psi	175 psi	175 psi
Maximum Temp.:	210 deg. F	210 deg. F	210 deg. F
Epconite Isolators:	#2	#2	#2
End Style:	Solder (Brass)	Weld neck	Iron Pipe Thread
Type:	Companion	Companion	Companion
Face Gasket:	Same as Isolators		

D. Dielectric fittings shall conform to ASA B16.8, and shall be plated as applicable a minimum of .0005" and have no flow restriction when assembled.

2.8 EQUIPMENT DRAINS AND OVERFLOWS

A. Copper Tubing: ASTM B88, Type M, hard drawn.

1. Fittings: ANSI/ASME B16.23 cast brass, or ANSI/ASME B16.29 solder wrought copper.
2. Joints: ASTM B32, solder, Grade 95TA.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. General: Unless otherwise specifically indicated on Drawings or in Specifications, install equipment and materials in accordance with recommendations of manufacturer, including performance of tests as manufacturer recommends.

B. Protection:

1. Close ends of pipe and ductwork during construction and cover equipment to prevent entry of foreign material. Protect insulation against dirt, water, chemical or mechanical damage before, during and after installation. Cover floor drains and protect fixtures and equipment against damage during concrete pours and mechanical work.

C. Quiet Operation and Vibration:

1. All work shall operate in accordance with Section 230540 - Mechanical Sound and Vibration Control under all conditions of load.
2. Sound or vibration conditions not in accordance with Section 230540 and considered objectionable shall be corrected in a manner approved by the Architect under the Work of Division 23.

3.2 WELDING

A. Joints between sections of pipe, between pipe and fittings, shall be fusion welded. Use only certified welders. Strength of finished welded joints to be equal to strength of pipe. Width of finished weld to be at least 2-1/2 times the thickness of the part joined. Thickness of weld to be at least 25% greater than the thickness of pipe or fittings. Finished welded joints to present neat and workmanlike appearance.

B. Make no direct welded connections to valves, strainers, apparatus, and related equipment. Make connections to flanged valves, and flanged equipment with welded pipe connection flanges.

C. Radii of weld ells to be 1-1/2 times nominal diameter of fittings. Fittings used for all branch connections, whether full-size or reducing, to have interior surfaces smoothly contoured. Wall thickness of welded fittings equal to adjacent piping.

3.3 ELECTRIC WIRING

A. Furnish equipment requiring electrical connections to operate properly and to deliver full capacity at electrical service available.

B. All control wiring to be in accordance with manufacturer's recommendations; all wiring shall be color coded to facilitate checking.

C. Unless otherwise indicated, all mechanical equipment motors, starters, and controls shall be furnished, set in place, and wired in accordance with the Electrical Equipment/Wiring Responsibility Matrix on the drawings. Contractor should note that the intent of this electric wiring matrix is to have the Division 23 Contractor responsible for coordinating all control wiring as outlined, whether or not specifically called for by the mechanical or electrical drawings and specifications. Mechanical Contractor shall comply with the applicable requirements of Division 26 for electrical work of this Division 23 which is not otherwise specified. No extras will be allowed for Contractor's failure to provide for these required items. The Division 23 Contractor shall also refer to the Division 26 specifications and plans for all power and control wiring and shall advise the Architect/Engineer of any discrepancies prior to bidding.

ELECTRICAL EQUIPMENT/WIRING RESPONSIBILITY MATRIX

Item	Furnished By*	Set By*	Power Wiring*	Control Wiring*
Equipment Motors	MC	MC	EC	MC
Motor Starters & Overload Heaters	MC – Except when shown on MCC	EC	EC	MC
Variable Frequency Drives (VFDs)	MC	EC	EC	MC
Fused & Unfused Disconnect Switches, Thermal Overload & Heaters	EC	EC	EC	--
Manual Switches & Speed Control Switches carrying full load currents.	MC	EC	EC	EC
Fire/Smoke and Smoke Dampers	MC	MC	EC – Requires emergency power circuit if air system served is on emergency power.	EC
Control Relays & Transformer (See Note 2)	MC	MC	EC	MC

* MC = Mechanical Contractor under Division 23 of the work.
* EC = Electrical Contractor under Division 26 of the work.

D. All temperature control conduit and wiring shall be furnished and installed under Section 23.

3.4 SLEEVES, PLATES AND CLOSURES

A. Division 23 Contractor shall provide and locate pipe sleeves, and inserts required before new floors and walls are built or shall be responsible for the cost of cutting and patching required where sleeves and inserts were not installed or where incorrectly located.

B. Provide sleeves for mechanical piping passing through concrete floor slabs and through concrete, masonry, tile, and gypsum wall construction. Provide metal collars to close and protect openings.

C. Where sleeves are placed in exterior walls below grade, pack spaces between the pipe or conduit and the sleeves with Hornflex Thiokol L-32 Sealant or Link Seal and make water-tight. Provide metal rodent collars securely fastened to structure. Link seal shall not be used on fire lines.

D. Where pipe motion due to expansion and contraction will occur, make sleeves of sufficient diameter to permit free movement of pipe. Where sleeves pass insulated pipes, the sleeves shall be large enough to pass the pipe only and the insulation shall be made to butt against the construction, except for pipes requiring insulation having a vapor barrier, in which case, the sleeves shall be large enough to pass the pipe and insulation. Check floor and wall construction finishes to determine proper length of sleeves for various locations, make actual lengths to suit the following:

1. Terminate sleeves flush with floors, walls, partitions, and ceilings.
2. Seal annular space around pipes watertight at floor penetrations.
3. In areas where pipes are concealed, as in chases, terminate sleeves flush with floor.
4. In all areas where pipes are exposed, extend sleeves 1/4" above finished floor, except in rooms having floor drains, where sleeves shall be extended 2" above floor and in Kitchens and Mechanical Equipment Rooms, where sleeves shall be extended 4" above floor.

E. Sleeves shall be constructed of 24 gauge galvanized sheet steel with lock seam joints for all sleeves set in concrete floor slabs terminating flush with the floor. All other sleeves shall be constructed of galvanized steel pipe unless otherwise indicated on the drawings. "Crete Sleeve" (plastic type) sleeves are acceptable for concrete construction as manufactured by Sperzel Division, Shamrock Industries or Willoughby Industries.

F. Fasten sleeves securely in floors and walls so that they will not become displaced when concrete is placed or when other construction is built around them.

G. Provide tight fitting floor and ceiling plates on pipes passing thru walls, ceilings, and floors. Nickel or chrome plated in finished areas, galvanized cast iron in unfinished areas. Provide wall and ceiling flanges for ducts in finished areas.

H. Provide all cutting, patching of holes, openings, notches. Obtain written approval for notching, boring, chipping, burning, drilling, welding to structural members in accordance with the General Conditions of the Contract and paragraph 3.7 of this Section.

I. Where pipe sleeves penetrate fire rated walls and floors, this contractor shall use fire safing to seal openings.

3.5 FOUNDATIONS, PADS AND CURBS

A. Provide dowels, anchor bolts, groutings, concrete foundations and pads for pumps, plumbing, heating and ventilating or air conditioning equipment in accordance with Concrete Specifications.

B. Dimensions and exact locations for foundations and concrete curbs for mechanical equipment to be field verified and located accurately by Division 23 Contractor.

3.6 EXCAVATING AND BACKFILLING

A. Excavate for all mechanical equipment such as fuel tanks, ductwork, sump pumps, manholes and trenches for underground pipelines to required depths. Compact bottoms of excavations. Slope to obtain required grade. Remove rocks, trash and debris before installation of equipment and backfilling. Backfill by hand tamping earth under the haunch of the pipe to specified compaction. Backfill and compact in thin layers until top of pipe is covered. Complete backfill by methods required or directed for soil characteristics to comply with the Architectural section of these specifications.

B. Excavations near footings shall be such that, when nearing building footings, or bearing foundation walls, the excavation bottom shall not be nearer the footing than a normal 45 degree bearing line from edge of footing bottom to bottom of excavation. When it is necessary to perpendicularly cross under a continuous foundation wall, care shall be taken to insure that crossing is clear of the structural foundation and of minimal width.

C. Do not place backfill over pipe lines until lines are properly tested.

D. When trenching through specially tested areas, such as paving, asphalt, etc., Contractor shall be responsible for restoring the surface to its original condition, and in a manner approved by the Architect. Repair trenches where settlement occurs, and restore the surface for the period of one year after final acceptance of the project. All cutting of paving, asphalt, etc. shall be by saw cutting.

3.7 CUTTING AND PATCHING

A. Cutting in Existing Building:

1. The Construction Manager/General Contractor shall make arrangements for required openings in the existing building to facilitate the passage of ductwork, piping, etc. thru existing floors, walls, and beams. Division 23 Contractor to coordinate all requirements.

B. Patching in Existing Building:

1. The Construction Manager shall provide for patching all existing walls and floors to match existing.

3.8 PIPE HANGERS/SUPPORTS

A. Use inserts, anchors, expansion bolts or other approved and acceptable means of attachment to concrete construction. Set inserts in advance of concrete installation, provide required reinforcement rod for all inserts carrying loading equivalent of one 4" pipe or more. All inserts shall be flush with face of slab or wall containing insert.

B. Provide flat square washers for rods thru metal decking with nut above washer, when acceptable and approved.

C. Cinch hangers to carry appropriate share of loading and slope piping without sags or "pocketing" as appropriate and required.

D. Rod offsets, or angle installation, plumber tape or wire will not be accepted. Hanger rods shall be true and plumb.

E. Piping shall not be hung from other piping or equipment items. Provide attachments to building structure only. Use trapeze, wall brackets, knee brackets, etc., where hanger rods cannot be attached within spacing plumb to structures.

F. Provide sway and earthquake bracing where required in accordance with Section 230548 - Mechanical Seismic Control.

3.9 INSTALLATION OF VALVES

A. General:

1. Provide valves as shown on Contract Documents and as required for pressure relief, balancing and/or control of flow.
2. Provide isolation valves for maintenance and service on each piece of equipment regardless of whether or not shown on Contract Drawings.
3. Provide isolation valves for all branch line take-offs that serve more than two items of fixtures or equipment.
4. Provide balancing valves for each branch of domestic hot water circulating system, all heating/cooling water returns or supplies to equipment, and as shown on Contract Documents.
5. Provide access means for each valve or group of valves either by access panels or utilization of inherent access provided by building methods i.e., lift out ceiling construction or exposed valve installations in non critical areas such as janitor's closets, storage rooms, etc.
6. Install all valves with valve bonnets or operating stems in vertical (upright) position when possible, valves may be installed with bonnets or stems not less than 35 degrees downward from vertical plane except valves on vertical piping may be 90 degrees from vertical plane. Swing type check valves shall be installed on horizontal piping no more than 45 degrees upward slope from horizontal plane, using lift checks on vertical piping. Lift check valves shall not be used on sewage or sump pump discharge piping.
7. Inspect and tighten all bonnet nuts, bolts, packing glands, lubricate all valves requiring lubrication, secure all hand wheels and identification plates, be responsible for all valves having manufacturers name, trade name, working pressure and size stamped or cast into the body of the valve. Perform all maintenance, repacking and inspection prior to installation of valve.

B. Proper Installation of Valves:

1. Provide valves in accordance with the following schedule unless specified otherwise in Contract Documents.

    a. Dead-end shut off: Gate, ball, butterfly, plug, stop and drain.
    b. Throttling: Ball, plug, globe, diaphragm, needle, butterfly (when using butterfly valves for throttling, additional valves must be provided for service shutoff.)
    c. Backflow prevention: Check.
    d. Water hammer prevention: Silent or pilot operated non slam check.
    e. Gas piping: Lubricated plug (or ground joint cock up to 1" only), or UL-Listed ball valve.

C. Removal and Repair Provisions:

1. Provide all valves which are not accessible for repair without removal from piping with union connection immediately adjacent to valve outlet.

3.10 PAINTING

A. Surfaces of exposed equipment and materials to be thoroughly cleaned and left ready for painting in accordance with Architectural Painting Specifications.

B. Duct interiors visible through registers, grilles and diffusers shall be painted flat black.

C. All other painting of mechanical equipment and piping, unless otherwise noted, shall be performed under other divisions of the work with the exception of identification of piping and equipment which will be the responsibility of the Division 23 Contractor.

3.11 IDENTIFICATION OF PIPING AND EQUIPMENT

A. General: Provide pipe identification, valve tags, stencils, or engraved nameplates to clearly identify the mechanical equipment, piping and controls of the various mechanical systems and direction of flow in piping.

B. Methods for identification shall be as follows:

1. Metal Tags: Stamp tags with letter prefixes to indicate service, followed by a number for location in system.
2. Engraved Nameplates: Attach nameplates with brass screws. Pressure-sensitive embossed labels are not acceptable. Nameplates shall bear the same identifying legend used on the Contract Documents.
3. Painted Stencils: Stenciled markings shall be neatly performed with no overspray, drips, or other imperfections. Pipes and equipment to be stenciled shall first be wiped clean of dirt, dust, rust, grease and moisture. Pipes and smooth, hard surface in the area the stencil is to be applied. Paint application shall comply with Architectural Painting Specifications.
Size of Legend and Letters for Stencils:

Insulation or Pipe Diameter	Length of Color Field	Size of Letters
¾" to 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
over 10"	32"	3-1/2"
Ductwork and Equipment	NA	2-1/2"

4. Pressure Sensitive Markers: Apply pressure sensitive markers in accordance with manufacturer's recommendations with complete wrap around may be used at Contractor’s option. Marker adhesion will be tested for permanence. Any markers showing dog ears, bubbles, or other failings shall be replaced.
5. Semi-Rigid Plastic Identification Markers: Seton Setmark premolded (not pressure sensitive) identification markers may be used at Contractor's option on service piping which is accessible for maintenance operations (but not on piping in finished spaces). This type marker shall not be installed on bare pipe when surface temperature exceeds 180 deg.F unless a 1" thick insulation band is first provided under marker for protection from the hot pipe.

C. Valves: All valves, including but not limited to domestic hot and cold water, hot water recirculation, heating water, chilled water, condenser water, steam, steam condensate return, fire protection, gas, medical gas, vacuum and special service valves located inside the building, shall be tagged and identified as to type of service, location number, and normal valve position (normally open or normally closed).

D. Controls: All magnetic starters and relays, shall have nameplates or be stenciled to identify connecting or controlled equipment. All manual operating switches, fused disconnect switches and thermal over-load switches which have not been specified as furnished with indexed faceplates shall also have nameplates or be stenciled as to "connected" or "controlled" equipment. All automatic controls, control panels, zone valves, pressure electric, electric pressure switches, relays, and starters shall be clearly identified.

E. Air Conditioning Equipment: Air conditioning equipment such as chillers, pumps, condensers, or roof-top equipment shall be identified by stencils, or system nameplates.

F. Access Doors: Provide engraved nameplates or painted stencils to identify concealed valves, controls, dampers or other similar concealed mechanical equipment. Obtain Architect approval before installation on all access doors in finished areas.

G. Lift Out Ceilings: Provide engraved nameplates or black lettering on transparent adhesive labels on ceiling tee stem to identify concealed valves, controls dampers or similar concealed mechanical equipment which is directly above nameplate in ceiling space. Obtain Architect approval before installation.

H. Expansion tanks shall be labeled to indicate system served and precharge pressure.

I. Access Flooring: Provide thin engraved nameplate on access panel to indicate location of underfloor fan coils and smoke/fire dampers.

3.12 DRIP PANS

A. Provide drip pans under all fluid conducting piping which runs over servers, telecom equipment, electric switchgear, busway, or electric motor starters, and under all point-of-use water heaters.

B. Pans: 18 gauge galvanized iron. Pans shall be two inch deep, with rolled top edges, and shall extend six inches each side of the pipe or group of pipes and six inches beyond the equipment below. Keep pans as close to the underside of the pipes as practicable. All seams shall be soldered, and pans shall be crossbraced as required to prevent sagging and warping.

C. Pitch each pan to a drain connection, and pipe a 1-1/2 inch or larger copper tube drain to discharge over nearest available open drain.

D. Provide a drip pan under all coils that may have condensate during operation like heat recovery coils, etc. Pipe drain to nearest drain.

3.13 FIRE SAFING

A. Mechanical Contractor shall provide fire safing for his work as follows: Where fire rated separations are penetrated by pipes, conduit or ductwork, the annular space around the pipe, conduit or ductwork shall be filled with a U.L. Rated fire safing material. Refer to Division 7 for materials and application specifications.

3.14 DIELECTRIC PIPE FITTINGS AND ISOLATORS

A. Provide dielectric pipe fittings and isolators at all connections between dissimilar metals in the domestic water, to control corrosion potential caused by galvanic or electrolytic action.

B. Typical locations for dielectric isolation are; water heaters, storage and pressure tanks, water conditioning equipment, pumps, changes in service piping materials, make-up connections to boilers and chilled water systems, valves, deaerators, flexible connectors and the like where materials of different electrode potential are joined.

C. Hangers for piping shall be isolated per Section 230529 when hanger and piping materials are dissimilar and subject to production of electrolysis or galvanic action.

D. Storage tanks shall be isolated from piping and tank stands by use of anti-electrolytic and galvanic isolators.

3.15 DRAIN LINES

A. Provide drain lines from each pump to nearest drain or to termination indicated.

B. Do not route condensate lines above electrical panels, switch gear, transformers, motor starters, elevator equipment, servers, or telecom equipment. Should there be a conflict with the plans and this paragraph, notify the Engineer immediately for corrective instruction prior to starting work.

3.16 EXISTING PIPES AND MECHANICAL EQUIPMENT TO BE REMOVED

A. Where existing mechanical equipment, fixtures and/or piping is to be removed and/or relocated, all piping shall be disconnected and capped. All existing piping and hangers not to remain in use shall be removed completely to an existing main that is to remain in use, and capped at the main. General Contractor shall do all cutting, patching, and restoring that may be required for the removal of this piping and equipment. Where it is not possible to remove branch piping not remaining in use, due to its being concealed in the structure, the Division 23 Contractor shall cap the piping concealed at both ends in these areas as approved by the Architect.

B. All mechanical equipment, fixtures, and piping to be removed and not re-used shall remain the property of the Division 23 Contractor for credit to the contract price except as noted otherwise.

END OF SECTION 230529

SECTION 230540 - MECHANICAL SOUND AND VIBRATION CONTROL

PART 1 - GENERAL

1.1 RELATED WORK

A. Requirements: Provide Mechanical Sound and Vibration Control in accordance with the Contract Documents.

B. Related work specified in other Sections:

Section 230500 - Basic Mechanical Requirements
Section 230529 - Basic Mechanical Materials and Methods
Section 233300 - Ductwork and Accessories - Flexible Ductwork Connections

1.2 SYSTEM DESCRIPTION

A. The work includes, but is not limited to the following:

1. Support isolation for motor/driven mechanical equipment.
2. Rails or beams for distribution of equipment loading to isolation units.
3. Fabricated bases for distribution of equipment loading to isolation units.
4. Isolation of pipes and ductwork.
5. Sound proofing of construction.
6. External sound proofing.

1.3 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings and Product Data for the following items in accordance with the General Conditions of the Contract.

1. Each type of isolator including spring diameters, deflections, compressed spring height and solid spring height.
2. Sound Lining.

B. Test Reports: Submit certified test reports showing compliance in accordance with General Conditions of the Contract of the following items:

1. Pressure drop and insertion loss ratings for sound attenuators.
2. Certification that sound lining meets erosion test method described in UL Publication No. 181.

PART 2 - PRODUCTS

2.1 PIPING AND EQUIPMENT ISOLATION

A. Manufacturer: Amber/Booth Co., Kinetics, Korfund, Mason Industries, Inc., Vibration Mountings and Control Co., Vibro-Acoustics.

B. Neoprene Mounting Pads (Specification Schedule Type 1)

1. Kinetics Noise Control Type NPD.
2. Minimum static deflection 0.04” for 0.22” thick pad.
3. Cross, double ribbed elastomer in-shear pads, capable of 60 or 120 PSI loading, depending on load density of equipment being isolated.
4. Material thickness as required to provide minimum deflections listed in table at end of the specification section.

C. Double Deflection Neoprene Mountings (Specification Schedule Type 2)

1. Mason Industries Type ND Mounting, Type DNR Rails.
2. Minimum static deflection 0.35 inch.
3. Bolt holes where required.
4. Steel rails above mountings to compensate for overhang where required.

D. Spring Isolator Mountings (Specification Schedule Type 3)

1. Mason Industries Type SLF.
2. Free-standing, laterally stable without housing, complete with 1/4 inch neoprene acoustical friction pads between base plate and support and with leveling bolts that must be rigidly bolted to equipment.
3. Spring diameters no less than 0.8 of the compressed height of the spring at rated load.
4. Springs with minimum additional travel to solid equal to 50 percent rated deflection.

E. Restrained Spring Isolator Mountings (Specification Schedule Type 4)

1. Mason Industries Type SLR.
2. Spring isolator mounting equal to Type SLF but with housing that includes vertical resilient limit stops to prevent spring extension when weight is removed from equipment.
3. Provide hot dipped galvanized mountings exposed to weather.

F. Vibration Hangers (Specification Schedule Type 6)

1. Mason Industries Type DNH.
2. Spring and double deflection neoprene element in series.
3. Neoprene element minimum deflection 0.35 inch.
4. Spring diameters no less than 0.8 of compressed height of spring at rated load.
5. Springs with minimum additional travel to solid equal to 50 percent rated deflection.

G. Integral Structural Steel Base (Specification Schedule Type B)

1. Mason Industries Type WF.
2. Rectangular for equipment other than "T" or "L" shaped pump bases.
3. Pump bases for split case pumps to include supports for suction and discharge base ells.
4. Beams for perimeter members minimum depth equal to one tenth of the longest dimension of the base. Depth need not exceed 14 inches if deflection and misalignment is kept within acceptable limits by manufacturer.
5. Provide height saving brackets to provide a clearance of one inch.

H. Steel Rail Base (Specification Schedule Type B)

1. Mason Industries Type ICS.
2. Steel members welded to height saving brackets to cradle machines having legs or bases that do not require a complete supplementary base.
3. Provide members sufficiently rigid to prevent strains in the equipment.

I. Concrete Inertia Bases (Specification Schedule C)

1. Mason Industries Type K.
2. Rectangular structural beam or channel concrete forms for floating foundations.
3. Provide bases for split case pumps large enough for suction and discharge base ells supports.
4. In general, unless shown otherwise on the Drawings, provide bases with a minimum depth of one twelfth of the longest dimension of the base, but not less than 6 inches.
5. Forms to include minimum concrete reinforcement consisting of 1/2 inch bars or angles welded in place on 6 inch centers running both ways in a layer 1-1/2 inches above the bottom, or additional steel as is required by the structural conditions.
6. Forms furnished with drilled steel members with sleeves welded below the holes to receive equipment anchor bolts.
7. Provide height saving brackets to maintain a 1 inch clearance below base.

2.2 ADHESIVE AND SEALER

A. Acceptable Products: Adhesive, Benjamin Foster "81-99", or accepted equal, Sealer, Benjamin Foster "82-07" or accepted equal.

B. In conformance with NFPA 90A.

C. Flamespread: Maximum 25.

D. Fuel contributed and smoke developed: Maximum 50.

2.3 NON-HARDENING CAULKING

A. Acceptable Products: Tremco "Polybutene", Schuller or accepted equal.

B. Guaranteed to be permanently elastic.

PART 3 - EXECUTION

3.1 GENERAL - PIPING AND EQUIPMENT ISOLATION

A. Unless otherwise noted on the Equipment Mounting Schedule, provide mechanical equipment mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators to be selected in accordance with the weight distribution so as to produce reasonable uniform deflection. Deflections to be as noted on the Equipment Mounting Schedule included at the end of this section.

B. Coordinate work with other trades to avoid rigid contact with the building. Inform other trades following the isolation work, to avoid any contact which would reduce the vibration isolation.

C. The installation or use of vibration isolators must not cause any change of position of equipment or piping which would result in stresses in piping connections or misalignment of shafts or bearings. In order to meet this objective, maintain equipment and piping in a rigid position during installation. Do not transfer the load to the isolator until the installation is complete and under full operational load.

D. Support the machine to be isolated with a structural steel frame.

E. Provide brackets to accommodate the isolator and provide a mechanical stop. The vertical position and size of the bracket to be recommended by the isolator manufacturer.

F. For restrained spring isolators, use housing as blocking during erection so that installed and operating heights can be the same. Maintain a minimum clearance of 1/2 inch around restraining bolts between housing and spring to avoid interference with spring action. Limit stops to be out of contact during normal operation.

3.2 HANGERS

A. Install type 2 or 3 vibration isolation piping hangers where indicated in Equipment Mounting Schedule at the end of this section and within 20 feet (measured along piping) upstream and downstream of all pumps 3 HP or larger.

B. Install the isolators with the isolator hanger box attached to or hung as close as possible to the structure.

C. Suspend the isolators from substantial structural members, not from slab diaphragm unless specifically accepted.

D. Align hanger rods to clear hanger box.

3.3 EQUIPMENT BASES

A. Provide minimum operating clearance between the equipment frame or rigid steel base frame and the housekeeping pad or floor of 1 inch. Provide minimum operating clearance between concrete inertia base and the housekeeping pad or floor of 1 inch.

3.4 SOUND PROOFING OF CONSTRUCTION

A. Required for opening between ductwork and piping and following construction:

1. Equipment room walls.
2. Floors, except in shafts.
3. Roofs, specifically inside roof curbs for mechanical equipment and where ductwork penetrates roof deck.

B. Sound proofing:

1. Fill openings with tightly packed fibrous glass blanket or board for full depth of penetration.
2. Caulk each side of opening with non-hardening, non-aging caulking compound.

3.5 EQUIPMENT MOUNTING SCHEDULE

A. Manufacturer: Mason Industries, Inc., Kinetics, Vibro-Acoustics.

B. Schedule: See the following pages.

EQUIPMENT VIBRATION ISOLATION SCHEDULE						
EQUIPMENT TYPE	SLAB ON GRADE			20 FT. FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN. DEFL. (IN.)	BASE TYPE	ISOL TYPE	MIN DEFL. (IN.)
PACKAGED AIR HANDLING EQUIPMENT						
A. Up to 10 HP	A	2	.25	A	3	.75
B. 15 HP & Over	A	2	.25	A	3	.75

BASE TYPES:

A = NO BASE, ISOLATORS ATTACHED DIRECTLY TO EQUIPMENT
B = STRUCTURAL STEEL RAILS OR BASE
C = CONCRETE INERTIA BASE
D = CURB-MOUNTED BASE

ISOLATOR TYPES

1 = RUBBER OR GLASS FIBER PAD
2 = RUBBER FLOOR ISOLATOR OR HANGER
3 = SPRING FLOOR ISOLATOR OR HANGER
4 = RESTRAINED SPRING ISOLATOR
5 = SPRING AND RUBBER IN SERIES HANGER

NOTES:

1. CONTRACTOR SHALL PROVIDE VIBRATION ISOLATION AND CALCULATIONS STAMPED BY A LICENSED PROFESSIONAL ENGINEER.

2. TO AVOID ISOLATOR RESONANCE PROBLEMS, SELECT ISOLATOR DEFLECTION SO THAT NATURAL FREQUENCY IS 40% OR LESS THAN LOWEST OPERATING SPEED OF EQUIPMENT (SEE ASHRAE HVAC APPLICATIONS HANDBOOK, 2007 EDITION).

EQUIPMENT VIBRATION ISOLATION SCHEDULE						
EQUIPMENT TYPE	30 FT. FLOOR SPAN			40 FT. FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN. DEFL. (IN.)	BASE TYPE	ISOL TYPE	MIN DEFL. (IN.)
PACKAGED AIR HANDLING EQUIPMENT						
A. Up to 10 HP	A	3	.75	A	3	.75
B. 15 HP & Over	A	3	1.5	A	3	1.5

BASE TYPES:

A = NO BASE, ISOLATORS ATTACHED DIRECTLY TO EQUIPMENT
B = STRUCTURAL STEEL RAILS OR BASE
C = CONCRETE INERTIA BASE
D = CURB-MOUNTED BASE

ISOLATOR TYPES

1 = RUBBER OR GLASS FIBER PAD
2 = RUBBER FLOOR ISOLATOR OR HANGER
3 = SPRING FLOOR ISOLATOR OR HANGER
4 = RESTRAINED SPRING ISOLATOR
5 = SPRING AND RUBBER IN SERIES HANGER

NOTES:

1. CONTRACTOR SHALL PROVIDE VIBRATION ISOLATION AND CALCULATIONS STAMPED BY A LICENSED PROFESSIONAL ENGINEER.

2. TO AVOID ISOLATOR RESONANCE PROBLEMS, SELECT ISOLATOR DEFLECTION SO THAT NATURAL FREQUENCY IS 40% OR LESS THAN LOWEST OPERATING SPEED OF EQUIPMENT (SEE ASHRAE HVAC APPLICATIONS HANDBOOK, 2007 EDITION).

END OF SECTION 230540

SECTION 230548 - MECHANICAL SEISMIC CONTROL

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Anchorage and seismic restraint systems for all Division 23 isolated and non-isolated equipment, ductwork and piping systems.

B. All Division 22 and 23 equipment/piping/ductwork shall be isolated and/or seismically supported in accordance with all requirements of the IBC and ASCE 7. This includes, but is not limited to, the following:

1. Piping
2. Ductwork
3. Unit Heaters
4. Hanging Exhaust Fans
5. Pumps

1.2 RELATED WORK

A. Requirements: Provide Mechanical Seismic Control in accordance with the Contract Documents.

B. Section 230500 - Basic Mechanical Requirements.

C. Section 230529 - Basic Mechanical Materials and Methods.

D. Section 230540 - Mechanical Sound and Vibration Control.

1.3 REFERENCES

A. International Building Code, Current Edition in use by Jurisdictional Authority.

B. NFPA Bulletin 90A, Current Edition.

C. UL Standard 181.

D. SMACNA Seismic Restraint Manual: Guidelines for mechanical systems.

1.4 SYSTEM DESCRIPTION

A. The Division 23 Contractor shall be responsible for supplying and installing equipment, vibration isolators, flexible connections, rigid steel frames, anchors, inserts, hangers and attachments, supports, seismic snubbers and bracing to comply with the following:

1. Short period design spectral response acceleration coefficient S_{DS}= 1.08.
2. One-second period design spectral response acceleration coefficient S_{D1}= 0.57.
3. Site Class D.
4. Seismic Design Category D.

B. The following components have a component importance factor I_P of 1.5:

1. Fire Sprinkler Protection System
2. Natural Gas Piping

All other components have an importance factor I_P of 1.0.

1.5 QUALITY ASSURANCE

A. All supports, hangers, bases, anchorage and bracing for all isolated equipment and non-isolated equipment shall be designed by a professional engineer licensed in the state where the project is located, employed by the restraint manufacturer, qualified with seismic experience in bracing for mechanical equipment. Shop drawings included with deferred submittal for earthquake bracing and anchors from the restraint manufacturer shall bear the Engineer's signed professional seal. All calculations/design work required for the seismic anchorage and restraint of all Division 23 equipment and systems shall be provided by a single firm.

B. The above qualified professional engineer shall determine specific requirements for equipment anchorage and restraints, locations and sizes based on shop drawings for the mechanical equipment which have been submitted, reviewed and accepted by the Architect/Engineer for this project.

C. Seismic Engineer or the Engineer’s Representative shall field inspect final installation and certify that bracing and anchorage are in conformance with the Seismic Engineer’s design, the requirements of this specification section, and all seismic restraint requirements of the building code. Provide a Certificate of Compliance stating all Division 22 and 23 utilities and equipment have been anchored and restrained in accordance with the requirements of the building code and ASCE 7. A certificate of compliance shall include the Seismic Engineer’s signed Professional Engineer’s seal. Include a copy of the certificate in each copy of the Operation and Maintenance Manual.

D. The Division 23 Contractor shall require all equipment suppliers to furnish equipment that meets the seismic code, with bases/skids/curbs designed to receive seismic bracing and/or anchorage. All isolated and non-isolated mechanical equipment bracing to be used in the project shall be designed from the equipment submittals and certified to be code-compliant by the equipment manufacturer for seismic description loads defined above, with direct anchorage capability.

1.6 SUBMITTALS

A. A single submittal shall be provided for all seismic anchorage and restraints for all Division 23 equipment and systems provided as part of this project. Individual submittals for specific systems will not be accepted.

B. Submit shop drawings, calculations, and printed data for the following items under provisions of the General Conditions of the Contract:

1. Complete engineering calculations and shop drawings for all seismic restraint requirements for all equipment as required by the IBC.
2. The professional seal of the engineer who is responsible for the design of the Seismic Restraint System.
3. Details for all seismic bracing.

4. Details for steel frames, concrete inertia bases, and housekeeping pads. Include dimensions, embed depths, dowelling details, and concrete reinforcing requirements.
5. Clearly outlined procedures for installing and adjusting the isolators, seismic bracing anchors, snubbers, cables, and bolt connections.
6. Floor plan noting the locations, size, and type of anchorage and restraint to be used.
7. Include confirmation that all calculations are based on the design criteria listed in Paragraph 1.4.A of this Section.
8. Certificate of Compliance.

PART 2 - PRODUCTS

2.1 RESTRAINT EQUIPMENT AND SYSTEMS

A. Acceptable Manufacturers and Suppliers for Non-Isolated Systems:

1. Mason Industries, Inc.
2. Korfund
3. Amber/Booth Company
4. Vibration Mountings and Control Company
5. Kinetics
6. International Seismic Application Technology
7. Tolco
8. Vibro Acoustics
9. Hilti
10. Vibration & Seismic Technologies

B. Manufacture of restraints and anchors for isolated equipment required by this specification section shall also furnish the vibration isolators required by Specification Section 230540.

2.2 SNUBBERS

A. Snubbers shall be all-directional and consist of interlocking steel members restrained by replaceable shock absorbent elastomeric materials a minimum of 3/4 inch thick.

B. Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8 inch or more than 1/4 inch.

C. Snubbers shall be Mason Industries Z - 1011 or accepted equivalent.

PART 3 - EXECUTION

3.1 DESIGN AND INSTALLATION

A. General:

1. All mechanical equipment, piping and ductwork shall be braced, anchored, snubbed or supported to withstand seismic disturbances in accordance with the criteria of this specification. Provide all engineering, labor, materials and equipment for protection against seismic disturbances as specified herein. The following mechanical components are exempt from seismic restraint requirements:

    a. Components in Seismic Design Categories A and B.
    b. Components in Seismic Design Category C that have an importance factor I_P of 1.0.
    c. Components that have an importance factor I_P of 1.0, that are mounted less than four feet above the floor, that weigh less than 400 pounds, and that have flexible ductwork, piping, and conduit connections.
    d. Components that have an importance factor I_P of 1.0, that weigh 20 pounds or less, and that have flexible ductwork, piping, and conduit connections.

2. Powder-actuated fasteners (shot pins) shall not be used for component anchorage in tension applications in Seismic Design Category D, E, or F.
3. Attachments and supports for mechanical equipment shall meet the following provisions:

    a. Attachments and supports transferring seismic loads shall be constructed of materials suitable for the application and designed and constructed in accordance with a nationally recognized structural code such as, when constructed of steel, AISC, Manual of Steel Construction (Ref. 9.8-1 or 9.8-2).
    b. Friction clips shall not be used for anchorage attachment.
    c. Expansion anchors shall not be used for mechanical equipment rated over 10 hp (7.45 kW). Exception: Undercut expansion anchors.
    d. Drilled and grouted-in-place anchors for tensile load applications shall use either expansive cement or expansive epoxy grout.
    e. Supports shall be specifically evaluated if weak-axis bending of light-gauge support steel is relied on for the seismic load path.
    f. Components mounted on vibration isolation systems shall have a bumper restraint or snubber in each horizontal direction. The design force shall be taken as $2F_p$. The intent is to prevent excessive movement and to avoid fracture of support springs and any non-ductile components of the isolators.
    g. Seismic supports shall be constructed so that support engagement is maintained.

B. Install ceiling mounted items in accordance with ASTM C 636.

1. Ceiling mounted air terminals or services weighing less than 20 pounds shall be positively attached to the ceiling suspension main runners or to cross runners with the same carrying capacity as the main runners.

2. Terminals or services weighing 20 pounds but not more than 56 pounds, in addition to the above, shall have two No. 12 gauge hangers connected from the terminal or service to the ceiling system hangers or to the structure above. These wires may be slack.
3. Terminals or services weighing more than 56 pounds shall be supported directly from the structure above by approved hangers.

C. Spring Isolated Equipment:

1. All vibration isolated equipment shall be mounted on rigid steel frames or concrete bases as described in the vibration control specifications unless the equipment manufacturer certified direct attachment capability. Each spring mounted base shall have a minimum of four all-directional seismic snubbers that are double acting and located as close to the vibration isolators as possible to facilitate attachment both to the base and the structure. Snubbers shall be installed with factory set clearances.

D. Non-Isolated Equipment:

1. The Division 230548 Contractor shall be responsible for thoroughly reviewing all drawings and specifications to determine all equipment to be restrained. This Contractor shall be responsible for certifying that non-isolated equipment is mounted and braced such that it adheres to the system description criteria in this specification section.

E. Piping:

1. Seismic braces for piping may be omitted when the distance from the top of the pipe to the supporting structure is 12" or less. Where pipes are supported by a trapeze, seismic braces may be omitted when the trapeze shall be supported by hangers having a length of 12” or less.
2. A rigid piping system shall not be braced to dissimilar parts of a building or two dissimilar building systems that may respond in a different mode during an earthquake. Examples: Wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.
3. Unbraced piping attached to in-line equipment shall be provided with adequate flexibility to accommodate differential displacements.
4. At the interface of adjacent structures or portions of the same structure that may move independently, utility lines shall be provided with adequate flexibility to accommodate the anticipated differential movement between the ground and the structure.
5. Provide large enough pipe sleeves through walls or floors to allow for anticipated differential movements.

F. Ductwork:

1. Seismic restraints are not required for HVAC ducts with importance factor I_P of 1.0, provided that either of the following conditions are met for the full length of each duct run:

    a. HVAC ducts are suspended from rod hangers and hangers are 12 inches or less in length from the point rod attaches to duct, to the point rod connects to the supporting structure. Rods must be secured to both top and bottom cross angles with locking nuts above and below angle iron.
    b. HVAC ducts have a cross-sectional area of less than 6 square feet.

c. This exception is not valid if the top of ductwork is not secured to hanger rods to limit pendulum length to 12 inches.

2. Equipment items installed in-line with the duct systems with an operating weight greater than 75 pounds shall be supported and laterally braced independently of the duct system.

END OF SECTION 230548

SECTION 230593 - TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 RELATED WORK

A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these Documents.

B. Related work specified in other Sections:

Section 230500 - Basic Mechanical Requirements
Section 233300 – Ductwork and Accessories

1.2 SYSTEM DESCRIPTION

A. The work includes, but is not limited to the following:

1. Upon completion of the installation of all the plumbing, water systems all necessary adjustments shall be made to provide capacities listed on the Drawings to properly balance these systems.
2. Submittals and written reports as specified.
3. Testing requirements as described in Specification Section 230500, paragraph 1.16.
4. Witness duct leakage test required by Specification Section 233300 – Ductwork and Accessories.
5. Provide assistance, in cooperation with the various trades, in the final adjustments and test of the Life Safety Systems to comply with the requirements of the Local Building and Fire Departments.
6. Provide Owner training as described in Specification Section 230500.

1.3 QUALITY ASSURANCE

A. Work under this section shall be executed under the direct supervision of a Registered Professional Engineer having an established professional office in the State of Utah and having an experience record of not less than five (5) years in the mechanical contracting industry, engaged in testing, balancing and adjusting of air and hydronic mechanical systems for not less than two (2) years of that time, or, under the direct supervision of a qualified testing, adjusting and balancing supervisor, possessing certification from the National Environmental Balancing Bureau (NEBB) or from the Associated Air Balance Council (AABC).

B. Comply with the applicable procedures in the chapter on Testing, Adjusting and Balancing in the latest ASHRAE Edition of the NEBB, AABC, and SMACNA Test and Balance documents.

C. Calibration and maintenance of instruments shall be in accordance with manufacturer's standards and recommendations, and calibration histories for each instrument shall be available for examination.

D. Accuracy of measurements shall be in accordance with the applicable measurement means as listed in the latest edition of NEBB, AABC, and SMACNA Test and Balance documents.

E. Allowable Tolerances:

1. Tolerances of adjustment for air handling systems are plus or minus 10% for supply, return, and exhaust systems at air devices and plus 10%/minus 0% at all fans/source equipment from figures shown on drawings.
2. Tolerances of adjustment for hydronic systems, are plus or minus 10% of design conditions shown on drawings at terminal devices and equipment, and plus 10%/minus 0% at all pumps.

F. Final Testing, Adjusting and Balancing of all hydronic and air systems shall be performed by an approved separate professional Testing, Adjusting and Balancing subcontractor meeting the above Quality Assurance requirements. Acceptable separate professional subcontractors approved to work on this project are as follows:

1. BTC Services, Inc.
2. Certified Testing & Balancing, Inc.
3. RS Analysis, Inc.

G. Subcontractors not listed above will not be approved.

H. Within 30 days after execution of the Owner-Contractor Agreement, transmit to Engineer the name and qualifications of the organization proposed to perform the services.

1.4 SUBMITTALS

A. Procedure: Submit Qualifications, Documentation, Test Schedules and Reports in accordance with the General Conditions of the Contract.

B. Qualifications:

1. Submit three copies of documentation to confirm compliance with Quality Assurance provisions:

a. Organization supervisor and personnel training and qualifications.
b. Specimen copy of each of the report forms proposed for use.

C. Preliminary Report: At least fifteen days prior to starting field work, submit three copies of:

1. A set of report forms filled out as to the design flow values and the installed equipment pressure drops, and the required CFM for air terminals.

2. A complete list of instruments proposed to be used, organized in appropriate categories, with data-sheets for each. Show:

a. Manufacturer and model number.
b. Description and use when needed to further identify the instrument.
c. Size of capacity range.
d. Latest calibration date.

3. Engineer will review submittals for compliance with Contract Documents, and will return one set marked to indicate:

    a. Discrepancies noted between measured data and Contract Documents.
    b. Additional, or more accurate, instruments required.
    c. Requests for re-calibration of specific instruments.

D. Schedules:

1. Schedule tests to comply with project completion schedules.
2. Schedule testing and balancing of parts of the systems which are delayed due to seasonal, climatic, occupancy, or other conditions beyond control of the Contractor, as early as the proper conditions will allow, after consultation with Engineer.
3. Submit reports of delayed testing promptly after execution of those services.

E. Final Report: At least fifteen days prior to Contractor's request for final inspection, submit three copies of final reports, on applicable reporting forms, for review. Submit a fourth copy directly to the Engineer. Each individual final reporting form must bear the signature of the person who recorded data and that of the NEBB or AABC certified supervisor of the reporting organization. Identify instruments of all types which were used and last date of calibration of each. Report shall include:

1. A detailed letter to Engineer outlining all abnormal or notable conditions not covered in above data specifically identifying all locations where specified flow tolerances could not be met.
2. A set of reduced black and white or blueline prints with all air openings clearly marked to correspond with data sheets and with thermometer locations clearly marked.
3. Data sheets showing amount of air handled at each opening, instrument used, velocity readings, and manufacturer free area factor.
4. Equipment data sheets giving make, size and model, of fans, starters and motors with rated amps and service factors, and drives. Include pumps, supply fans, exhaust and recirculating fans.
5. Operating data including fan RPM, inlet and outlet pressures, pressure drop across filters, face and bypass dampers, and measured motor current and voltage, BHP and CFM (total).
6. Equipment and operating data as required to show performance of pumps, unit heaters, fans and temperature control devices.

1.5 PROJECT CONDITIONS

A. The following job conditions must be verified before any testing, adjusting or balancing of the environmental systems begin:

1. Installation of the designated system is complete and in full operation.
2. On hydronic systems, strainers shall be cleaned, temperature control valve operation shall be checked, pump rotation shall be checked, pressure reducing valves shall be adjusted, and other such conditions requiring correction.
3. Air systems shall be checked for dirty filters, filter leakage, equipment vibrations, damper operation, fan rotation, and other such conditions requiring correction.

PART 2 – PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PROCEDURE

A. Confirm that project conditions have been verified and that necessary corrections have been made before proceeding with the Work.

B. The Test and Balance Contractor must proportion air/water flows in the system while introducing a minimum amount of resistance. All systems are to be proportionally balanced.

C. Hydronic Systems:

1. Using system flow meters and/or contact pyrometer, the balancing firm shall adjust the quantity of water handled by each pump and mark each balancing cock at final setting.

D. Air Systems:

1. The balancing firm shall adjust all dampers, diffusers, registers, belts and sheaves for the delivery and distribution of air quantities shown in the Contract Documents and shall mark each balancing device at final setting.
2. Adjust fan speeds and motor drives within drive limitations for required air volume, provide new sheaves as necessary, or adjustable bands on constant volume plenum fans, and notify Division 26 Contractor of any thermal overloads that need to be changed/replaced.
3. Exhaust and recirculation air systems shall be adjusted for air quantities shown on Drawings.
4. Report: After all adjustments are made, a detailed report shall be prepared by the balancing firm and submitted to the Engineer for approval. Owner reserves the right to spot check the report prior to final acceptance.

END OF SECTION 230593

SECTION 230900 - ELECTRONIC CONTROLS

PART 1 – GENERAL

1.1 RELATED WORK

A. Contractor shall review and adhere to all requirements of these documents.

B. Related work specified in other Sections:

Section 230500 - Basic Mechanical Requirements
Section 230529 - Basic Mechanical Materials and Methods
Section 230540 - Mechanical Sound and Vibration Control
Section 230593 - Testing, Adjusting and Balancing
Section 232113 - HVAC Piping & Specialties
Section 232123 - HVAC Pumps
Section 233300 - Ductwork and Accessories
Section 233400 - Air Handling Fans
Section 250125 - Building Automation System
Section 250126 - Sequence of Operation for Pump and HVAC Controls
Section 250130 - Bas Interface Requirements
Section 250205 - Field Devices for Building Automation System
Section 260913 - Electric Power Monitoring

1.2 SYSTEM DESCRIPTION

A. Provide an expansion and modifications of existing controls of the Airport's existing Building Automation System for control, monitoring, and energy management as specified and indicated on the Drawings.

B. BAS manufacturer is responsible for all BAS design, installation, startup and testing. BAS design shall comply with the guidelines established in this Section.

C. Furnish and install all control equipment necessary for a complete and operable system.

D. Provide all BAS controls cabling for a complete and operable system. Any cabling to support an Internet Protocol (IP) connection to BAS equipment shall be coordinated with and installed by the Division 26 low voltage contractor. Cabling to support IP connections shall conform to all Division 26 requirements.

E. Coordinate with other Divisions as required for interface with the BAS.

F. Furnish all Terminal Unit Controllers.

G. Interface this BAS expansion with the existing BAS system, including any new head-end equipment which the Airport may install during the project construction.

H. Provide system testing, including demonstration and systems integration testing

1.3 SUBMITTALS

A. Action Submittals:

1. Product Data for all components provided in the project.
2. When manufacturer's cutsheets apply to a product series rather than a specific product, clearly indicate applicable data by highlighting or by other means. Clearly reference covered specification and drawing on each submittal. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements.
3. Project specific schematics, including:

    a. Overall system architecture, including flow diagram.
    b. Sequence of operations.
    c. Instrumentation diagrams
    d. Points lists
    e. Point names.
    f. Point addresses.
    g. Interface wiring diagrams.
    h. Control Panel layouts.
    i. System riser diagrams.

4. Floor plans showing:

    a. Control panel locations
    b. Terminal unit locations
    c. Floor Level Network routing and identification.

5. Interface Diagrams

    a. For all equipment with BAS interface, provide diagrams showing:
    b. Equipment supplier's scope
    c. BAS scope
    d. Points to be integrated.
    e. Interface protocol.

6. Screen Displays

    a. Before creating screen, displays submit color samples. Submit typical equipment, such as a single example of:

        1) Pumps
        2) Exhaust Fans.

B. Informational submittals

1. Provide copies of BAS QA/QC procedures to be used for system installation, startup and checkout. Procedures shall, as a minimum, include:

    a. Controller installation.
    b. Sensor installation, calibration and checkout.
    c. Point-to-point wiring checkout.

d. Third-party interface validation.
e. Control loop verification.
f. Alarm verification.

C. Closeout Submittals

1. Operating Instructions and Maintenance Data: Submit printed Operating Instructions and Maintenance Data for the following items in accordance with Operating and Maintenance Data paragraph in Section 230500. Provide the following:

a. Manufacturer's equipment parts list of all functional components of the system.
b. Electronic copies of system schematics, including wiring diagrams.
c. System schematics, including wiring diagrams.
d. Description of sequence of operations.
e. As-built interconnection wiring diagrams.
f. Operator's Manuals.
g. Riser diagram showing panel locations and networking.
h. List of connected data points, including panels to which they are connected and input device (occupancy sensors, push buttons, light sensors, etc).
i. Conduit routing diagrams.
j. Transformer and Breaker locations.
k. Control program, point definitions, and all other setup information needed to replace the controller.
l. Printout of supplied dynamic graphics displays.
m. Certificate: ATC Contractor shall submit a letter certifying completion of the control system in accordance with the Contract Documents.

1.4 WORK BY OTHERS

A. Division 26 shall provide power connections to BAS control panels.

B. Division 26 shall provide Technet Data Communications Network connections to the BAS control panels.

1.5 TRADE CONTRACTOR QUALITY ASSURANCE

A. The BAS system shall be designed and installed, commissioned and serviced by manufacturer employed, factory trained personnel.

B. Materials and equipment shall be the catalogued products and shall be manufacturer's latest standard design that complies with the specification requirements. Material and equipment installed shall be new and unused.

C. All equipment shall be compatible with the Owner's version of Siemens Enterprise Software.

D. Installation shall be in conformance with the manufacturer's printed installation instructions.

E. All BAS controllers and local user displays shall be UL Listed under Standard UL 916, category PAZX.

F. BAS components which are part of engineered smoke control systems, as noted on the Drawings, shall be rated for such use and be listed under UL 864, UUKL, PAZX.

G. The manufacturer shall provide documentation supporting compliance with ISO-9002 (Model for Quality Assurance in Production, Installation, and Servicing) and ISO-140001 (The application of well-accepted business management principles to the environment). 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.

H. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Section 15, governing radio Frequency Electromagnetic Interference and be so labeled.

1.6 WARRANTY

A. Provide all service, materials and equipment necessary for the successful operation of the entire BAS system for a period of one year after beneficial use or manufacturer's standard warranty, whichever is longer.

B. The adjustment, required testing, and repair of the system includes all computer equipment, transmission, equipment and all sensors and control devices.

1.7 DEFINITIONS

A. BAS: Building Automation System.

B. BACnet Specific Definitions:

1. BACnet: Building Automation Control Network Protocol, ANSI/ASHRAE 135.1. A communications protocol allowing devices to communicate data and services over a network.
2. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.
3. BACnet/IP: Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.
4. BACnet Testing Laboratories (BTL): Organization responsible for testing products for compliance with ASHRAE 135, operated under direction of BACnet International.
5. PICS (Protocol Implementation Conformance Statement): Written document that identifies the particular options specified by BACnet that are implemented in a device.

C. BTL: BACnet Testing Laboratory.

D. Device: any physical object that is controlled, monitored or otherwise communicates with the BAS.

E. Gateway: Bidirectional protocol translator that connects control systems using different communication protocols.

F. MODBUS/RTU: A serial data communication protocol.

G. MS/TP: Master-slave/token-passing, IEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.

H. Peer to Peer: Networking architecture that treats all network stations as equal partners.

I. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

J. Third-Party Device: A device not manufactured specifically for or manufactured by a supplier.

1.8 PRODUCT REQUIREMENTS

A. Any system or device which is part of, connected to, monitored by or communicates with the BAS through a network connection must use either MODBUS or BACnet protocol. All cabling required to support the network connection shall be installed in accordance with Division 27 requirements.

B. BACnet Requirements

1. BACnet systems or devices must be certified by BTL and must carry a “BTL Mark” signifying compliance with ANSI/ASHRAE 135.1.
2. All systems and devices shall use BACnet/IP or MSTP protocol.
3. Devices shall communicate peer-to-peer with other devices.
4. Devices shall be able to use local broadcasts received by all peer devices on the network.
5. Devices shall be able to send remote broadcasts to devices residing on networks having different network numbers.
6. Devices shall be capable of data sharing to include BACnet priority, change of value, trending, scheduling, alarm/event management, device and network management.
7. Devices shall conform to the BACnet PICS.
8. All devices shall be certified, listed and stamped by the BTL.

C. MODBUS Requirements:

1. Devices shall adhere to MODBUS TCP/IP or MODBUS RTU protocol.
2. Devices shall follow the client/server model for communication between devices. The client initiates the transaction, the server responds to complete the transaction.
3. Devices which translate any protocol to MODBUS shall not be used.

D. Gateways shall not be used.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

A. Siemens Industry, Inc. Building Technologies Division. All equipment shall be compatible with the latest version of Siemens Enterprise Software.

2.2 WIRING AND CABLES

A. Low voltage cables including field device, network and signal cables shall comply with Division 27.

B. All power wiring and related devices shall comply with Division 26.

C. All power, field device and network wiring shall be in minimum of ¾" conduit, except the final 12" of field device wiring.

D. All wiring shall comply with project specifications, codes, and BAS manufacturer's published standard.

2.3 PROJECT DESIGN REQUIREMENTS

A. Control Panels shall contain controllers, power supplies, I/O modules, bus interface modules and any other necessary devices.

1. Panel enclosure shall be Siemens, UL listed, with hinged, lockable door. NEMA 1 for panels inside and NEMA 4X for panels outside or exposed to ambient air.
2. Panel enclosure shall have sufficient space for 50% increase in I/O points.
3. All control wiring shall be routed through a gutter before entering control panel.
4. Controller shall be PXCM.
5. Controller and I/O modules shall be provided with 10% spare points of each type (AI, AO, BI, BO)
6. All digital and analog output modules shall include manual override feature. Analog modules shall include LCD display.
7. Install transformers in a separate enclosure
8. Provide permanent printed labels on each control panel. Label information shall include cabinet number designation and power feed information

B. Provide Control Panels for the following:

1. BAS Panel to be located in the Pump Room
2. Other service panels, boxes, component panels as required for monitoring and systems integration.

C. Terminal Unit Controllers shall be standard products as required for the sequences of operation. Terminal Unit Controllers with integral damper actuators are not allowed. Each controller shall be labeled with system name, address, transformer location, and circuit breaker number

D. Provide one Terminal Unit Controller for each Fan Coil Unit and each Air Terminal Unit. Air Terminal Units shall be connected to a floor level network originating in the AHU control panel serving the terminal unit.

E. All transformers required, shall be sized so that power load is no more then 50% of full load.

F. Install transformers in a separate enclosure from the controllers. Transformer locations and de- vices served need to be clearly labeled on enclosure.

G. Junction boxes shall be in an accessible location for troubleshooting.

H. Surge transient protection shall be incorporated in design of system to protect electrical components in all DDC Controllers and operator's workstations.

2.4 PERFORMANCE REQUIREMENTS

A. Environmental Conditions:

1. Instruments shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.

2.5 CURRENT SENSORS

A. Binary Sensors: minimum 1 – 135 continuous amperage rating with trip setpoint adjustable to plus or minus 1 percent of range.

1. Operating Parameters; 5 degrees F to 140 degrees F; Humidity 0 – 95 percent non- condensing.
2. Output Signal: Solid state, NO contact closure, 0.1A at 30 VAC/Vdc
3. Supply Voltage: self-induced from load being monitored.

B. Analog Sensors: Minimum 0 – 200 continuous amperage rating with adjustable zero and span, frequency insensitive range between 10- 80 Hz to 1 percent of range, minimum response of 150 ms.

1. Accuracy: 0.5 percent of full scale
2. Output Signal 4-20 ma directly proportional to sensed amperage range.
3. Supply Voltage: 12 – 30 Vdc, 30 mA maximum supply circuit.

2.6 LIQUID-FLOW METERS

A. General Requirements for Liquid Flow Meters:

1. Adjustable for changes in system operational parameters.
2. Manufacturer shall certify that each flow instrument indicated complies with specified performance requirements and characteristics.
3. Product certificates are required.

B. Display Module:

1. Remote from sensor.
2. House in a NEMA 250, Type 4X enclosure.
3. Label terminal strip for all wiring connections.
4. 120-V ac power supply with 24-V dc output to power the flow sensor.
5. Remote Interface:

a. Hardwired Analog Outputs for Flow Rate and Totalization: 4 to 20 mA and zero- to 10-V dc.
b. Outputs linear to within 0.1 percent of calibrated span.

6. Digital display for flow rate and totalized flow.

    a. At least eight display digits for totalization.
    b. Bi-directional units with separate digital display for flow and totalization in each direction.

7. Local reset of flow totalization.
8. Program and data shall be stored in nonvolatile memory in event of power loss.
9. For bi-directional units, with display of flow direction (contacts open or closed).

2.7 LEVEL TRANSMITTERS

A. Description: Complete package with electronic unit, sensing element, connecting cable.

1. Continuous level transmitter shall produce an output signal that is proportional to level.
2. Measurement shall be free from effects of changes in temperature, density, or acoustic noise in vapor space above level.
3. Continuous measurement shall be independent of changes in material density and unaffected by presence of material clinging to sensing element.
4. No moving parts and no routine cleaning and recalibration necessary.
5. Electronic unit shall be integral to sensing element or mounted remotely up to 100 feet away from sensor.
6. Listed and labeled as defined in NFPA 70, by a qualified testing agency.

B. Sensor:

1. Length: To suit installation.

C. Electronic unit housed in NEMA 250, Type 4X enclosure.

1. Calibrated Range: Varies with application. At least 20 percent beyond high- and low-level set point and alarm levels.
2. Accuracy: Within 1 percent of calibrated range.
3. Two wire, loop powered.
4. Supply Voltage: 11.5 to 50-V dc.
5. Maximum Load: 625 ohms at 24-V dc.
6. Output Signal: 4 to 20 mA dc.
7. Response Time: 0.5 to 30 seconds, adjustable.
8. Temperature Range: Minus 40 to 165 deg F.
9. Zero and Span Adjustments: Noninteracting.
10. Visual Indication: Continuous digital display of level and associated units of measure. Provide separate display device if not integral to instrument.
11. Field-changeable failsafe condition and phasing in event measurement requires changes to optimize level reading.
12. Free from effects of radio frequency interference.
13. Free from harmful effects of static electricity on sensing element with discharges of up to 10 A without damage.
14. Adjustable time delay (signal dampening).

PART 3 - EXECUTION

3.1 GENERAL

A. Installation of the automatic control system shall be made and supervised by mechanics who are full time employees of the Controls Subcontractor.

B. All installation work shall be scheduled and coordinated with other trades to expedite job progress.

C. All work shall be installed in accordance with current control industry practices.

D. Only top quality workmanship will be permitted.

E. Any work not properly executed shall be removed and replaced without extra expense to the Owner.

3.2 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.

C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.3 INSTALLATION, GENERAL

A. Install products level, plumb, parallel, and perpendicular with building construction.

B. Properly support instruments, tubing, piping, wiring, and conduit to comply with requirements indicated Fastening Hardware:

1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

C. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.4 ELECTRIC WIRING

A. All control and interlock wiring shall be as specified in "Electric Wiring" paragraph in Section 230529 - Basic Mechanical Materials and Methods. Provide diagrams and coordinate all work with the Division 26 contractor as required.

3.5 SERVICE AND WARRANTY

A. The control system herein specified shall be free from defects and workmanship and material under normal use and service. After completion of the installation the controls contractor shall regulate and adjust all thermostats, control valves, damper motors and other equipment provided under this contract. If within twelve (12) months from the date of completion any of the equipment herein described is proved to be defective in workmanship or materials, it will be replaced or repaired free of charge in accordance with "Warranties" paragraph in Section 230500.

B. The controls contractor shall after completion, provide any service incidental to the proper performance of the control system under guarantees outlined in Division 1 for the period of one year.

C. When all devices are installed, a fully qualified technician shall set, adjust and calibrate all components.

1. A letter certifying completion of the system shall be forwarded to the Engineer's office, prior to acceptance of project by Owner.

3.6 INSTRUCTION AND ADJUSTMENT

A. On completion of the job the controls contractor shall have completely adjusted the entire control system. He shall arrange to instruct the Owner's representative on operation of the control system and supply him with three (3) copies of the control operating and instruction manuals. He shall obtain from the owner's representative a signed receipt that he has received the instruction manuals and complete instructions on the operation of the system.

B. Record Drawing: At completion of the job the controls contractor shall furnish two (2) copies of corrected wiring diagrams, one enclosed in laminated plastic and mounted on wall of the main mechanical room or as directed.

C. Contractor Adjustments: At the completion of the job the controls contractor must submit to the Architect a letter stating that he has made final calibrations and adjustments to the system and that the owner's operating personnel have been instructed in its use.

3.7 SEQUENCE OF OPERATION

A. See Drawings.

3.8 EXISTING CONTROL DEVICES

A. Where work of this section includes interfacing with existing systems, Contractor shall assume that existing control devices are fully operational unless otherwise noted. Contractor shall verify existing conditions and locations of devices and communications tie-ins before beginning the project.

3.9 INSTALLATION

A. All BAS equipment, conduit and other devise shall be located to provide adequate clearance for maintenance and shall not interfere with maintenance or code required clearances for other equipment.

B. Any connection to the Owner's LAN or other system devices shall be connected to a termination outlet (wall jack, biscuit type jack, patch panel, etc.) on both ends of the connection via a Category 6a patch cable complying with specification 27 15 10 "Communications Horizontal Cabling". No field device shall be directly connected to an Owner's local area network switch or similar device.

C. Provide all necessary copper and fiber patch cables for making all network switch interconnections to support the BAS including room-to-room cabling connections and from network equipment to in-room termination panel. The Contractor shall ensure that all patch cables meet patch cable requirements as specified in Section 27 15 10 Communication Horizontal Cabling. Any known cabling issues discovered during implementation shall be brought to the attention of the Owner.

D. Coordinate with other Divisions so that application specific controllers have a minimum of 18" clearance from the controller face to any obstruction and that this service space can be accessed from below.

E. All BAS conduit, including those for field devices and networks shall be labeled. Network conduit labels shall identify the specific network.

3.10 PROGRAMMING

A. Provide necessary programming to implement the written sequences of operation.

3.11 ALARM MANAGEMENT

A. System alarms are defined in the specifications and on the drawings.

B. Each alarm shall be assigned an Alarm Level. The Alarm Levels are characterized as:

1. Level 1: Life Safety / Security Critical Alerts
2. Level 2: Life Safety / Security non-Critical Alerts
3. Level 3: Critical Equipment Failure
4. Level 4: Non-Critical Equipment Failure
5. Level 5: Energy Conservation Alert
6. Level 6: Maintenance Notification

C. Alarm reports and messages shall be routed to a user-defined list of responsible groups.

D. The alarm message text shall be used to describe the nature and location of the alarm, required response and contact information.

E. Each alarm shall be individually resettable. In addition, each system shall be capable of resetting all associated alarms with a single input.

3.12 DATA LOGGING

A. Data logging and trending is described on the drawings. Points to be logged shall be recorded at the intervals given, for a period of one year. Data logs shall be easily retrievable and shall be displayed in either tabular form or graph form.

B. Logs shall include the equipment identification (EQUIPMENT NAMEPLATE), value recorded, units, date and time.

3.13 DYNAMIC COLOR GRAPHICS (SCREEN DISPLAYS)

A. Contractor is responsible for updating Owner’s screen displays with new graphics as required for this work

B. Screen displays shall be hierarchical linked dynamic operator interface for displaying system data and for commanding and modifying equipment operation. The interface shall use pull-down menus, tool bar and dialog boxes.

C. Screen displays shall include systems segregated by user groups. For each user group screens shall be provided for the complete project, showing the extent of this project, each building or area (such as parking lots), each floor and each room.

D. User Groups are:

1. Facilities Maintenance
2. Plumbing / FM Coordination / 520
3. Fire
4. Control Center
5. Electrical
6. Lighting
7. IT / Technical
8. Environmental
9. Energy Conservation.

E. Screen displays shall be provided for each system and piece of equipment monitored or controlled. Each piece of equipment shall show all associated points and alarms. All points shall be dynamic with continuously updated values.

F. The Contractor shall develop, coordinate, and administer a series of workshops with BAS stake- holders to define, prototype and finalize the screen displays that will be provided with the system. At a minimum the contractor shall support three (3) workshops. These workshops shall include:

1. Initial workshop; Contractor shall provide a baseline prototype of the screen display and describe to the stakeholders the available options, fields, layouts, etc. During this workshop the stakeholders will provide input and direction to the desired layouts, fields to include, and other information required by the Contractor to develop the initial screen layouts. An appropriate number of specific screen displays shall be identified for further development.

    a. Following the initial workshop, the contractor shall develop screen displays for fur- ther review by the stakeholders.

2. Follow up workshop: Following the initial workshop, and after the development of preliminary screen displays, a follow up workshop will be conducted by the Contractor. The intent of the follow up workshop is to review the preliminary screen displays and for the stakeholders to provide comments and further input into the desired displays. The results of the follow up workshop will be to gather all required information and input to finalize the screen displays.
3. Final workshop: The final workshop will be utilized to present the final screen displays and to obtain stakeholder acceptance for incorporation into the screen display submittals.

3.14 NAMING CONVENTIONS

A. All BAS points and graphics shall incorporate naming conventions as defined by the Owner which are shown on drawings as “EQUIPMENT NAMEPLATE”. This name shall be used for all system points, equipment identification on system graphics, point logs and other items.

3.15 SYSTEM START UP, CALIBRATION, AND SIGNOFF

A. Contractor shall be responsible for start up, check out, and calibration for the BAS. All setpoints shall be input, and the system shall be operated and adjusted, as required, to provide satisfactory operation as to the intent of the plans and specifications during the warranty period. Owner shall be notified before any start-up or calibration processes.

B. The Contractor shall provide the labor and test apparatus required to calibrate and prepare for operation of all instruments, controls and accessory equipment furnished under this specification. This work includes; zero, span and calibration checks of all instruments, devices, equipment and accessories both field and panel mounted.

C. The Contractor shall furnish labor and test apparatus required to check the operation of all control loops, setpoints and interlocks. After testing, the BAS operation shall be officially demonstrated to and accepted by the Owner. Contractor will be responsible for correcting any work unacceptable to the Owner

1. Owner will select a number of systems to be demonstrated. For each system, all related equipment and sub-systems shall be tested.
2. Demonstration testing shall include:

a. Each system point shall be tested for hardware and software functionality.
b. Each control loop shall be tested to verify the sequence of operation.
c. Alarm verification including alarm level and alarm clearing.
d. Graphics verification including displayed values, parameter updating.

D. Systems integration testing: test each system for proper integration. Show that each point imported into the BAS is correctly displayed, the variables are correct and alarms functional. Test performed by contractor, witnessed by owner.

E. The Contractor shall provide signoff forms for all operational testing to be accomplished under this contract. Sign off shall include verification of all changes made to the existing BAS, and for each item of mechanical, electrical, and instrumentation equipment provided or installed under this Contract, and shall contain provisions for recording relevant performance data for original testing and not less than 2 retests. Separate sections shall be provided to record values and for the initials of the Contractor and the Owner's representative.

F. Provide Owner with a copy of commissioning data showing that each device is operating properly.

G. Contractor shall demonstrate that equipment monitoring and system integration requirements are fully functional.

H. Provide any recommendation for system modification in writing to the Owner. Do not make any system modification, including operating parameters and control settings, without prior approval of owner.

3.16 INTEGRATION RESPONSIBILITIES

A. BAS responsibility for systems integration:

1. Provide the necessary server and software to act as a BACnet or Modbus client.
2. Verify that the Source device is communicating with the BAS.
3. Configure all points provided by the third-party system (Source) as BACnet or Modbus objects.
4. Represent the integrated points on BAS graphics.
5. Display and update objects, including alarms, using COV or polling mechanism of the Source. Data will be represented as received from the Source. No additional processing will be performed.
6. Provide Source with necessary addressing and network information for Source programming.

B. Third-party (Source) responsibility for systems integration:

1. Program intrinsic reporting of alarms and events as Notification Class objects.
2. Provide Device ID, Name, Object ID, Object Type, Description and other parameters as a electronic file of the proper type.
3. Install source communication device and configure settings to communicate with the BAS.
4. Program Device ID, Port Numbers, and Network Numbers into Source device, based on information provided by BAS.
5. Program IP addresses into all Source IP devices.
6. Provide BACnet PICS or equivalent Modbus information for Source.
7. Provide necessary Source equipment.
8. Verify that the Source device is communicating with the BAS.
9. Provide support for integration, startup, testing and commissioning.
10. Coordinate with Division 27 contractor to provide all horizontal cabling for any BAS device that requires an Internet Protocol (IP) network connection. All horizontal cabling shall be installed in accordance with Division 27 specification requirements.

3.17 ACCEPTANCE TESTING

A. Acceptance testing for any system or equipment with network connection to BAS shall include demonstrating that all points required by the contract documents are properly originated (by the Source or BAS) and received (by the BAS or Source).

B. Systems or equipment will not be accepted until the network communication is functional.

3.18 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.19 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

B. Wash and shine glazing.

C. Polish glossy surfaces to a clean shine.

3.20 CHECK-OUT PROCEDURES

A. Check installed products before continuity tests, leak tests, and calibration.

B. Check temperature instruments for proper location and accessibility.

C. Verify sensing element type and proper material.

D. Verify location and length.

E. Verify that wiring is correct and secure.

3.21 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
4. Equipment and procedures used for calibration shall meet instrument manufacturer's written instructions.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
8. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements and to supplement requirements indicated.

B. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistance source.

C. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

D. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

E. Switches: Calibrate switches to make or break contact at set points indicated.

F. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.

2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistance source.

3.22 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform according to manufacturer's written instruction.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Prepare test and inspection reports.

3.23 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.24 TRAINING

A. Train Owner's maintenance personnel to adjust, operate, and maintain temperature instruments.

B. Provide a complete set of instructional videos covering each product specified and installed and showing the following:

1. Software programming.
2. Calibration and test procedures.
3. Operation and maintenance requirements and procedures.
4. Troubleshooting procedures.

C. Coordinate video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.

D. Record videos on DVD disks.

E. Owner shall have right to make additional copies of video for internal use without paying royalties.

F. Since the Owner may require personnel to have more comprehensive understanding of the hardware and software, additional training must be available from the Contractor. If the Owner requires such training, it will be contracted later.

31 COORDINATION

A. Division 23 contractor shall coordinate all work with division 25 requirements to connect generator and associated equipment to BMS.

END OF SECTION 230900

SECTION 232113 - HVAC PIPING AND SPECIALTIES

PART 1 - GENERAL

1.1 RELATED WORK

A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these documents.

B. Related work specified in other Sections:

Section 230500 - Basic Mechanical Requirements
Section 230529 - Basic Mechanical Materials and Methods
Section 230540 - Mechanical Sound and Vibration Control
Section 230548 - Mechanical Seismic Control
Section 230593 - Testing, Adjusting and Balancing
Section 230700 - Mechanical Insulation
Section 232123 - HVAC Pumps
Section 233400 - Air Handling Fans

C. Work installed but furnished under other Sections:

1. Flexible pipe connectors - Section 230540.

1.2 SYSTEM DESCRIPTION

A. The work includes, but is not limited to the following:

1. Site drainage piping system and specialties.
2. Air Vents.
3. Strainers
4. Valves in accordance with Section 230529.
5. Pipe hangers and supports, saddles and shield in accordance with Section 230529.
6. Expansion joints, anchors and guides.
7. Mechanical sound and vibration control in accordance with Section 230540.
8. Flow Measuring Stations.
9. Water Meters.
10. Tests.

1.3 QUALITY ASSURANCE

A. Welder Qualifications: Welding shall be performed by an NCPWB Certified Welder with current certificate in accordance with ANSI B31.9 for shop and project site welding of piping work.

1.4 REFERENCES

A. Reference Standards: Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations of the following:

1. Comply with American Welding Society (AWS) National Certified Pipe Welding Bureau (NCPWB) and American National Standards Institute (ANSI) Code Numbers B31.2, B31.9 as applicable for welding requirements.
2. Comply with American National Standards Institute (ANSI B31.1) Code for Pressure Piping.
3. ANSI/ASME - Boiler and Pressure Vessel Code.
4. ANSI/ASME B31.9 - Building Services Piping.
5. ANSI/AWS D1.1 - Structural Welding Code.
6. ANSI/ASME Sec. 9 - Welding and Brazing Qualifications.
7. ASTM B32 - Solder Metal.
8. ANSI/AWS A5.8 - Brazing Filler Metal.

1.5 SUBMITTALS

A. Submit Product Data for the following items under provisions of The General Conditions of the Contract.

1. Flow Indicators.
2. Flow Measuring Stations.
3. Balancing Valves.
4. Pressure Gauges.
5. Expansion Joints and Guides.
6. Backflow Preventer.
7. Water Meters.

B. Submit printed Operating Instructions and Maintenance Data for the following items under provisions of Operating and Maintenance Data paragraph in Section 230500.

1. Strainers.
2. Flow Measuring Stations.
3. Balancing Valves.
4. Water Meters.
5. Expansion Joints and Guides.
6. Backflow Preventer.

C. Test Reports: Submit certified test reports for the following showing compliance in accordance with the General Conditions of the Contract:

1. Piping pressure tests.
2. Piping systems cleaning and flushing per Section 232500.
3. Certificates: Before proceeding with the Work, submit to the Architect/Engineer/Construction Manager/General Contractor, two copies of Certification that the welding work will be done according to ANSI B31.1 by welders who have been tested and whose qualification test sheets are available, attesting to their ability to weld in accordance with Standard Procedure Specifications as established by the National Certified Pipe Welding Bureau.

1.6 PROJECT CONDITIONS

A. Contractor shall not fabricate or install any piping until he has assured himself that the piping can be run as contemplated in cooperation with Contractors of other Divisions of the Work and the physical constraints of the Structural and Architectural Work.

PART 2 - PRODUCTS

2.1 SITE DRAINAGE - (90-200 PSIG)

A. Pipe:

2 Inch or smaller	ASTM A53, Schedule 40 black buttweld or continuous welded steel.
2-1/2 Inch or larger	ASTM A53, Grade A or B, Schedule 40 black seamless steel or continuous welded steel.

B. Fittings:

2 Inch or smaller	ASTM A197, Class 250 black malleable iron screwed.
2-1/2 Inch or larger	ASTM A234, Schedule 40 weld fittings.

C. Unions:

2 Inch or smaller	Class 250 black malleable iron screwed bronze to iron, ground joint.
2-1/2 Inch or larger	Use flanges.

D. Gaskets:

All Sizes	Class 250 1/8 inch full faced metal spiral wound, 304 stainless steel and flexible graphite filled with entering ring and inner ring.

E. Bolting: ASTM A370, Grade B, regular square head machine bolts with heavy hex nuts.

F. Flanges:

All Sizes	ASTM A181, Grade 1, Class 250 slip-on or weld neck flat faced.

2.2 STATIONARY PRESSURE GAUGES

A. Acceptable manufacturers: Miljoco, Trerice 600C Series, Weiss Instruments, Weksler Glass, Weksler Instrument Regal Series.

B. Schedule:

Type	4-1/2” Dial	4-1/2” Dial
Bourdon tube/socket	Phosphor bronze tube brass socket	Stainless steel tube 316 stainless steel socket
Accuracy	ASME B40.1 Grade 1A 1% FS over middle half of range	ASME B40.1 Grade 1A 1% F.S. over middle half of range
Case	Cast aluminum	Cast aluminum
Window	Clear glass	Clear glass
Snubber	Yes	Yes
Coil siphon	For steam service	For steam service
Gauge cock	Yes	Yes

C. Range: Select gauges for the following standard ranges unless otherwise indicated on drawings, or as required for special systems:

1. Pump Gauges -30 in Hg to +100 psi

2.3 EXPANSION JOINTS, ANCHORS AND GUIDES

A. Approved Manufacturers: Barco, Flex-Hose, Metraflex, Hyspan, Twin City Hose.

B. Provide expansion joints where called for on drawings or otherwise necessary to prevent noise or damage.

C. Braided Pipe Seismic Connectors: Two or three equal lengths of annular corrugated flexible stainless steel hose with stainless steel overbraid and four stainless 90° elbows, resulting in a device that absorbs/compensates for pipe motion in all 6 degrees of freedom simultaneously. Device shall allow for ± 4” of pipe motion in any direction. Unit to be rated for operating pressures of 150 psi and operating temperatures of 600°F. Include support lugs on elbows and fitting on distant elbow for drain plug or air relief valve. Use Flex-Hose, Tri-Flex Loop or equal from list of approved manufacturers.

D. Pipe Guides: Provide pipe guides and anchors as shown on drawings or as recommended by expansion joint manufacturer. Pipe guides must allow axial movement of pipe while eliminating lateral pipe movement. Guides to be constructed of painted carbon steel, and consist of a two-piece split spider clamp that bolts around the pipe, and a two-piece bolted split housing with integral base that anchors the unit to the structure. Pipe anchors shall be made of carbon steel, are to be welded to the pipe they serve, and are to be painted to protect the anchor and welds from corrosion. Anchors to include an integral base that bolts to the structure.

2.4 FLANGES, UNIONS, AND COUPLINGS

A. Pipe Size 2 Inches and Under: 150 psig malleable iron unions for threaded ferrous piping; bronze unions for copper pipe, soldered joints.

B. Pipe Size Over 2 Inches: 150 psig forged steel slip-on flanges for ferrous piping; bronze flanges for copper piping; 1/16 inch thick preformed neoprene bonded to asbestos.

C. Grooved and Shouldered Pipe End Couplings: Malleable iron housing clamps to engage and lock, designed to permit some angular deflection, contraction, and expansion; C-shape elastomer composition sealing gasket for operating temperature range from -30 degrees F to 230 degrees F; steel bolts, nuts, and washers; galvanized couplings for galvanized pipe.

2.5 STRAINERS

A. Acceptable Manufacturers: Armstrong, Boylston, AW Cash, ITT, Hoffman, Keckley, Mueller, Trane, Metraflex, Victaulic, Gustin-Bacon, Conbraco, Spirax Sarco, Gruvlok, IFC, Nexus.

B. Size 2 inch and Under: Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.

C. Size 2-1/2 inch to 4 inch: Flanged or grooved iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

D. Size 5 inch and Larger: Flanged or grooved iron body for 175 psig working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

2.6 AIR VENTS

A. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/4 inch copper tubing to a petcock.

2.7 FLOW MEASURING STATIONS

A. Furnish and install where shown on drawings, complete Ultrasonic Flow and Energy Measuring System as manufactured by Spirax Sarco.

B. Description:

1. UTM10 ultrasonic flow and energy meters clamp onto the outside of pipes and do not contact the internal liquid.

   The UTM10 is an energy flow meter used in conjunction with dual clamp-on RTDs. The energy flow meter measures energy usage in BTU, Tons, kJ and Wh.

C. Specifications:

System	
Liquid Types	Most clean liquids or liquids containing small amounts of suspended solids or gas bubbles
Velocity Range	Bi-directional to 40 FPS (12 MPS)
Flow Accuracy	UTT10-050S/050L/050H: ± 1% of rate at flows > 1 FPS; ± 0.01 FPS (0.003 MPS) at flows < 1 FPS (0.3 MPS) UTT10-025S - UTT10-040S:1" (25 mm) and larger ± 1% of rate from 4 to 40 FPS (1.2 to 12 MPS); ± 0.04 FPS (0.012 MPS) at rates < 4 FPS (1.2 MPS) UTT10-015S - UTT10-020S: ± 1% Full Scale
Temperature Accuracy (Energy Meters Only)	Option 1: 32-122 °F (0-50 °C); Absolute: 0.22 °F (0.12 °C) Difference: 0.09 °F (0.05 °C) Option 2: 32-212 °F (0-100 °C); Absolute: 0.45 °F (0.25 °C) Difference: 0.18 °F (0.1°C) Option 3: -40-350 °F (-40-177 °C); Absolute: 1.1 °F (0.6 °C) Difference: 0.45 °F (0.25 °C)
Sensitivity	**Flow:** 0.001 FPS (0.0003 MPS) **Temperature:** Option 1: 0.03 °F (0.012 °C); Option 2: 0.05 °F (0.025 °C); Option 3: 0.1 °F (0.06 °C)
Repeatability	0.5% of reading
Installation Compliance	General Safety: UL 61010-1, CSA C22.2 No. 61010-1 and EN 61010-1 Hazardous Location: Class I Division 2 Groups C,D; Class II and III, Division 2, Groups C, D, F, and G for US/CAN; ATEX II 2 G Ex nA II T4: UL 1604, CSA 22.2 No. 213, EN 60079-0 and EN 60079-15 CE: EN61326-1:2006 on meter systems with integral flow transducers, transducers constructed with twinaxial cable or remote transducers with conduit
Transmitter	
Power Requirements	AC: 95-264 VAC 47-63 Hz @ 17 VA max. DC: 10-28 VDC @ 5 VA max. Protection: auto resettable fuse, reverse polarity and transient suppression
Display	Two line LCD, LED backlit; Top row 0.7 inch (18mm) height, 7-segment; Bottom row 0.35 inch (9 mm) height, 14-segment Icons: RUN, PROGRAM, RELAY1, RELAY2 Flow rate indication: 8-digit positive, 7-digit negative max.; auto decimal, lead zero blanking Flow accumulator (totalizer): 8-digit positive, 7-digit negative max. (reset via keypad press, USP, network command or momentary contact closure)
Enclosure	Type 4 (IP65) Construction: powder-coated aluminum, polycarbonate, stainless steel, polyurethane, nickel-plated steel mounting brackets Size (electronic enclosure only): 6.0" W x 4.4" H x 2.2" D (152 mm W x 112 mm H x 56mm D) Conduit Holes: (2) ½" NPT female; (1) ¾" NPT female; Optional Cable Gland Kit
Temperature	-40 °F to +185 °F (-40 °C to +85 °C)
Configuration	Via optional keypad or PC running USP software (Note: not all configuration parameters are available from the keypad – i.e. flow and temperature calibration and advanced filter settings)
Engineering Units	**Flow Meter:** Feet, gallons, cubic feet, million gallons, barrels (liquor and oil), acre-feet, lbs., meters, cubic meters, liters, million liters, kg **Energy Meter:** BTU, MBTU, MMBTU, Tons, kJ, kWh, MWh and the Flow Meter list from above

Inputs/Outputs	**USB** 2.0: for connection of a PC running USP configuration utility **RS485:** Modbus RTU command set **10/100 Base-T:** RJ45, communication via Modbus TCP/IP, EtherNet/IP™ and BACnet®/IP **4-20mA:** 12-bit, internal power, can span negative to positive flow/energy rates **Flow Meter Model Only:** 0-1,000 Hz:open-collector, 12-bit, can span negative to positive rates; square-wave or turbine meter simulation outputs **Two Alarm Outputs:** open-collector, configure as rate alarm, signal strength alarm or totalizer pulse
Transducers	
Type	Compression mode propagation, clamp-on
Construction	UTT10-050S/050L: NEMA 6 (IP 67), CPVC, Ultem®, Nylon cord grip, PVC cable jacket; -40 to 250°F (-40 to 121°C) UTT10-015S - UTT10-040S: NEMA 6 (IP 67), CPVC, Ultem®, Nylon cord grip, PVC cable jacket; -40 to 250°F (-40 to 121°C) UTT10-050S/050L: NEMA 6P (IP 68) option, CPVC, Ultem®, Nylon cord grip, Polyethylene cable jacket; -40 to 250°F (-40 to 121°C) NEMA6: Submersible to a depth of 3ft (1m) for 30 days max. NEMA6P: Submersible to a depth of 100ft (30m) indefinitely
Frequency	UTT10-015S - UTT10-040S: 2 MHz UTT10-050S/050H: 1 MHZ UTT10-050L: 500 KHz
Cables	RG59 Coaxial, 75 ohm or Twinaxial, 78 ohm (optional armored conduit)
Cable Length	990 feet (300 meter) max. in 10 ft. (3 m) increments
RTDs	**Energy Meters Only:** Platinum 385, 1,000 ohm, 3-wire; PVC jacket cable
Installation	**DTT10-050S (S option)/050L/050H:** General and Hazardous Location (see Installation Compliance) **DTT10-050S and IS Barrier (F option):** "Class I Div I, Groups C&D T5 Instrinically Safe Exia;" "CSA C22.2 No.'s 142 & 157, UL 913 & 916"
Software Utilities	
USP	Utilized to configure, calibrate and troubleshoot Flow and Energy meters. Connection via USB A/B cable; software is compatible with Windows 95, Windows 98, Windows 2000, Windows XP, Windows Vista® and Windows® 7
EnergyLink	Utilized to monitor a network of Flow and Energy meters. Connection via RS485. Operates within Microsoft Excel®2003 and Microsoft Excel®2007

D. UTM10 Network Options:

1. UTM10 Network:

   a. UTM10 meters come equipped with RS485 drivers and utilize a Modbus RTU command set (data can be returned in single-precision, double-precision, integer or floating point values). Up to 126 UTM10 products can be run on a single daisy-chain network and be individually queried for flow rate, positive flow accumulator, negative flow accumulator Excel®, application detailed below.

2. UTM10 Base-T Network

   a. Ethernet communications module, the UTM10 can be plugged into a LAN and queried for flow rate, positive flow accumulator, negative flow accumulator, supply temperature, return temperature and signal strength. The module contains Modbus TCP/IP, EtherNet/IP™ and BACnet®/IP network compatibility.

E. Meter with Remote Flow Transducer:

1. UTM10 with remote mounted transducers that permit separation of up to 990 feet (300 m) using coaxial or twinaxial cable. PVC constructed transducers are rated to 185 °F (85 °C), CPVC are rated to 250 °F (121 °C) and PTFE are rated to 350 °F (176 °C).

a. Features:

1) Rate-Total backlit display
2) 4-20mA Output
3) 0-1,000 Hz Rate Pulse and Dual Alarm Outputs (Flow Meter Model Only)
4) USB Programming Port
5) RS485 Modbus Network Connection
6) Remote Totalizer Reset

PART 3 - EXECUTION

3.1 PIPE WORKMANSHIP

A. Piping shown on the drawings shall be installed complete, and shall be of the size shown on the drawings. When a size is not indicated, the sub-contractor shall request the pipe size from the Engineer thru the General Contractor. All piping shall be installed parallel or perpendicular to the building construction. All piping shall be installed so as to allow for expansion. Install saddles and shields per Section 230529.

3.2 PIPE SLOPE

A. Slope all domestic water, site drainage water, piping at 1”/40’ toward drains.

3.3 PIPING JOINTS

A. All pipe shall be reamed to full pipe diameter before joining. Screwed joints shall be made with standard pipe thread, and an approved compound applied to the male thread only. Welded joints shall be made in accord with the procedure outlined in National Certified Pipe Welding Bureau, or by other reputable testing laboratory or agency. Subcontractor shall use only "Threadolet" or "Weldolet" fittings for intersection welding of branches to mains. Valves and specialties shall have screwed or flanged joints. No bushings allowed.

B. All pipe shall be reamed to full pipe diameter before joining.

C. Pull tee (T-drill) fittings are forbidden.

3.4 CHANGE IN PIPE SIZE

A. Where changes in the pipe size are required at equipment connections, change the pipe size within a maximum length of three pipe size diameters of the final connection.

B. Where changes in pipe size occur in horizontal straight lengths of pipe, install concentric reducers.

3.5 EXPANSION JOINTS, ANCHORS AND GUIDES

A. Pipe anchors shall be installed as shown and at the closest feasible point to all changes in pipe direction and elevation and at main branch take-offs, except at expansion loops. All piping shall be supported, anchored, braced and guided to control expansion-contraction and pipe movement due to pressure or shock, and to result in quiet operation.

3.6 BALL JOINTS

A. Install ball joints and anchoring for piping where it crosses expansion joints of building.

3.7 AIR VENTS

A. At all changes in elevation downward in direction of flow, and where shown, provide a manual air vent as follows: install a full size air chamber and pipe down with 1/4 inch copper tubing to a petcock.

3.8 FLOW MEASURING STATIONS

A. Install in accordance with all manufacturer’s recommendations, including minimum pipe diameters of straight pipe upstream and downstream of the flow measuring station.

3.9 PIPING CONNECTORS

A. Install flexible pipe connectors at pumps and elsewhere as required to accommodate thermal expansion, misalignment and vibration in accordance with Section 230540 - Mechanical Sound and Vibration Control.

3.10 STRAINERS

A. Provide a strainer in the supply pipe just upstream of each pump.

B. Remove and clean all strainer screens after 24 hours of system operation, and again after 30 days.

3.11 TESTS

A. General: Provide test pump, gauges, meters, other instruments, materials, and labor, in connection with tests.

B. Relief Valve: Install a 1” safety relief valve, set at a pressure no more than 5 psig less than the relief valve on boiler or chiller evaporator barrel, to protect against damage by expanding liquid or other source of overpressure during test or normal operation. Discharge of this system relief valve shall be piped to the glycol fill tank for recovery of glycol should relief valve be discharged.

C. Pressure Tests: Before testing piping systems, remove or otherwise protect from damage, control devices, air vents and other parts which are not designed to stand pressure used in testing piping.

D. Hydrostatic Pressure: Test hydronically, piping for all services (except pneumatic system compressed air) to 125 psi or 1.5 times the maximum working pressure, whichever is greater, for at least six consecutive hours, during which time pressure shall remain constant without pumping. Subject welded joints to the hammer test, and copper joints to soap suds while under hydrostatic pressure.

3.12 CLEANING OF PIPING SYSTEMS

A. Provide for the cleaning of the Site Drainage Water Piping Systems after hydrostatic tests have been completed and prior to the operating tests in accordance with Section 232500 - HVAC Water Treatment.

B. 232113 Contractor is to provide bypasses and isolation valves as required by 232500 Contractor to allow circulation of cleaning solution in new piping system without allowing system cleaning solution to circulate through existing piping system. Division 232113 Contractor is responsible for removing and cleaning strainers in new or existing system plugged by cleaning of new system. Simply blowing down strainers is unacceptable.

END OF SECTION 232113

SECTION 232123 - HVAC PUMPS

PART 1 - GENERAL

1.1 RELATED WORK

A. The General Conditions, Supplementary Conditions and Division 1 General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these documents.

B. Related work specified in other Sections:

Section 230500 - Basic Mechanical Requirements
Section 230529 - Basic Mechanical Materials and Methods
Section 230540 - Mechanical Sound and Vibration Control
Section 230548 – Mechanical Seismic Control
Section 230593 - Testing, Adjusting and Balancing
Section 232113 - HVAC Piping and Specialties
Section 233400 - Air Handling Fans

1.2 SYSTEM DESCRIPTION

A. The work includes, but is not limited to, providing the following:

1. Site drainage dewater system pumps.

1.3 REFERENCES

A. Reference Standards: Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations of the following:

1. Comply with American National Standards Institute (ANSI B31.1) Code for Pressure Piping.

1.4 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings and Product Data including materials of construction, actual impeller size, pump speed, motor size, motor efficiency, motor amps, mounting requirements, weights, dimensioned drawings, and performance curves at scheduled flow conditions and 120% of scheduled head, for the following items in accordance with the General Conditions of the Contract:

1. Site drainage dewater system pumps.

B. Operating Instructions and Maintenance Data: Submit printed Operating Instructions and Maintenance Data for the following items in accordance with Operating and Maintenance Data paragraph in Section 230500.

1. All pumps.

PART 2 - PRODUCTS

2.1 VERTICAL TURBINE PUMPS

A. Acceptable Manufacturers: Bell & Gossett, Taco, Weinman, Grundfos, Paco, Flo Fab, Fairbanks Morse.

B. Pump Construction:

1. Bowl assembly: The intermediate bowls, suction bell, and discharge bowl shall be flanged type constructed of close grained cast iron, and shall conform to ASTM designation A48, class 30. They shall be free from sand holes, blowholes, or other faults and must be accurately machined and fitted to close tolerances. The intermediate bowls shall have enamel or epoxy lined waterways for maximum efficiency and wear protection. All intermediate bowls shall be of identical design for interchangeability. A discharge bowl shall be used to connect bowls to the discharge column. All the bowls shall be fitted with sleeve type bearings of bronze alloy C89835.

2. Impellers: The impellers shall be constructed from ASTM B584 Silicon Bronze and shall be the enclosed type. They shall be free from defects and must be accurately cast, machined for optimum performance and minimum vibration. Impellers are to be balanced to grade G6.3 of ISO 1940 as minimum. They shall be securely fastened to the bowl shaft with taper locks of C1018 steel and key and split thrust ring of SS. The impeller running position shall be adjustable by shaft adjusting nut in the discharge head or on top of the hollow shaft driver.

3. Suction: The suction bell shall be provided with a non-soluble grease packed bronze bearing, and a bronze sand collar shall be incorporated in the pump design to protect this bearing from abrasives. The bearing housing shall have sufficient opening at the bottom for easy removal of the bearing. A bronze basket type strainer shall be attached to the suction bell. It shall have a free area of at least four times the flow area of the suction connection size and the opening shall be sized to restrict the passage of ½” solids.

4. Wear Ring: Bowl assembly shall be fitted with replaceable wear rings of C95200 bronze material in the suction bowl and intermediate bowls. Wear rings shall have the minimum practical clearance to the mating cylindrical surface of the impeller to provide adequate sealing independent of vertical positioning of the impellers.

5. Shaft: The bowl shaft shall be constructed from ASTM 582 type 416 stainless steel. It shall be precision turned and ground with surface finish better than 40 RMS and shall be supported by water lubricated bearings of C89835 bronze alloy.

C. Column Assembly-Water Lubricated:

1. Column pipe: The column pipe shall be furnished in sections not exceeding a nominal length of 10 ft and shall be connected by threaded sleeve couplings or flanges. The length of the top and bottom sections shall not be more than 5 ft. It shall be of ASTM A53 grade A steel pipe and the weight shall be not less than schedule 30. The threaded pipe shall be with 8 threads per inch with 3/16" taper per foot thread and faced parallel to butt against the centering spiders to form accurate alignment. All column flange faces shall be parallel and machined for

rabbet fit to permit accurate alignment. The inside diameter of the pipe shall be such that the head losses shall not be more than 5 feet per 100 feet of pipe.

2. Lineshaft: The lineshaft shall be furnished in interchangeable section not over ten feet in length, and shall be coupled with threaded steel couplings machined from solid steel bar. It shall have left-hand thread to tighten during pump operation. The diameter of the shaft shall be based on a combined shear stress of not more than 18% of the ultimate strength or not excess of 30% of the elastic limit in tension of the shafting material. The coupling shall be designed with higher safety factor than shaft. Lineshaft and coupling shall be of type 416 stainless steel. Centering spiders shall be furnished at each column pipe joint for shaft stabilization. Bearings shall be fluted rubber.

D. Discharge Head Assembly-Water Lubricated:

1. Discharge Head: It shall be of the high profile type to allow shaft coupled above stuffing box and provided for mounting the driver and support the column and bowl assemblies it shall be of high-grade cast iron, ASTM A48 Class 30, or fabricated steel. The above ground outlet shall be flanged to match 8 inch ANSI class 150. It shall have a 1/2" NPT connection for a pressure gauge.

2. Stuffing Box: The stuffing box shall be cast iron and shall contain a minimum of five rings of packing with lantern ring. It shall have a pressure relief connection. The packing gland shall be a 316SS split type secured in place with non--corrosive studs and nuts. The bearing shall be C89835 bronze. A rubber slinger shall be secured to the shaft above the packing gland.

E. Accessories:

1. ¾” casing relief valve (250 GPM through 2500 GPM) or 1” casing relief valve (3000 GPM and larger).
2. 1-1/2” automatic air release valve.
3. 3 ½” dial suction and discharge gauges.
4. Concentric discharge increaser.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide installation in accordance with Section 230540 - Mechanical Sound and Vibration Control.

B. Lubricate the pumps in accordance with manufacturer's instructions after completion of the system and before start-up.

END OF SECTION 232123

SECTION 232500 - HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Pre-Startup cleaning of HVAC Piping Systems.

1.2 RELATED WORK

A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these documents.

B. Section 230500 - Basic Mechanical Requirements.

C. Section 230529 - Basic Mechanical Materials and Methods.

D. Section 230548 – Mechanical Seismic Control

E. Section 221411 - Disinfecting Water Supply System.

F. Section 232113 - HVAC Piping and Specialties.

1.3 QUALITY ASSURANCE

A. All products shall be provided by a single Contractor to ensure there being a single source of responsibility.

B. Water Treatment, Chemical and Service Suppliers approved for this project are as follows:

1. Power Engineering Company
2. WEST, Inc.

1.4 SUBMITTALS

A. Water Analysis: Illustrate water quality available at project site.

B. Technical Data: Submit Shop Drawings and Product Data for the following items in accordance with the General Conditions of the Contract:

1. Water Treatment Materials and Equipment.
2. Control Diagrams.
3. Chemicals and quantity provided.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available at project site.

C. All cleaners and chemicals shall be compatible with the piping system components and connected equipment in the systems in which they are used. Contractor shall review all pipe, pipe components, pipe specialties, and connected equipment materials (steel, cast iron, copper, stainless steel, aluminum, etc.) that the contractor will provide for this project, then select cleaners and chemicals recommended by the water treatment system manufacturer that are compatible with these materials.

2.2 PRE-STARTUP CLEANER

A. Provide a pre-startup liquid alkaline dispersant cleaner for the flushing and cleaning of all HVAC water systems to remove oil and foreign matter from the piping and equipment prior to the final filling of the systems. This chemical shall not be injurious to persons, piping, pipe joint compounds, packings, coils, valves, pumps, and their mechanical seals, tubes or other parts of the system.

B. Furnish complete instructions dictating the quantities of the cleaner to use, methods, and duration of the operation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate where installation of equipment in piping systems is required with the Section 232113 - HVAC Piping and Electrical requirements per Section 230529 - Basic Mechanical Materials and Methods and provide installation instructions to installing personnel as necessary

3.2 CLEANING OF PIPING SYSTEMS

A. Thoroughly clean the HVAC water piping systems after hydrostatic tests have been completed and prior to the operating tests with liquid alkaline dispersant cleaner per instructions specified in Part 2 dictating the quantities of the cleaner to use, methods, and duration of the operation. Systems shall then be drained and thoroughly flushed out with fresh water.

B. Contractor shall notify Engineer prior to cleaning operation, and shall verify in writing to the Engineer after the system has been cleaned.

C. Failure of any part of the system due to improper cleaning shall be the responsibility of the Division 23 Contractor.

D. Contractor is to provide bypasses and isolation valves as required to allow circulation of cleaning solution in new piping system without allowing system cleaning solution to circulate through existing piping system. Coordinate proper bypass and isolation valve locations with all trades to ensure proper cleaning of entire new HVAC piping systems.

3.3 SYSTEM START-UP

A. Provide a written report to the Owner and Architect indicating that the start-up has been completed and that all equipment is operating properly.

END OF SECTION 232500

SECTION 233300 - DUCTWORK AND ACCESSORIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Low pressure ductwork.

B. Volume control dampers.

C. Gravity backdraft dampers.

D. Flexible duct fan connections.

E. Access door hardware.

F. Duct access doors.

1.2 RELATED REQUIREMENTS

A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these documents.

B. Section 230500 - Basic Mechanical Requirements.

1.3 RELATED SECTIONS

A. Section 230529 - Basic Mechanical Material and Methods.

B. Section 230540 - Mechanical, Sound and Vibration Control.

C. Section 230548 – Mechanical Seismic Control.

D. Section 230593 - Testing, Adjusting and Balancing.

E. Section 230700 - Mechanical Insulation.

1.4 REFERENCES AND CODE REQUIREMENTS

A. ASHRAE - Handbook 2009 Fundamentals; Duct Design Chapter.

B. ASHRAE - Handbook 2008 HVAC Systems and Equipment; Duct Construction Chapter.

C. ASTM A90 - Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.

D. ASTM A167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

E. ASTM A525 - General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.

F. ASTM A527 - Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality.

G. ASTM B209 - Aluminum and Aluminum Alloy Sheet and Plate.

H. ASTM C14 - Concrete Sewer, Storm Drain, and Culvert Pipe.

I. ASTM C443 - Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.

J. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

K. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.
NFPA 92A - Smoke Control Systems.
NFPA 92B - Smoke Management Systems.

L. NFPA 96 - Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment.

M. SCAQMD Rule 1168 – Adhesive and Sealant Applications

N. SMACNA - HVAC Duct Construction Standards.

O. SMACNA - HVAC Air Duct Leakage Test Manual

P. SMACNA - Fibrous Glass Duct Construction Standards.

Q. UL 33 - Heat Responsive Links for Fire-Protection Service.

R. UL 181 - Factory-Made Air Ducts and Connectors.

S. UL 555 - Fire Dampers and Ceiling Dampers.
UL 555S - Leakage Rated Dampers for Smoke Control Systems.

1.5 DEFINITIONS

A. Duct Sizes: Inside clear dimensions. For lined ducts, maintain sizes inside lining.

B. Low Pressure: Design and Construct to SMACNA 2 in. w.g. pressure class. Low pressure duct shall include: Supply duct downstream of VAV boxes, return duct, general/toilet exhaust ducts, fresh air duct, relief duct, smoke exhaust duct and combustion air duct, unless otherwise indicated on drawings.

1.6 REGULATORY REQUIREMENTS

A. Construct ductwork to NFPA 90A standards.

1.7 SUBMITTALS

A. Submit Shop Drawings for the following items under provision of The General Conditions of the Contract:

1. Shop fabricated assemblies including duct or plenum access doors.

2. Duct fittings, particulars such as gauges, sizes, weld, and configuration prior to start of work for low pressure systems.

B. Submit Product Data for the following items under provision of The General Conditions of the Contract:

1. Backdraft dampers.

1.8 PROJECT CONDITIONS

A. Do not fabricate or install any ductwork until Contractor has confirmed that the ductwork can be run as contemplated in cooperation with Contractors of other Divisions of the Work and the physical constraints of the Structural and Architectural Work.

B. Prepare 1/4" = 1'-0" scale shop drawings of all ductwork and plenums within confines of mechanical rooms for coordination with other trades and the Architectural and structural work.

C. Provide any and all off-sets and fittings required to coordinate with field conditions. The lack of coordination will not constitute a change in contract price. The contract drawings are of a schematic nature only, exact duct routing and field coordination is the responsibility of the Contractor.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Nonmetallic air ducts and connectors shall conform to UL 181 Class 0 or Class 1.

B. Steel Ducts: ASTM A525 and ASTM A527 galvanized steel sheet, lock-forming quality, having G90 zinc coating each side in conformance with ASTM A90.

C. Aluminum Ducts: ANSI/ASTM B209; aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T6 or of equivalent strength.

D. Fasteners: Rivets, bolts, or sheet metal screws.

E. Sealant: Non-hardening, water resistant, fire resistive, compatible with mating materials; liquid used alone or with tape, or heavy mastic, and comply with the chemical content requirements of SCAQMD Rule 1168.

2.2 LOW PRESSURE DUCTWORK

A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards and ASHRAE handbooks, except as indicated. Provide duct material, gauges, reinforcing, and sealing for operating pressures specified or as indicated on drawings.

B. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows are used, provide turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fiber insulation.

C. Construct fittings with 45 degree wye or 90 degree wye with 45 degree entry.

D. Round branch connections shall be plain flanged or spin collar fittings of 90 degrees unless indicated otherwise on drawings. Round branch connections fittings serving low-pressure duct run-outs to diffusers and grilles shall include damper blade with two quadrants, fully retractable zinc alloy bearings, washers, and position handle with wing nut to lock damper position. Where used on externally insulated ducts. Provide with single quadrant installed on 2” standoff bracket plate with position handle and wing nut to lock damper position.

1. Provide gear driven cable operated damper where round branch connection fitting is not located above a lay-in ceiling or ceiling access door. Include manual HEX Head Actuator, ceiling mounting bracket, white ceiling cover plate, and cable.

E. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.

F. Provide easements where low pressure ductwork conflicts with piping and structure. Where easements exceed 10 percent duct area, split into two ducts maintaining original duct area.

G. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of airflow.

2.3 DUCT SUPPORTS

A. Hanger Rods: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

B. Hanger Straps for Galvanized Steel Duct: Galvanized steel.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

E. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

2.4 DAMPER OPERATOR HARDWARE

A. Manufacturers: Ventfabrics Ventlok Regulators, Metropolitan Air.

B. Other acceptable manufacturers offering equivalent product: Duro Dyne, Daniel.

C. Regulators and End Bearings.

Damper shaft length:
12" or less - Ventlok #620 Regulator.
12" to 20" - Ventlok #635 Regulator and #607 Bearings.
Larger dampers - Ventlok #640 or #641 Regulator and #607 Bearings.

D. Provide equivalent model elevated bases for insulated ducts.

E. Provide remote damper control where any damper does not have permanent access. System to include a locking worm drive gear, ¼" flexible steel shaft and a concealed ceiling cap of 1". Manufacturers: Young Regulator, Price, or approved equal.

2.5 VOLUME CONTROL DAMPERS

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards, and as indicated.

B. Fabricate single blade dampers for duct sizes to 9-1/2 x 30 inch.

C. Fabricate multi-blade damper of opposed blade pattern with maximum blade sizes 6 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.

D. Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, polymer or sintered bronze bearings.

E. Provide locking, indicating quadrant regulators on single and multi-blade dampers.

F. On insulated ducts, mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

G. Specification for low-pressure spin collar fittings with integral balancing dampers is found in paragraph 2.2.

2.6 GRAVITY BACKDRAFT DAMPERS (LOW VELOCITY COUNTERBALANCE TYPE) (< 2.0" w.c.)

A. Acceptable Manufacturers: Air Balance, American Warming, Arrow United (Type 655), Louvers and Dampers Inc., Prefco, Ruskin (CBD4 or CBD6), C.E. Sparrow, Airstream, Greenheck, Pottorff.

B. Gravity backdraft dampers, size 18 x 18 inches or smaller, furnished with air moving equipment, may be air moving equipment manufacturers standard construction.

C. Fabricate multi-blade, parallel action gravity balanced backdraft dampers of extruded aluminum, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.7 FLEXIBLE DUCT FAN CONNECTIONS

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards, and as indicated.

B. Indoor: UL listed fire-resistant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz. per sq. yd., minimum 4-inch wide, crimped into metal edging strip.

C. Outdoor: UL listed hypalon coated woven glass fabric to NFPA 90A, minimum density 24 oz. per sq. yd., minimum 4-inch wide, crimped into metal edging strip.

D. Leaded vinyl sheet, minimum 0.55 inch thick, 0.87 lbs, per sq. ft., 10 dB attenuation in 10 to 10,000 Hz range.

2.8 ACCESS DOOR HARDWARE

A. Manufacturer: Ventfabrics Ventlok Series

B. Other acceptable manufacturers offering equivalent product: Duro Dyne.

C. Latches, hinges and gasketing:

Doors less than 4 square feet - Series 100.
Doors 4 to 8 square feet - Series 200.
Larger doors and in medium pressure systems - Series 300.

2.9 DUCT ACCESS DOORS

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards as indicated.

B. Review locations prior to fabrication.

C. Fabricate rigid and close-fitting doors of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum one inch thick insulation with sheet metal cover.

D. Access doors smaller than 12 inches square may be secured with sash locks.

E. Provide two hinges and two sash locks for sizes up to 18 inches square, three hinges and two compression latches with outside and inside handles for sizes up to 24 x 48 inches. Provide an additional hinge for larger sizes.

F. Access doors with sheet metal screw fasteners are not acceptable.

PART 3 - EXECUTION

3.1 GENERAL SHEET METAL INSTALLATION

A. Duct sizes fall within the limiting dimensions indicated on the Drawings. Provide sheet metal duct systems, connections, dampers, duct turns, housings, hinged sheet metal doors and necessary removable access doors for the complete supply, return, and exhaust systems. Install accessories in accordance with manufacturer's instructions.

B. Wherever exposed ducts pass through walls, floors, or ceilings, a 2-inch flanged sheet-metal collar fitting close around ducts to be slipped along duct until flange is tight against finished surface covering edges of openings and presenting a neat appearance. Lock collar to duct.

C. Wherever ducts penetrate floors or fire walls, install safing insulation to maintain fire wall integrity.

D. Cut or drill temporary test holes in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps. Permanent test holes shall be factory fabricated, airtight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

E. Provide openings in ductwork where required to accommodate thermometers and controllers.

F. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

G. Where Bellmouth fittings are specifically called for on Drawings, provide standard Bellmouth fittings per SMACNA Standards.

H. On smoke management system ducts, conduct a leakage test, per Chapter 9 of the 2009 IBC, to 1.5 times the design pressure. Total leakage shall not exceed 5% of design flow.

I. Wherever dampers are concealed under insulation, provide marker ribbon for identification. Hang ribbon below adjacent ductwork to allow view from any angle.

J. Requirements for duct liner are located in Specification Section 230540 – Mechanical Sound and Vibration Control.

3.2 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.

4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.3 SEALING OF DUCTWORK

A. Seal all ductwork to Seal Class A per SMACNA HVAC Duct Construction Standards and as required by the International Energy Conservation Code. Additional sealing will be required if audible air leaks are observed. Where joints are not accessible for proper sealing, cut hand holes in duct and seal the joints from the inside.

3.4 DUCT LEAKAGE TESTING

A. Conduct a complete duct leakage test of all medium pressure supply air mains and vertical risers as outlined in the most current edition of the SMACNA Air Duct Leakage Test Manual. Unless specifically noted otherwise on Drawings, testing for medium pressure ductwork is defined as Leakage Class 6 for rectangular ductwork and Leakage Class 3 for round or flat oval ductwork. .

B. Total leakage of each duct system not to exceed recommendations in SMACNA Air Duct Leakage Test Manual per Leakage Classifications defined above. If leakage rate exceeds maximum allowed, reseal ductwork until measured system leakage rate is less than the maximum allowable leakage rate.

C. Test all medium pressure ductwork 2” wc positive pressure and extrapolate values out to 6” wc positive pressure. Provide all necessary blank-offs to perform test.

D. Perform a leakage test on all field erected air handler casings from the outdoor/return air dampers through to the point the medium pressure duct connects to the discharge opening at the end of the air handler. Leakage shall be limited to 1% of design flow. Test casing to 2” wc positive pressure, and extrapolate values out to 6” wc positive pressure. Provide all necessary blank-offs.

3.5 MANUFACTURED DUCT JOINTS

A. The installation of the manufactured duct joints shall be in accordance with the manufacturer's printed instruction and installation manuals. Apply multiple thicknesses of folded butyl gasket material at each corner of rectangular duct joints to assure air tightness.

3.6 DUCTWORK APPLICATION SCHEDULE

A.

AIR SYSTEM	MATERIAL
General Exhaust	Aluminum

3.7 DAMPER OPERATOR HARDWARE

A. Install per manufacturer’s instructions and recommendations. Coordinate any ceiling control locations prior to installation.

B. Coordinate length of flexible shaft on site.

3.8 VOLUME CONTROL DAMPERS

A. Provide balancing dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing.

3.9 GRAVITY BACKDRAFT DAMPERS (LOW PRESSURE SYSTEMS)

A. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside of building and where indicated.

B. Provide counter-balanced gravity backdraft dampers in return air duct sections from CRAC units to ceiling plenums to prevent air bypass from raised floor to ceiling space when CRAC unit fan is “off”.

3.10 FLEXIBLE DUCT FAN CONNECTIONS

A. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment.

B. At least 1-inch slack shall be allowed in these connections to insure that no vibration is transmitted from fan to duct work. The fabric shall either be folded in with the metal or attached with metal collar frames at each end to prevent air leakage.

3.11 DUCT ACCESS DOORS

A. Provide duct access doors for inspection, maintenance and cleaning at all automatic dampers, flow station, humidifiers, fire and smoke dampers and before and after all booster coils.

B. Provide minimum 8 x 8 inch size for hand access, 24 x 24 inch size for shoulder access, unless indicated otherwise on drawings.

END OF SECTION 233300

SECTION 233400 - AIR HANDLING FANS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Power Roof Ventilators

1.2 RELATED WORK

A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this section and Contractor shall review and adhere to all requirements of these documents.

1. Section 230500 - Basic Mechanical Requirements.
2. Section 230529 - Basic Mechanical Materials and Methods.
3. Section 230540 - Mechanical Sound and Vibration Control.
4. Section 230548 - Mechanical Seismic Control.
5. Section 230593 - Testing, Adjusting and Balancing.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of specified fans with characteristics, sizes, and capacities required, whose specified fan has been in satisfactory use in similar service for not less than 3 years.

1.4 SUBMITTALS

A. Submit shop drawings and product data for the following items under provisions of the General Conditions of the Contract:

1. Shop Drawings: Submit assembly-type shop drawings showing unit dimensions, weight loadings, required clearances, construction details, and field connection details for each fan.
2. Product Data: Submit manufacturer's technical product data for all fans showing dimensions, weights, capacities, ratings, fan performance curves with operating point clearly indicated, motor electrical characteristics, gages and finishes of materials. Provide multiple-speed performance curves for fans with variable speed drives.

B. Submit printed Operating Instructions and Maintenance Data for the following items under provisions of Operating and Maintenance Data paragraph in Section 230500:

1. All fans.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver fans with factory-installed shipping skids and lifting lugs; pack components in factory-fabricated protective containers.

B. Handle fans carefully to avoid damage to components, enclosures, and finish. Do not install damaged components; replace and return damaged components to fan manufacturer.

C. Store fans in clean dry place and protect from weather and construction traffic.

D. Comply with Manufacturer's rigging and installation instructions for unloading fans and moving them to final location.

1.6 EXTRA STOCK

A. Provide one spare set of belts for each belt-driven fan.

PART 2 - PRODUCTS

2.1 POWER ROOF VENTILATORS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide Power Roof Ventilator of one of the following: ACME, Jenn-Air, Penn, Greenheck, Cook, Powerline, Carnes, Twin City Fans, Soler and Palau.

B. Furnish and install Power Roof Ventilators of model, size and capacity as shown on Drawings.

C. Housings shall be of contour, type, and material as shown on drawings.

D. Fan: Shall be the backwardly inclined type with centrifugal wheel that has been statically and dynamically balanced at the factory.

E. Motor: Shall be installed in a totally enclosed weatherproof housing outside of the air stream and in accordance with "Motors" in Section 230529.

F. Drive: Units shall be belt driven. Belt shall be oil resistant. An adjustable sheave on the motor shall be provided to allow changes in the fan speed.

G. Installation: Ventilators shall be installed on the roof on a nominal 12-inch high, pre-fabricated, self-flashing aluminum curb with 2" fiberglass insulation and metal liner, furnished with the fan.

H. Disconnect Switch: A factory wired non-fused disconnect switch shall be located under the hood of the unit.

I. Backdraft Dampers: Shall be installed on the curb of the unit unless specifically shown otherwise on the Drawings.

J. Bird Screen: Entire air outlet of the fan shall be protected by a 1/2" x 1/2" aluminum mesh securely installed in place.

PART 3 – EXECUTION

3.1 INSTALLATION OF FANS

A. Install fans where indicated, in accordance with equipment manufacturer's installation instructions, and with recognized industry practices, to ensure that equipment complies with requirements and serves intended purposes.

B. Coordinate with other work, including ductwork, floor construction, and electrical work as necessary to interface installation of air handling equipment with other work.

C. Access: Provide access space around fans for service as indicated, but in no case less than that recommended by manufacturer.

D. Do not operate fans for any other purpose, temporary or permanent, until ductwork is clean, filters in place, bearings lubricated, and fan has been test run under observation.

E. Support: Install floor-mounted fans on 4" high reinforced concrete pad, 6" larger on each side than unit base in accordance with Section 230529.

F. Mounting: Mount fans on vibration isolators, in accordance with manufacturer's instructions and Section 230540.

G. Seismic Restraint: Provide seismic restraints in accordance with Section 230548.

H. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer with rotation in direction indicated and intended for proper performance. If there is no rotation arrow supplied by the manufacturer, install a correct rotation arrow.

I. Duct Connections: Refer to Division 23 Air Distribution sections. Provide ductwork, accessories, and flexible connections as indicated.

J. Dryer exhaust booster fan airflow must be adjusted to match the dryer fan capacity. Booster fan airflow rate cannot exceed the dryer fan capacity.

3.2 FIELD QUALITY CONTROL

A. Upon completion of installation of air handling equipment, and after motor has been energized with normal power source, test equipment to demonstrate compliance with requirements. Where possible, field correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment which cannot be satisfactorily corrected.

3.3 EXTRA BELTS

A. Deliver one spare set of belts for each belt-driven fan unit, obtain receipt from Owner that belts have been received.

END OF SECTION 233400

SECTION 233713 - AIR INLETS AND OUTLETS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Diffusers.

B. Registers.

C. Grilles.

D. Goosenecks.

1.2 RELATED REQUIREMENTS

A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these documents.

B. Section 230500- Basic Mechanical Requirements.

1.3 RELATED SECTIONS

A. Section 230529 - Basic Mechanical Materials and Methods: Painting of ductwork visible behind outlets and inlets.

B. Section 233300 - Ductwork and Accessories.

C. Section 230593 - Testing, Adjusting and Balancing.

1.4 REFERENCES

A. AMCA 500 - Test Method for Louvers, Dampers and Shutters.

B. ANSI/NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

C. ARI 890-91 - Rating of Air Diffusers.

D. ASHRAE 70 - Methods of Testing for Rating the Air Flow Performance of Outlets and Inlets.

E. SMACNA - HVAC Duct Construction Standard.

F. ASTM C 636 – Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.

1.5 QUALITY ASSURANCE

A. Test and rate performance of air outlets and inlets in accordance with ASHRAE 70 and ARI 890.

B. Test and rate performance of louvers in accordance with AMCA 500.

1.6 REGULATORY REQUIREMENTS

A. Conform to ANSI/NFPA 90A.

1.7 SUBMITTALS

A. Submit Product Data for the following items under provision of The General Conditions of the Contract:

1. Diffusers.
2. Registers.
3. Grilles.

B. Submit schedule of outlets and inlets indicating type, size, location, application, and noise level.

1. Review requirements of outlets and inlets as to size, finish, and type of mounting prior to submitting product data and schedules of outlets and inlets.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS (SEE AIR DEVICE SCHEDULE ON PLANS)

A. Acceptable Manufacturers: Titus, Anemostat, Barber Colman, Krueger, Carnes, Metal-Aire, Nailor-Hart, Tempo, Air Diffusion Products, Tuttle & Bailey, TurboX, Price, Hart & Cooley.

2.2 CEILING REGISTERS AND GRILLES (SEE AIR DEVICE SCHEDULE ON PLANS)

A. Acceptable Manufacturers: Titus, Anemostat, Barber Colman, Krueger, Carnes, Metal-Aire, Nailor-Hart, Tuttle & Bailey, Price, Hart & Cooley.

2.3 WALL REGISTERS AND GRILLES (SEE AIR DEVICE SCHEDULE ON PLANS)

A. Acceptable Manufacturers: Titus, Metal-Aire, Barber-Colman, Anemostat, Krueger, Tuttle & Bailey, Air Concepts, Price.

2.4 GRAVITY ROOF HOODS

A. Acceptable Manufacturers: Acme, Louvers and Dampers, Inc., Penn Ventilator, Greenheck, Ruskin, Cook, Carnes.

B. Fabricate air inlet or exhaust hoods in accordance with SMACNA Low Pressure Duct Construction Standards.

C. Fabricate of galvanized steel, minimum 16 gauge base and 20 gauge hood, or aluminum, minimum 16 gauge base and 18 gauge hood; suitably reinforced; with removable hood; birdscreen with 1/2 inch square mesh for exhaust and 3/4 inch for intake, and factory baked enamel finish.

D. Provide minimum 12 inch high insulated curb base.

E. Make hood outlet area minimum of twice throat area.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install items in accordance with manufacturers' instructions.

B. Install ceiling mounted items in accordance with ASTM C 636.

1. Ceiling mounted air terminals or services weighing less than 20 pounds shall be positively attached to the ceiling suspension main runners or to cross runners with the same carrying capacity as the main runners.
2. Terminals or services weighing 20 pounds but not more than 56 pounds, in addition to the above, shall have two No. 12 gauge hangers connected from the terminal or service to the ceiling system hangers or to the structure above. These wires may be slack.
3. Terminals or services weighing more than 56 pounds shall be supported directly from the structure above by approved hangers.

C. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, regardless of whether dampers are specified as part of the diffuser, or grille and register assembly.

E. Paint ductwork visible behind air outlets and inlets matte black.

F. Install diffusers to ductwork with air tight connection.

G. Install duct connections to fire rated UL Listed and Labeled diffusers and return grilles in strict accordance with instructions furnished by manufacturer.

END OF SECTION 233713

SECTION 250125 – BUILDING AUTOMATION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Provide an expansion of the Airport's existing Building Automation System for control, monitoring, and energy management as specified and indicated on the Drawings.

B. BAS manufacturer is responsible for all BAS design, installation, startup and testing. BAS design shall comply with the guidelines established in this Section.

C. Furnish and install all control equipment necessary for a complete and operable system.

D. Provide all BAS controls cabling for a complete and operable system. Any cabling to support an Internet Protocol (IP) connection to BAS equipment shall be coordinated with and installed by the Division 26 low voltage contractor. Cabling to support IP connections shall conform to all Division 26 requirements.

E. Work of this section includes all electrical distribution except as noted below.

F. Coordinate with other Divisions as required for interface with the BAS.

G. Furnish all Terminal Unit Controllers.

H. Interface this BAS expansion with the existing BAS system, including any new head-end equipment which the Airport may install during the project construction. .

I. Provide system testing, including demonstration and systems integration testing.

1.3 WORK BY OTHERS

A. Division 26 shall provide power connections to BAS control panels.

B. Division 23 shall install control valves, control dampers, sensor wells, differential pressure transmitter, liquid flow measuring stations, and other field devices in duct or piping systems.

C. Division 23 TAB contractor to be present and assist with calibration of air flow measuring stations and flow meters.

D. Division 26 shall provide Technet Data Communications Network connections to the BAS control panels.

1.4 TRADE CONTRACTOR QUALITY ASSURANCE

A. Materials and equipment shall be the catalogued products and shall be manufacturer's latest standard design that complies with the specification requirements. Material and equipment installed shall be new and unused.

B. All equipment shall be compatible with the Owner's version of Siemens Enterprise Software.

C. Installation shall be in conformance with the manufacturer's printed installation instructions.

D. All BAS controllers and local user displays shall be UL Listed under Standard UL 916, category PAZX.

E. BAS components which are part of engineered smoke control systems, as noted on the Drawings, shall be rated for such use and be listed under UL 864, UUKL, PAZX.

F. The manufacturer shall provide documentation supporting compliance with ISO-9002 (Model for Quality Assurance in Production, Installation, and Servicing) and ISO-140001 (The application of well-accepted business management principles to the environment). 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. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Section 15, governing radio Frequency Electromagnetic Interference and be so labeled.

1.5 SUBMITTALS

A. Action Submittals

1. Product Data for all components provided in the project.
2. When manufacturer's cutsheets apply to a product series rather than a specific product, clearly indicate applicable data by highlighting or by other means. Clearly reference covered specification and drawing on each submittal. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements.
3. Project specific schematics, including:

    a. Overall system architecture, including flow diagram.
    b. Sequence of operations.
    c. Instrumentation diagrams
    d. Points lists
    e. Point names.
    f. Point addresses.
    g. Interface wiring diagrams.
    h. Control Panel layouts.
    i. System riser diagrams.

4. Floor plans showing:

    a. Control panel locations
    b. Terminal unit locations

5. Interface Diagrams

    a. For all equipment with BAS interface, provide diagrams showing:

        1) Equipment supplier's scope
        2) BAS scope
        3) Points to be integrated.
        4) Interface protocol.

6. Screen Displays

    a. Before creating screen, displays submit color samples. Submit typical equipment, such as a single example of:

        1) Pumps
        2) Exhaust Fans.

B. Informational submittals

1. Provide copies of BAS QA/QC procedures to be used for system installation, startup and checkout. Procedures shall, as a minimum, include:

    a. Controller installation.
    b. Sensor installation, calibration, and checkout.
    c. Point-to-point wiring checkout.
    d. Third-party interface validation.
    e. Control loop verification.
    f. Alarm verification.

C. Closeout Submittals

1. Comply with the requirements of Division 1 for Operation and Maintenance manuals and with the following

    a. Manufacturer's equipment parts list of all functional components of the system.
    b. Electronic copies of system schematics, including wiring diagrams.
    c. System schematics, including wiring diagrams.
    d. Description of sequence of operations.
    e. As-built interconnection wiring diagrams.
    f. Operator's Manuals.
    g. Riser diagram showing panel locations and networking.
    h. List of connected data points, including panels to which they are connected and input device (occupancy sensors, push buttons, light sensors, etc).
    i. Conduit routing diagrams.
    j. Transformer and Breaker locations.

k. Control program, point definitions, and all other setup information needed to replace the controller.
l. Printout of supplied dynamic graphics displays.
m. Certificate: ATC Contractor shall submit a letter certifying completion of the control system in accordance with the Contract Documents.

1.6 WARRANTY

A. Provide all service, materials and equipment necessary for the successful operation of the entire BAS system for a period of one year after beneficial use or manufacturer's standard warranty, whichever is longer.

B. The adjustment, required testing, and repair of the system includes all computer equipment, transmission, equipment and all sensors and control devices.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

A. Siemens Industry, Inc. Building Technologies Division. All equipment shall be compatible with the latest version of Siemens Enterprise Software.

2.2 WIRING AND CABLES

A. Low voltage cables including field device, network and signal cables shall comply with Division 27.

B. All power wiring and related devices shall comply with Division 26.

C. All power, field device and network wiring shall be in minimum of ¾" conduit, except the final 12" of field device wiring.

D. All wiring shall comply with project specifications, codes, and BAS manufacturer's published standard.

2.3 PROJECT DESIGN REQUIREMENTS

A. Control Panels shall contain controllers, power supplies, I/O modules, bus interface modules and any other necessary devices.

1. Panel enclosure shall be Siemens, UL listed, with hinged, lockable door. NEMA 1 for panels inside and NEMA 4X for panels outside or exposed to ambient air.
2. Panel enclosure shall have sufficient space for 50% increase in I/O points.
3. All control wiring shall be routed through a gutter before entering control panel.
4. Controller shall be PXCM.
5. Controller and I/O modules shall be provided with 10% spare points of each type (AI, AO, BI, BO)

6. All digital and analog output modules shall include manual override feature. Analog modules shall include LCD display.
7. Install transformers in a separate enclosure
8. Provide permanent printed labels on each control panel. Label information shall include cabinet number designation and power feed information

B. Provide Control Panels for the following:

1. BAS Panel to be located in the Pump Room
2. Other service panels, boxes, component panels as required for monitoring and systems integration.

C. All transformers required, shall be sized so that power load is no more then 50% of full load.

D. Install transformers in a separate enclosure from the controllers. Transformer locations and devices served need to be clearly labeled on enclosure.

E. Junction boxes shall be in an accessible location for troubleshooting.

PART 3 - EXECUTION

3.1 EXISTING CONTROL DEVICES

A. Where work of this section includes interfacing with existing systems, Contractor shall assume that existing control devices are fully operational unless otherwise noted. Contractor shall verify existing conditions and locations of devices and communications tie-ins before beginning the project.

3.2 INSTALLATION

A. All BAS equipment, conduit and other devise shall be located to provide adequate clearance for maintenance and shall not interfere with maintenance or code required clearances for other equipment.

B. Any connection to the Owner’s LAN or other system devices shall be connected to a termination outlet (wall jack, biscuit type jack, patch panel, etc.) on both ends of the connection via a Category 6a patch cable complying with specification 27 15 10 “Communications Horizontal Cabling”. No field device shall be directly connected to an Owner’s local area network switch or similar device.

C. Provide all necessary copper and fiber patch cables for making all network switch interconnections to support the BAS including room-to-room cabling connections and from network equipment to in-room termination panel. The Contractor shall ensure that all patch cables meet patch cable requirements as specified in Section 27 15 10 Communication Horizontal Cabling. Any known cabling issues discovered during implementation shall be brought to the attention of the Owner.

D. Coordinate with other Divisions so that application specific controllers have a minimum of 18” clearance from the controller face to any obstruction and that this service space can be accessed from below.

E. All BAS conduit, including those for field devices and networks shall be labeled. Network conduit labels shall identify the specific network.

3.3 PROGRAMMING

A. Provide necessary programming to implement the written sequences of operation.

3.4 ALARM MANAGEMENT

A. System alarms are defined in the specifications and on the drawings.

B. Each alarm shall be assigned an Alarm Level. The Alarm Levels are characterized as:

1. Level 1: Life Safety / Security Critical Alerts
2. Level 2: Life Safety / Security non-Critical Alerts
3. Level 3: Critical Equipment Failure
4. Level 4: Non-Critical Equipment Failure
5. Level 5: Energy Conservation Alert
6. Level 6: Maintenance Notification

C. Alarm reports and messages shall be routed to a user-defined list of responsible groups.

D. The alarm message text shall be used to describe the nature and location of the alarm, required response and contact information.

E. Each alarm shall be individually resettable. In addition each system shall be capable of resetting all associated alarms with a single input.

3.5 DATA LOGGING

A. Data logging and trending is described on the drawings. Points to be logged shall be recorded at the intervals given, for a period of one year. Data logs shall be easily retrievable, and shall be displayed in either tabular form or graph form.

B. Logs shall include the equipment identification (EQUIPMENT NAMEPLATE), value recorded, units, date and time.

3.6 DYNAMIC COLOR GRAPHICS (SCREEN DISPLAYS)

A. Contractor is responsible for updating Owner’s screen displays with new graphics as required for this work

B. Screen displays shall be hierarchical linked dynamic operator interface for displaying system data and for commanding and modifying equipment operation. The interface shall use pull-down menus, tool bar and dialog boxes.

C. Screen displays shall include systems segregated by user groups. For each user group screens shall be provided for the complete project, showing the extent of this project, each building or area (such as parking lots), each floor and each room.

D. User Groups are:

1. Facilities Maintenance
2. Plumbing / FM Coordination / 520
3. Fire
4. Control Center
5. Electrical
6. Lighting
7. IT / Technical
8. Environmental
9. Energy Conservation.

E. Screen displays shall be provided for each system and piece of equipment monitored or controlled. Each piece of equipment shall show all associated points and alarms. All points shall be dynamic with continuously updated values.

F. The Contractor shall develop, coordinate, and administer a series of workshops with BAS stake- holders to define, prototype and finalize the screen displays that will be provided with the system. At a minimum the contractor shall support three (3) workshops. These workshops shall include:

1. Initial workshop; Contractor shall provide a baseline prototype of the screen display and describe to the stakeholders the available options, fields, layouts, etc. During this workshop the stakeholders will provide input and direction to the desired layouts, fields to include, and other information required by the Contractor to develop the initial screen layouts. An appropriate number of specific screen displays shall be identified for further development.

    a. Following the initial workshop, the contractor shall develop screen displays for fur- ther review by the stakeholders.

2. Follow up workshop: Following the initial workshop, and after the development of preliminary screen displays, a follow up workshop will be conducted by the Contractor. The intent of the follow up workshop is to review the preliminary screen displays and for the stakeholders to provide comments and further input into the desired displays. The results of the follow up workshop will be to gather all required information and input to finalize the screen displays.
3. Final workshop: The final workshop will be utilized to present the final screen displays and to obtain stakeholder acceptance for incorporation into the screen display submittals.

3.7 SYSTEM START UP, CALIBRATION, AND SIGNOFF

A. Contractor shall be responsible for start up, check out, and calibration for the BAS. All setpoints shall be input, and the system shall be operated and adjusted, as required, to provide satisfactory operation as to the intent of the plans and specifications during the warranty period. Owner shall be notified before any start-up or calibration processes.

B. The Contractor shall provide the labor and test apparatus required to calibrate and prepare for operation of all instruments, controls and accessory equipment furnished under this specification. This work includes; zero, span and calibration checks of all instruments, devices, equipment and accessories both field and panel mounted.

C. The Contractor shall furnish labor and test apparatus required to check the operation of all control loops, setpoints and interlocks. After testing, the BAS operation shall be officially demonstrated to and accepted by the Owner. Contractor will be responsible for correcting any work unacceptable to the Owner

1. Owner will select a number of systems to be demonstrated. For each system, all related equipment and sub-systems shall be tested.
2. Demonstration testing shall include:

    a. Each system point shall be tested for hardware and software functionality.
    b. Each control loop shall be tested to verify the sequence of operation.
    c. Alarm verification including alarm level and alarm clearing.
    d. Graphics verification including displayed values, parameter updating.

D. Systems integration testing: test each system for proper integration. Show that each point im- ported into the BAS is correctly displayed, the variables are correct and alarms functional. Test performed by contractor, witnessed by owner.

E. The Contractor shall provide signoff forms for all operational testing to be accomplished under this contract. Sign off shall include verification of all changes made to the existing BAS, and for each item of mechanical, electrical, and instrumentation equipment provided or installed under this Contract, and shall contain provisions for recording relevant performance data for original testing and not less than 2 retests. Separate sections shall be provided to record values and for the initials of the Contractor and the Owner’s representative.

F. Provide Owner with a copy of commissioning data showing that each device is operating properly.

G. Contractor shall demonstrate that equipment monitoring and system integration requirements are fully functional.

H. Provide any recommendation for system modification in writing to the Owner. Do not make any system modification, including operating parameters and control settings, without prior approval of owner.

3.8 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 project specific training modules for the system installed. All training shall be held during normal working ours of 8:00 AM to 4:30 PM weekdays.

B. Provide 16 hours of training for Owner's designated operating personnel. Training shall include:

1. Explanation of drawings, operations and maintenance manuals.
2. Walk-through of the job to locate control components.
3. Operator workstation and peripherals.
4. DDC controller and ASC operation/function.
5. Operator control functions including graphic generation and field programming.
6. Operation of portable operator's terminal.
7. Explanation of adjustment, calibration and replacement procedures.
8. Student binder with training modules.
9. Unused hours of training will be added to an on-going Airport training account maintained by SBT and the Airport to be used at Airport's discretion.

C. Since the Owner may require personnel to have more comprehensive understanding of the hard- ware and software, additional training must be available from the Contractor. If the Owner re- quires such training, it will be contracted at a later date.

D. Since the Owner may require personnel to have more comprehensive understanding of the hard- ware and software, additional training must be available from the Contractor. If the Owner re- quires such training, it will be contracted at a later date.

END OF SECTION 250125

SECTION 250126 – SEQUENCE OF OPERATION FOR PUMP AND HVAC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes control sequences for the pumps and HVAC systems, subsystems, and equipment.

B. Provide and install a Siemens Building Technologies Modular Building Controller. Provide an online UPS to supply power to the control panel and associated controls to allow continuous monitoring. The UPS shall be sized to provide power for 30 minutes.

C. Fiber for the will be installed as indicated in the electrical drawings. The BAS Contractor shall provide and install fiber convertors and make final terminations.

D. The sump level transmitter, shall be provided and installed by the BAS Contractor. The pump discharge pressure switches, shall be provided by the BAS Contractor and installed by the mechanical contractor.

E. The BAS Contractor shall generate dynamic graphics of the system at the existing BAS Consoles. Coordinate with airports BAS Manager for graphics standards and preapproval before implementation.

F. The BAS Contractor shall provide and install a current activated switch to prove operation of each pump and the exhaust fan.

G. Furnish and install all relays, switches, conduit, wiring, etc. required to facilitate the pumps, exhaust fans and unit heaters operation.

H. The BAS System shall monitor the pumps, and exhaust fan status and generate an alarm if status deviates from required operation.

I. Since the Owner may require personnel to have more comprehensive understanding of the hard- ware and software, additional training must be available from the Contractor. If the Owner re- quires such training, it will be contracted at a later date.

J. Since the Owner may require personnel to have more comprehensive understanding of the hard- ware and software, additional training must be available from the Contractor. If the Owner re- quires such training, it will be contracted at a later date.

1.3 SEQUENCE OF OPERATION

A. Pumps (Storm Drain)

B. Agitator Pump:

1. The agitator pump shall run whenever one of the other pumps (storm drain) are running. In addition, the agitator pump shall run for 15 minutes (adj) every two hours (adj).

C. Exhaust Fans:

1. Sensor Pit Exhaust Fan shall be controlled by a wall switch.

D. Point Schedule Matrix – I/0 Summary

1. The panels shall contain the following Inputs and Outputs: Matching Existing

1.4 SEQUENCE OF OPERATION – AUTOMATIC TRANSFER SWITCH

A. Transfer Switches: Transfer switches shall be integrated into the building automation system. Systems shall be MODBUS certified and shall require a single point connection only. Systems with relay points only are not acceptable. Each automatic transfer switch (ATS) MODBUS interface shall provide the following data for the Building Automation System:

1. External test of ATS operation
2. Start and stop of the emergency power source
3. Indicate the availability of the normal power source
4. The switch position of the ATS
5. Line frequency of Source 1
6. Line-to-line voltage(s) of Source 1
7. Line-to-neutral voltage(s) of Source 1
8. Line current(s) of the electrical load
9. Power factor of the electrical load
10. Real power of the electrical load as a floating type (in watts)

1.5 GENERATOR, AUTOMATIC TRANSFER SWITCHES AND LEAK DETECTION

A. Generator: Generator set controls and monitoring shall be integrated into the building automation system. Controls and monitoring points shall be MODBUS Certified. Systems with relay points only are not acceptable. Provide MODBUS interface to furnish the following data for the Building Automation System:

1. Genset running
2. High temperature
3. Low oil pressure
4. Low temperature
5. Low fuel
6. High temperature

7. Low oil pressure
8. Over crank
9. Over speed
10. Not in auto
11. Fuel Tank Leak

END OF SECTION 250126

SECTION 250130 – BAS INTERFACE REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section defines product requirements and documentation to be provided for devices which are a part of, or communicate with the Building Automation System (BAS) through a network connection.

1.3 DEFINITIONS

A. BAS: Building Automation System.

B. BACnet Specific Definitions:

1. BACnet: Building Automation Control Network Protocol, ANSI/ASHRAE 135.1. A communications protocol allowing devices to communicate data and services over a network.
2. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.
3. BACnet/IP: Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.
4. BACnet Testing Laboratories (BTL): Organization responsible for testing products for compliance with ASHRAE 135, operated under direction of BACnet International.
5. PICS (Protocol Implementation Conformance Statement): Written document that identifies the particular options specified by BACnet that are implemented in a device.

C. BTL: BACnet Testing Laboratory.

D. Device: any physical object that is controlled, monitored or otherwise communicates with the BAS.

E. Gateway: Bidirectional protocol translator that connects control systems using different communication protocols.

F. MODBUS/RTU: A serial data communication protocol.

G. MS/TP: Master-slave/token-passing, IEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.

H. Peer to Peer: Networking architecture that treats all network stations as equal partners.

I. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

J. Third-Party Device: A device not manufactured specifically for or manufactured by a supplier.

1.4 PRODUCT REQUIREMENTS

A. Any system or device which is part of, connected to, monitored by or communicates with the BAS through a network connection must use either MODBUS or BACnet protocol. All cabling required to support the network connection shall be installed in accordance with Division 27 requirements.

B. BACnet Requirements

1. BACnet systems or devices must be certified by BTL and must carry a “BTL Mark” signifying compliance with ANSI/ASHRAE 135.1.
2. All systems and devices shall use BACnet/IP or MSTP protocol.
3. Devices shall communicate peer-to-peer with other devices.
4. Devices shall be able to use local broadcasts received by all peer devices on the network.
5. Devices shall be able to send remote broadcasts to devices residing on networks having different network numbers.
6. Devices shall be capable of data sharing to include BACnet priority, change of value, trending, scheduling, alarm/event management, device and network management.
7. Devices shall conform to the BACnet PICS.
8. All devices shall be certified, listed and stamped by the BTL.

C. MODBUS Requirements:

1. Devices shall adhere to MODBUS TCP/IP or MODBUS RTU protocol.
2. Devices shall follow the client/server model for communication between devices. The client initiates the transaction, the server responds to complete the transaction.
3. Devices which translate any protocol to MODBUS shall not be used.

D. Gateways shall not be used.

1.5 SUBMITTALS

A. Action Submittals

1. Product Data: For each type of product demonstrating compliance with this specification including the following:

a. Product description with complete technical data and product specification sheets.
b. Installation, operation and maintenance instructions.
c. BACnet specific information:

1) PICS data sheet.
2) BIBB document.
3) Functional Specification Document (FSD) describing how the device will provide the specified BAS interface.

d. MODBUS specific information:

1) Configuration guide including a register of all system points.

B. Informational Submittals:

1. Data Communications Protocol Certificates: Certifying that each proposed BACnet system component complies with ASHRAE 135.

1.6 TRADE CONTRACTOR'S QUALITY ASSURANCE

A. MODBUS devices shall be installed, configured, and programmed by technicians or application engineers certified by the manufacturer for MODBUS products.

PART 2 - PRODUCTS NOT USED

PART 3 - EXECUTION

3.1 INTEGRATION RESPONSIBILITIES

A. BAS responsibility for systems integration:

1. Provide the necessary server and software to act as a BACnet or Modbus client.
2. Verify that the Source device is communicating with the BAS.
3. Configure all points provided by the third-party system (Source) as BACnet or Modbus objects.
4. Represent the integrated points on BAS graphics.
5. Display and update objects, including alarms, using COV or polling mechanism of the Source. Data will be represented as received from the Source. No additional processing will be performed.
6. Provide Source with necessary addressing and network information for Source programming.

B. Third-party (Source) responsibility for systems integration:

1. Program intrinsic reporting of alarms and events as Notification Class objects.
2. Provide Device ID, Name, Object ID, Object Type, Description and other parameters as a electronic file of the proper type.

3. Install source communication device and configure settings to communicate with the BAS.
4. Program Device ID, Port Numbers, and Network Numbers into Source device, based on information provided by BAS.
5. Program IP addresses into all Source IP devices.
6. Provide BACnet PICS or equivalent Modbus information for Source.
7. Provide necessary Source equipment.
8. Verify that the Source device is communicating with the BAS.
9. Provide support for integration, startup, testing and commissioning.
10. Coordinate with Division 27 contractor to provide all horizontal cabling for any BAS device that requires an Internet Protocol (IP) network connection. All horizontal cabling shall be installed in accordance with Division 27 specification requirements.

3.2 ACCEPTANCE TESTING

A. Acceptance testing for any system or equipment with network connection to BAS shall include demonstrating that all points required by the contract documents are properly originated (by the Source or BAS) and received (by the BAS or Source).

B. Systems or equipment will not be accepted until the network communication is functional.

END OF SECTION 250130

SECTION 250205 – FIELD DEVICES FOR BUILDING AUTOMATION SYSTEM

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Liquid level control
2. Liquid flow meter
3. Current sensors

1.1 SUBMITTALS

A. Action Submittals

1. Product Data: For each type of product, including the following:

a. Field device matrix: provide a matrix of all field devices including generic description, specification reference, model number and application. This must be submitted with the produce information. Produce information will not be approved without this matrix.
b. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
c. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
d. Product description with complete technical data, performance curves, and product specification sheets.
e. Installation operation and maintenance instructions, including factors affecting performance.

B. Informational Submittals

1. Product Certificates: For each product requiring a certificate. PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Environmental Conditions:

1. Instruments shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.

2.2 CURRENT SENSORS

A. Binary Sensors: minimum 1 – 135 continuous amperage rating with trip setpoint adjustable to plus or minus 1 percent of range.

1. Operating Parameters; 5 degrees F to 140 degrees F; Humidity 0 – 95 percent non- condensing.
2. Output Signal: Solid state, NO contact closure, 0.1A at 30 VAC/Vdc
3. Supply Voltage: self-induced from load being monitored.

B. Analog Sensors: Minimum 0 – 200 continuous amperage rating with adjustable zero and span, frequency insensitive range between 10- 80 Hz to 1 percent of range, minimum response of 150 ms.

1. Accuracy: 0.5 percent of full scale
2. Output Signal 4-20 ma directly proportional to sensed amperage range.
3. Supply Voltage: 12 – 30 Vdc, 30 mA maximum supply circuit.

C. Ultrasonic Flow Meter

1. Ultrasonic flow meter shall be a wall mount, clamp on designed to be installed in a fixed location for flow measurement from the outside of a pipe.
2. Sensing devices shall be clamped on the pipe. The Nema 4X weather resistant enclosure shall be wall mounted. Provide transducer design, low voltage transmission digital signal processing. Accuracy to be within +/- 1% of velocity.
3. Provide all accessories, cabling, communication interfaces, display, etc. necessary for a complete system. Provide output suitable for the BAS system for remote flow monitoring.
4. Install in accordance with manufactures recommendations.

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D. Water Level Monitor

1. Ultrasonic echo ranging level monitor shall provide multi point monitoring of different water levels to be able to control pump staging operations and alarm monitoring.
2. The Nema 4X weather resistant enclosure shall be wall mounted.
3. Provide all accessories, cabling, communication interfaces, display, etc. necessary for a complete system. Provide output suitable for the BAS system for remote flow monitoring.
4. Install in accordance with manufactures recommendations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.

C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 INSTALLATION, GENERAL

A. Install products level, plumb, parallel, and perpendicular with building construction.

B. Properly support instruments, tubing, piping, wiring, and conduit to comply with requirements indicated Fastening Hardware:

1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

C. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.4 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

B. Wash and shine glazing.

C. Polish glossy surfaces to a clean shine.

3.5 CHECK-OUT PROCEDURES

A. Check installed products before continuity tests, leak tests, and calibration.

B. Check temperature instruments for proper location and accessibility.

C. Verify sensing element type and proper material.

D. Verify location and length.

E. Verify that wiring is correct and secure.

3.6 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
4. Equipment and procedures used for calibration shall meet instrument manufacturer's written instructions.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
8. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements and to supplement requirements indicated.

B. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistance source.

C. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

D. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

E. Switches: Calibrate switches to make or break contact at set points indicated.

F. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistance source.

3.7 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform according to manufacturer's written instruction.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Prepare test and inspection reports.

3.8 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.9 TRAINING

A. Train Owner's maintenance personnel to adjust, operate, and maintain temperature instruments.

B. Provide a complete set of instructional videos covering each product specified and installed and showing the following:

1. Software programming.
2. Calibration and test procedures.
3. Operation and maintenance requirements and procedures.
4. Troubleshooting procedures.

C. Coordinate video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.

D. Record videos on DVD disks.

E. Owner shall have right to make additional copies of video for internal use without paying royalties.

END OF SECTION 250205

SECTION 26 05 00 – BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 WORK INCLUDED:

A. Provide all items, articles, materials, equipment, operations and/or methods listed, mentioned, shown and/or scheduled on the drawings and/or in these specifications, including all labor, services, permits, fees, utility charges, and incidentals necessary and required to perform and complete the electrical work described in this Division. Apply for all permits early in the project to avoid problems due to code revisions.

B. See the contract conditions (general and supplementary) and Division 1 for requirements concerning this Division including, but not limited to, submittals, shop drawings, substitution requests, change orders, maintenance manuals, record drawings, coordination, permits, record documents and guarantees.

C. Division 26 Contractor shall be responsible for all work indicated by divisions 26, 27, 28, and the electrical portions of 33 within the drawings and specifications. Any work indicated by Division 16 shall be provided and installed by the Division 26 Contractor.

1.3 RELATED WORK SPECIFIED ELSEWHERE:

A. Mechanical equipment motors to be furnished under another Division but connected under this Division. Starters to be mounted and connected by this Division, but furnished by another Division unless otherwise noted on the electrical drawings. Verify and coordinate all equipment locations and electrical characteristics with other trades involved in the work. Coordination shall be done prior to rough-in or ordering equipment.

B. Control wiring for mechanical equipment beyond provisions shown on the Electrical Drawings shall be performed under another Division of the work.

1.4 QUALITY ASSURANCE:

A. Do all work in accordance with regulations and requirements of serving electric utility, National Electrical Code, state and local codes and amendments, National Fire Codes, and all other applicable codes. Coordinate with local utility services prior to work and product release. Where Owners Design Standards have been incorporated into the design, the contractor shall refer to these Standards for additional clarification.

1.5 PROJECT CONDITIONS:

A. The Contractor shall inspect the job site prior to bidding and familiarize himself with existing conditions which will affect the work. Prior to start of work, obtain "As built", "Record", or other Drawings showing existing underground utilities.

B. Electrical drawings are diagrammatic indicating approximate location of outlets, lighting fixtures, electrical equipment, etc. Consult the existing and new Architectural, Structural,

Civil, and Mechanical Drawings to avoid conflicts with equipment, structural members, etc. When required make all deviations from Drawings to make the work conform to the building as constructed, and to related work of others. Minor relocations ordered prior to installation may be made without added cost to Owner.

C. Call to the attention of the Engineer any error, omission, conflict or discrepancy in Drawings and/or Specifications. Do not proceed with any questionable items of work until clarification of same has been made.

D. Under no conditions are beams, girders, footings or columns to be cut for electrical items unless so shown on Drawings or written approval obtained from the Engineer.

E. Verify the physical dimensions of each item of electrical equipment to fit the available space and promptly notify the Engineer prior to roughing-in if conflicts appear. Coordination of equipment to the available space and to the access routes through the construction shall be the Contractor's responsibility.

1.6 SHOP DRAWINGS:

A. Prior to ordering equipment, and prior to Contractor's first application for payment, the Contractor shall, within 14 days after award of this work, submit complete shop drawings, electronic PDF copy with PDF index tabs, to the Engineer, of materials and equipment they propose to furnish. It is preferred that all sections be submitted at once, however, in the event that one or more sections need approvals quickly and others are not prepared yet, the Engineer will agree to review the individual section submittals needing immediate approval. However, each individual submittal section must be complete and remaining submittals that are not a rush shall be submitted all in one package as quickly as possible. Submitting individual sections over many weeks/months will not be tolerated.

B. List shall bear Contractor's stamp, signature or other means to show that he has inspected same and certified that submitted material is correct in regard to quantity, size, dimension, quality and is coordinated with the Contract Documents.

C. See individual sections within this Division for products requiring submittal.

D. Each shop drawing submittal shall be prepared by the manufacturer, and shall clearly show manufacturer's name, catalog numbers, pictures, details, layout, type, size, rating, style, and all options identified in a permanent fashion. Specific items or options shall be permanently marked on sheets containing more than one option – do not rely on the Engineer to mark options. Yellow highlight will not be an acceptable means of marking.

E. Large equipment drawings such as automatic transfer switches, transformers, panelboards, switchboards, and similar large equipment shall include the size, weight, manufacturers seismic certification rating, and wiring diagrams in addition to the product data.

F. Some sections of this Division may require shop drawings prepared on full size floor plans in AutoCAD or other CAD software. Where required, contact the Engineer for the latest version of the electronic plans and match the size and scale of the construction drawings. Drawings delivered to the contractor from the Engineer may not include addenda changes. Contractor shall only use electronic plans for purposes of the construction on this job, and not for any other use or reuse. Add any required addenda items prior to finishing shop drawings and submittals.

G. Provide complete materials (all materials) list at the beginning of each tabbed section showing “Submittal Number”, “Specification Section”, “Material Item”, “Manufacturer’s Name and Catalog Number”, and all pertinent data.

H. Provide samples where required in individual sections of this Division.

I. Contractor agrees that Shop Drawing Submittals processed by the Engineer are not Change Orders; that the purpose of Shop Drawing Submittals by the Contractor is to demonstrate to the Engineer that the Contractor understands the design concept, that they demonstrate their understanding by indicating which equipment and material they intend to furnish and install and by detailing the fabrication and installation methods they intend to use.

J. Contractor further agrees that if deviations, discrepancies or conflicts between Shop Drawings and Specifications are discovered either prior to or after Shop Drawing Submittals are processed by the Engineer, the design Drawings and Specifications shall control and shall be followed.

PART 2 - PRODUCTS

2.1 MATERIALS:

A. All materials shall be new and bear manufacturer's name, model number, electrical characteristics and other identification. All equipment to be U.L. approved or listed by another testing agency approved by authorities having jurisdiction.

B. Material and equipment shall be standard product of manufacturer regularly engaged in production of similar material for at least five years (unless specifically exempted) and shall be manufacturer's latest design.

C. If the description of a product is in conflict with the product as specified in the catalog number, the description shall generally take precedence. Contact the Engineer for clarification if this occurs.

D. All equipment must be rated and certified for the appropriate seismic design category or seismic use group for the installed geographical location. For essential or life safety equipment, provide an additional seismic factor of 1.5.

2.2 DISCONNECTS:

A. Safety and disconnect switches to be Heavy duty quick-make, quick-break, dual rated, lockable, and of such electrical characteristics as required for the load served. Switches to have defeatable cover interlock.

B. Fuse clips shall accept Class R or Class L fuses if required.

C. In wet locations and where located inside of manholes and vaults, where less than 30 amps, disconnects shall be Hubbell Circuit Lock fused disconnect, NEMA 4X, with lockable off red handle.

D. Disconnect switches required by code shall be installed whether or not specifically shown on the Drawings.

E. Disconnect switches for all motor equipment shall be fusible type.

F. Safety and disconnect switches of circuit breaker type for service entrance to be of same manufacturer as new switchgear and panelboards.

2.3 FUSES:

A. Provide fuses as indicated on the drawings, sized per NEC, or as required by the equipment manufacturer, whichever provides maximum protection, for a fully operational system.

B. All fuses shall be furnished of the same manufacturer.

C. All fuses shall be installed by the electrical contractor at job-site and only when equipment is to be energized. Fuses shall not be installed during shipment.

D. All fuses to be 200,000 AIC, Current-limiting, U.L., Time Delay, Dual-element Type as follows:

1. For motor circuits beyond the main and sub distribution boards, 600 volt and below:

a. Class RK-5 for 600 volt; FRS-R, FLS-R, & TRS-R
b. Class RK-5 for 250 volt; FRN-R, FLN-R, & TR-R

E. SPARE PARTS: Provide 10% spare fuses, but not less than 3 of any one size and type. Deliver spare parts to owner directed storage space on airport property.

F. Approved Manufacturers, with catalog numbers listed in order: Bussman, Littelfuse, Ferraz Shawmut.

G. If the electrical contractor wishes to furnish materials other than those specified, a written request, along with a complete short circuit and selective coordination study, shall be submitted to the engineer for evaluation at least 8 days prior to the bid date. If the engineer's evaluation indicates acceptance, a written addendum will be issued listing the other acceptable manufacturer.

2.4 BOXES:

A. Outlet and junction boxes shall be sized in accordance with code requirements or as noted on the drawings.

B. Unless otherwise specified or shown on the drawings, all outlet boxes for new work shall be cast metal outlet boxes. Steel boxes with punched knockouts are not acceptable in the pump building or outside or in vaults. Gangable boxes are not acceptable. Outlet boxes shall not be smaller than 4" square and 1-1/2 inches in depth, unless otherwise noted. All outlet box covers, rings, or other fittings shall be galvanized. Boxes which are exposed to the weather or inside of vaults shall be cast metal. Outlet boxes for BAS system shall be minimum 2.5" deep boxes.

C. Outlet boxes shall be designed for the intended use, and shall be installed surface mounted with finish surface lines.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION METHODS:

A. All items, articles, materials, and equipment specified under this Division shall be installed per the manufacturer's installation instructions. Where the manufacturer's instructions are in conflict with the directions provided elsewhere in this Contract, the Engineer shall be notified prior to beginning rough-in.

B. Cutting or notching shall be kept to an absolute minimum and done when, and in a method approved by the Engineer. Patch and correct finished surfaces damaged by electrical work.

C. Relays, panels, cabinets and equipment shall be level and plumb and installed parallel with structural building lines. All equipment and enclosures shall fit neatly without gaps, openings, or distortions. Provide approved devices for closing all unused openings.

D. Arrange circuit wiring as shown on the Drawings and do not alter or combine runs or homeruns without the specific approval of the Engineer. Feeder runs shall not be recombined or altered.

E. Drivers, Ballasts, contactors, starters, transformers and like equipment which are found to be noticeably noisier than other similar equipment on the project will be deemed defective and shall be replaced.

F. In general, the mounting heights shall be as noted on the Drawings, or as listed below, the drawing notes taking precedence. Where no heights are indicated, request clarification from the Engineer. Consult the existing and new Architectural, Mechanical Civil, and Structural drawings to avoid conflicts prior to roughing-in and for exact locations. All dimensions are to the top of the back box or device whichever is higher. Lighting dimensions are to the bottom of suspended fixtures and center of wall mounted fixtures unless otherwise noted.

Light Switches	48 inches to center or at top of manhole access ladder.
Convenience Receptacles	36 inches to center or at top of manhole access ladder.
Disconnects and Motor Controllers	72 inches to top

G. Where raceways penetrate floors, ceilings, ducts, chases, and fire walls, provide fire stopping to maintain integrity of the fire assembly. Firestopping method shall be approved by the Code Authority having jurisdiction.

H. All materials and equipment installed under this work shall be properly and adequately supported from the building structure except where ceiling construction or other provisions are specifically designed to support them. Support systems shall provide a safety factor of four. This shall apply to chains, hangers, anchors, clamps, screws, structural iron, and all other hardware and appurtenances associated with the support system.

I. Rough-in for BAS outlets shall consist of a 4" square deep (4SD) box with a single gang ring.

J. Maintain the following minimum separations from BAS, voice and data cables. Power conduit - 12", transformers and motors - 40", lighting - 12".

3.2 LOW VOLTAGE WIRING METHODS:

A. Provide Conduit homeruns complete for all low voltage systems. Plenum cabling will not be acceptable.

3.3 LABELING:

A. Clearly and properly label the complete electrical system to indicate the loads served or the function of each item of equipment provided under this work.

B. Permanent Engraved nameplates: shall be 1/16 inch thick, laminated three-ply plastic, center-ply white, outer-ply black (for normal power) or red (for emergency power) "Lamicoid" or equal. Letters shall be formed by engraving outer colored ply, exposing white center-ply, and shall be a minimum of 5/8 inch high. Nameplates shall be secured with screws or pop rivets.

C. Provide permanent engraved nameplates for the equipment listed below as well as all other similar equipment; refer to each section for specific labeling requirements:

1. Service Equipment, including the maximum available fault current and date calculated as provided by Engineer
2. Switchboards and Panelboards
3. Transformers and Surge Protection Devices
4. Motor Controllers, Variable Frequency Drives (VFD), Safety Disconnects
5. Automatic Transfer Switches
6. Generator Tap Box
7. Generator Accessories Circuit
8. Other similar electrical devices and equipment

D. Self-Adhesive Labels: shall have self-adhesive “P-Touch” or equivalent sticky backs, black lettering with a clear (see through) background.

E. Provide self-adhesive labels for the devices and equipment listed below as well as all other similar equipment; each label shall list the applicable circuit number feeding the device and devices fed from Emergency shall also list “EMERGENCY” as applicable next to the circuit number (for example, a receptacle fed from circuit 2 in panel 1P1 would read “1P1-2” on the label):

1. Thermal Switches and Manual Starters
2. Power outlet receptacles
3. Light Switches

F. For Service switchboards, panelboards, and/or disconnecting means, provide a permanent engraved label indicating maximum available fault current as calculated by the Engineer. Include the date calculation was made.

G. Where existing service entrance components are modified, including where conductors are increased in size, or the service transformer or service disconnecting means is replaced or increased in size, provide a new permanent engraved label on each service switchboard, panelboard, and/or disconnecting means with required information as indicated by the National Electrical Code.

H. Provide neat and clearly legible handwritten labeling using a permanent “Sharpie” or equivalent chisel tip black marker for all junction boxes containing power and fire alarm wiring. Label each junction box with the applicable circuit number(s) for the cables contained within each junction box in a location and large enough to be clearly visible from the floor.

I. Provide a laminated copy of the electrical one line diagram(s), size of sheets as required to be clearly visible. Permanently mount within main electrical room, coordinate final location with architect.

J. Where changes are made in existing panels, distribution boards, etc., provide new labeling and schedules to accurately reflect the changes.

3.4 SAFETY:

A. The Engineer has not been retained or compensated to provide design and construction review services relating to the Contractor's safety precautions or to means, methods, techniques, sequences or procedures required for the contractor to perform the work.

3.5 DEMOLITION:

A. It is the intent of these specifications to require the contractor to make all necessary adjustments to the electrical system, required to meet code, and accommodate installation of the new and remodeled work.

B. Remove all existing devices, switches, receptacles, raceways, and other electrical equipment and devices and associated wiring from walls, ceilings, floors, and other surfaces scheduled for remodeling or demolition unless specifically shown as retained or relocated on the drawings. If existing plumbing or pipes etc. are moved, and new work blocks access to pullboxes or devices, extend existing devices, fixtures, and circuiting to an accessible new location.

C. Disconnect all existing mechanical equipment scheduled for removal or relocation. See mechanical drawings for scope of work. Remove abandoned cables. Abandonned conduit is ok to leave intact. Relabel panels and switchboards to reflect changes.

D. If existing junction boxes will be made inaccessible, or if abandoned outlets serve as feed through boxes for other existing electrical equipment which is being retained, new conduit and wire shall be provided to bypass the abandoned outlets.

E. Locations of items shown on the drawings as existing are partially based on as-built and other drawings which may contain errors. The Contractor shall verify the correctness of the information shown prior to bidding and provide such labor and material as is necessary to accomplish the intent of the contract documents. The plans may show some demolition conditions, but are not intended to show all of them.

F. All materials accumulated during the demolition process are the Owners property and shall be removed from the job site and delivered to an Owner storage facility as directed by the Owner. If owner does not wish to salvage materials, contractor shall remove from jobsite and dispose, or recycle materials at contractor's discretion, in a lawful manner.

G. Where changes are made in existing panels, distribution boards, etc., provide new labeling and schedules to accurately reflect the changes.

I. Demolish and dispose of hazardous materials in a lawful manner, such as PCB containing transformers or ballasts, mercury containing lamps, or materials containing lead. All costs for proper disposal shall be paid by the contractor unless specified elsewhere in the general conditions.

3.6 POWER INTERRUPTIONS:

A. Keep outages to occupied areas to a minimum and prearrange all outages with the Owner's representative and utilities involved. Requests for outages shall state the specific dates and hours and the maximum durations, with the outages kept to these specified times. When power interruptions will last longer than 15 minutes and cover the pumps, then provide diesel driven bypass pumps or trailer set generators to keep water flowing for the duration of the outage. Do not assume that the GC has bypass pumps or generator in their price. Where the vaults are reconstructed the GC may have diesel driven bypass pumps in place for several weeks, however, outages may be required by the electrician or Rocky Mountain Power at different times than the GC's schedule, and the electrician shall carry money for Generator Power during at least one potential outage in the bid.

B. Contractor shall coordinate with the Owner so that work can be scheduled not to interrupt operations, normal activities, building access, etc. Coordinate work with other crafts for proper scheduling.

C. No circuits shall be turned off without prior approval from owner. Coordinate with the Owner any interruptions which affect the operation of the remaining portions of the facility.

D. This contractor will be liable for any damages resulting from unscheduled outages or for those not confined to the preapproved times. Include all costs for overtime labor as necessary to maintain electrical services in the initial bid proposal. Temporary wiring and facilities, if used, shall be removed and the site left clean before final acceptance. Requests for outages must be submitted at least (5) days prior to intended shutdown time.

E. Include in bid cost of minimum temporary power for the CASS security System, Security cameras, radio, and BAS equipment and any other equipment designated by Owner, during time when primary building power has been interrupted. Assume at least a 15 kW generator for this type of equipment, in addition to the power to serve two 75 HP pumps when needed.

3.7 GROUNDING:

A. Ground all electric equipment, raceways and enclosures in accordance with code rules and established safety practices. Provide a single main grounding point where grounding

conductors from the Grounding Electrode System ground rods, ground grids, water pipes, main switchgear, etc. may be terminated.

B. Rebond any existing Concrete encased UFER grounds to the new grounding electrode system with minimum 2/0 Bare Copper

C. Grounds shall be installed where accessible for future inspection and servicing. Where ground connections are made underground or in inaccessible locations, they shall be made using an exothermic weld process, Cadweld or equivalent, or Ampact pressure connectors.

D. Install grounding conductors in approved metallic raceways unless specifically shown or specified otherwise. Bond at each end and at all intervening boxes and enclosures between the service equipment and grounding electrode.

E. No. 8 and smaller grounding conductors shall have green insulation. No. 6 and larger shall be marked with green colored tape at each end and at every box, panel, switchboard, or point where conductor is accessible.

3.8 TVSS (Transient Voltage Surge Suppression) INSTALLATIONS

A. When TVSS units are specified, they are to be shipped with complete installation instructions which are to be followed in detail. The manufacturer's representative is always to be contacted and is to supervise the TVSS installation.

B. Supplemental installation information for both new and reused or relocated TVSS units is as follows:

1. Use the breaker space closest to the neutral bus. Nipple the suppressor to the panel where the suppressor can be installed so as to keep both the hot leads and the neutral lead as short and straight as possible from the suppressor to the breakers and the neutral bus.
2. The best performance is achieved with the shortest leads and neutral. All efforts within the code should be used to minimize the lead lengths. Ideally the leads should be less than eight inches long. Each inch of lead above six inches will add approximately 20 volts to the quoted let-through voltage. Cut the leads down to the shortest size that will allow installation.
3. If the neutral bus is out of reach of the leads, then a #4 AWG conductor is to be run from the remote neutral bus to a lug near the suppressor, and the lead from the suppressor should be cut as short as possible.
4. The ground is to be connected to the case of the panel (equipment ground only).

3.9 EQUIPMENT CONNECTIONS:

A. The location and method for connecting to each item of equipment shall be verified prior to roughing-in. The voltage and phase of each item of equipment shall be checked before connecting. Motor rotations shall be made in the proper direction. Pump motors are not to be test run until liquid is in the system and proper lubrication to all bearings in unit is checked.

B. Conduit, wire and circuit breaker sizes for mechanical, and similar equipment are based on the equipment ratings of one manufacturer. The equipment actually furnished may

have entirely different electrical characteristics. Conduit, wire, circuit breakers, disconnects, etc. shall not be ordered or installed until exact electrical requirements are obtained. Responsibility for this coordination rests with the Contractor.

3.10 SEISMIC BRACING:

A. Furnish and install all seismic bracing of equipment, feeders, lighting fixtures, and other electrical items in accordance with prevailing codes. Refer to ASCE 7-10, section 13.3 and 13.6 for calculation methods. Provide and submit the required designs, calculations, certifications, and stamped drawings to the authority having jurisdiction and obtain their approval prior to installation or fabrication.

3.11 PROJECT RECORD DOCUMENTS:

A. Maintenance of Documents:

1. Maintain at Jobsite, One Record Copy of: Contract Drawings, Specifications, Addenda, Reviewed Shop Drawings, Change Orders, Other Modifications to Contract and Field Test Records.
2. Keep apart from documents used for construction.
3. Keep documents available at all times for inspection by Architect.

B. Recording:

1. Label each document "PROJECT RECORD."
2. Keep record documents current. Do not permanently conceal any work until required information has been recorded.
3. Contract Drawings, legibly mark to record actual construction; including but not limited to the following:

    a. Depths of various elements; locations of underground items, with dimensions to building walls and corners; changes of dimensions and details; changes made by Addendum, Field Orders or Change Order.
    b. Specifications and Addenda; legibly mark each Section to record changes made by Addendum, Field Order or Change Order.

C. As-Built Submittals:

1. At completion of project, transfer changes, addenda items, variations from drawings, exact routes of all feeders and service conduits, and locations of stubbed conduits to clean new prints and specifications which will be supplied by the Engineer and deliver to the Engineer as "As-reported Record" drawings. Include dimensions to all buried or concealed conduits to permanent structures.

D. Operation and Maintenance Manuals

1. At completion of project, prepare Operation and Maintenance Manuals with operation and Maintenance Data, contractors warranties, and copies of approved electrical permits. Include corrected copies of original submittals and shop drawings. Include all testing data and reports.
2. See Division 1 for additional requirements.

3.12 WARRANTIES:

A. Provide a minimum 1 year warranty on all electrical equipment, devices, labor, and work by Division 26 whether specified or not.

B. Provide warranties greater than 1 year as specified in other sections where stated. The warranty requirement most stringent shall be used where conflicts arise.

C. The systems listed below require warranties exceeding the minimum warranty:

1. Automatic Transfer Switches; 2 years refer to Section – 26 36 23
2. Surge Protective Devices (TVSS); 10 years refer to Section – 26 43 00
3. Lighting; 5 years for ballasts refer to Section – 26 51 00

D. Provide copies of all warranties to the owner upon completion of the project.

3.13 COMPLETION:

A. Complete each system as shown or specified herein and place in operation except where only roughing-in or partial systems are called for. Each system shall be tested and left in proper operation free of faults, shorts or unintentional grounds. Demonstrate system in the presence of the Engineer, the Owner or their representative when requested.

3.14 FINAL OBSERVATION:

A. Contractor shall submit written certification that:

1. Contract Documents have been reviewed.
2. Contractor has inspected Project for compliance with Contract Documents.
3. Work has been completed in accordance with Contract Documents.
4. Equipment and Systems have been tested and are operational.
5. Project is completed and ready for final inspection.

B. Engineer will make final inspection as soon as possible after receipt of Certification.

C. Should Engineer consider that work is finally complete in accordance with Contract Document requirements, Contractor shall make Contract Closeout submittals.

D. Should Engineer consider that work is not finally complete:

1. He will so notify Contractor, stating reasons.
2. Contractor shall take immediate steps to remedy deficiencies, and send second written notice to Engineer certifying that work is complete.
3. Engineer will re-inspect work.

E. The Engineer will make two final inspections. The first will determine deficiencies and errors in the work and the second will determine whether or not the noted deficiencies and errors have been satisfactorily corrected.

F. If additional inspections are required because of the Contractor's failure to complete the deficiencies and errors prior to the second inspection, costs for the successive inspections will be back-charged to the Contractor by the Owner, who, in turn, will reimburse the Engineer. Charges will be based as follows:

1. Engineer time at current billing rates.
2. Travel time, and all other expenses incurred in making inspections.

G. Contractor to provide one (1) journeyman, tools, meters, instruments and other test equipment required by Engineer. Contractor to remove and replace trims, covers, fixtures, etc., for Engineer to review and test materials, systems, methods and workmanship. (Example: Removing switchboard and panel covers to take voltage/amp readings, review connections and wire size, etc.)

END OF SECTION

SECTION 26 05 19 – WIRES & CABLES (600V)

PART 1 - GENERAL

1.1 WORK INCLUDED:

A. Provide all wires and cables as herein specified and shown on the associated drawings for service conductors, feeder conductors and branch circuit conductors.

1.2 RELATED WORK SPECIFIED ELSEWHERE:

A. Basic Material & Methods – Section 26 05 00.

B. Raceways – Section 26 05 33.

1.3 QUALITY ASSURANCE:

A. All wire and cable shall meet or exceed the following standards:

1. ASTM-B series specifications
2. ICEA S-61-402/NEMA WC 5 - Thermoplastic insulated cables 0-2000 volt
3. UL Standard 62 and 83 – Thermoplastic insulated cable
4. UL VW-1 Flame Test for sizes #12 through #1
5. National Electric Code (NFPA 70) – Latest edition

B. Manufacturer's shall be engaged in the manufacturing of industry accepted quality wires and cables for a period of no less than 5 years for all types and sizes required.

1.4 SUBMITTALS:

A. None required.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Provide products of Southwire, Houston Wire, Rome Cable, or similar manufacturer located within the continental North American market. Cables made in Europe, Asia, South America, Africa, or other overseas markets are not acceptable.

B. Substitutions: Equivalent manufacturers are allowed at contractors option, no submittals or prior approvals are necessary if cable meets specifications.

2.2 MATERIALS:

A. Application: For use in general wiring applications for lighting and power in ducts, conduits, wireways and other approved raceways with a maximum conductor temperature of 90 degrees C in dry locations and 75 degrees C in wet locations.

B. Provide wires and cables that are chemical, gasoline, and oil resistant. Provide wires and cables that are sunlight resistant.

C. Minimum conductor size shall be No. 12 AWG unless otherwise noted.

D. Where adverse conductor exposure exists, code approved insulation suitable for the conditions encountered shall be used unless shown otherwise on the Drawings.

E. Wire and cable shall be new, shall have grade of insulation, voltage and manufacturer's name permanently marked on outer covering at regular intervals and shall be delivered in complete coils or reels with identifying size and insulation tags.

2.3 COPPER CONDUCTORS:

A. For No. 10 AWG and smaller provide soft drawn stranded or solid copper conductors with type THHN/THWN insulation.

F. For No. 8 AWG and larger provide soft drawn stranded, Class B stranded copper conductors with type THHN/THWN insulation.

2.4 ALUMINUM AND/OR METAL CLAD (MC) CABLING OPTIONS:

A. Aluminum and MC Cabling not acceptable – Provide copper only conductors.

2.5 COLOR CODE:

A. All wires shall be fully colored in sizes 12 through 6 AWG, and color banded at each end with colored tape at all terminations, panels, equipment, junction boxes, and pull boxes for sizes 4 AWG and larger.

G. Color Code throughout the project shall be:

1. 480Y/277V System

Phase A	Brown
Phase B	Orange
Phase C	Yellow
Neutral	Grey
Neutral A (dedicated)	Grey w/brown stripe #12 & #10
Neutral B (dedicated)	Grey w/orange stripe #12 & #10
Neutral C (dedicated)	Grey w/yellow stripe #12 & #10
Equipment Ground	Green

2. 208Y/120V System

Phase A	Black
Phase B	Red

Phase C	Blue
Neutral	White
Neutral A (dedicated)	White w/black stripe #12 & #10
Neutral B (dedicated)	White w/red stripe #12 & #10
Neutral C (dedicated)	White w/blue stripe #12 & #10
Equipment Ground	Green
Isolated Ground	Green w/yellow stripe #12 & #10 Green and Yellow bands #8 and up

C. Provide a permanent, plastic engraved label on the inside of each branch-circuit panelboard throughout the project identifying the Color Code used throughout the project. Refer to NEC 200.6 (D).

2.6 SPLICES AND TERMINATIONS:

A. Splices shall utilize Scotch "Hyflex" or "Ideal" wing nut connector installed properly. Crimp on splices designed to be used without wire stripping are not acceptable.

B. Splices for No. 8 and larger wires shall be made with mechanically applied pressure type connectors.

C. All taped joints shall be with "Scotch 33+" or equal, applied in half-lap layers without stretching to deform.

D. Where splice box is subject to rain, weather, or moisture, provide “Rain Tight” termination device.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Inspect exposed cables for physical damage and remove as length allows.

B. Utilize pulling compound on long pulls. Ensure that cable reels and pulling apparatus are firmly secured prior to pulling. Use pulling attachments and materials including approved swivel connections, pulling eyes, and/or friction tape as applicable. Carefully follow all applicable safety requirements when pulling cables.

C. Do not exceed manufacturers recommendations for maximum allowable tension, or side wall pressure. In all cases, pulling tension applied to the conductors shall be limited to 0.008 lbs. per circular mil of conductor cross-section area.

D. Do not exceed manufacturers recommendations for minimum allowable bending radius. For training of cables, minimum bend radius to inner surfaces of cable shall be 12 times cable diameter. Where cable is pulled under tension over sheaves, conduit bends, or other curved surfaces, make minimum bend radius 50% greater than specified above for training.

E. Provide dedicated neutrals on all branch power receptacle circuits of 120/208 volt.

3.2 BRANCH CIRCUIT GROUNDED CONDUCTOR (NEUTRAL) WIRING METHODS:

A. Dedicated (separate) neutral wiring methods

1. Provide dedicated neutral wiring for the following system(s):
   a. Lighting
   b. Receptacles
   c. Other than lighting and receptacle branch circuits

2. Provide dedicated (separate) neutral for each branch circuit; shared/common neutral wiring is not allowed.
3. For dedicated neutral branch wiring, there shall be no more than six (6) current carrying conductors allowed within a single raceway unless specifically allowed otherwise in the drawings. All neutral conductors shall be considered current carrying. Provide all required wire size increases to account for the applicable NEC wire ampacity deratings.
4. Provide dedicated neutral cables with colored stripe as required in wire color coding section for identification.

3.3 PARALLELED CONDUCTORS:

A. Under no condition shall conductors less than #1/0 AWG copper be run in parallel. Where paralleled runs are used, the contractor must cut to exact length on each phase leg. Where parallel conductors are run in parallel conduits, each conduit shall carry all phase legs as well as neutral, equipment ground, and/or isolated ground conductor as applicable.
B. Size parallel ground conductors as per NEC 250.

3.4 SPLICES AND TERMINATIONS:

A. Splices are to be made up complete promptly after wire installation.

B. Single wire pigtails shall be provided for fixture and device connections. Wirenuts may be used for fixture wire connections to single wire circuit conductor pigtails.

C. Install wing nut connector properly, according to manufacturers written instructions. Crimp on splices designed to be used without wire stripping are not acceptable.

D. Torque bolted connections to manufacturer’s recommendations. Torque both ends of the cable, or parallel cables, to the same Torque level.

E. Insulation shall be removed with a stripping tool designed specifically for that purpose. A pocket knife is not an acceptable tool. All conductors shall be left nick-free.

F. Thermoplastic insulated wire and cable shall not be installed or handled in temperatures below +14 degrees F (-10 C).

3.5 LABELING:

A. Service Cables - Provide an engraved laminated 3-ply plastic “Lamicoid” or equal label which designated as “SERVICE CABLE(S)” attached with a nylon wire tie to the cables at each entry and exit from pullboxes, wireways and any other similar locations.

B. Feeders – Provide an engraved laminated 3-ply plastic “Lamicoid” or equal label with feeder name attached with a nylon wire tie to the feeder at each entry and exit from pullboxes, wireways and any other similar locations.

C. Branch Circuits – Clearly mark and identify the circuit number(s) at each junction box and similar location with a permanent black marker or equivalent that is clearly visible. For concealed junction boxes the marking shall be made on the outside coverplate; for exposed boxes or boxes with finished coverplates marking shall be made on the interior of the box where visible when removing the coverplate.

3.6 COMMISSIONING AND TESTING:

A. Contractor shall provide for access and inspection of installed wires and cables by the Engineer and owner.

B. Document all tests and provide written copies in the O&M manuals.

C. Perform continuity tests and resistance measurements through bolted connections to ensure correct cable connections.

D. Perform insulation resistance test on all feeder conductors exceeding 100 amps, size #2 and larger. Values shall not be less than 50 megaohms.

END OF SECTION

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SECTION 26 05 26 – GROUNDING AND BONDING

PART 1 - GENERAL

1.1 WORK INCLUDED:

A. Provide all grounding and bonding as code required and as herein specified and shown on the associated drawings.

1.2 APPLICATION:

A. All grounding and bonding shall be by copper only connectors, copper cable and wire, and/or copper braids.

1.3 RELATED WORK SPECIFIED ELSEWHERE:

A. Basic Material & Methods – Section 26 05 00.

B. Wires & Cables – Section 26 05 19.

1.4 QUALITY ASSURANCE:

A. All installation of grounding and bonding conductors shall meet or exceed the following standards:

1. ANSI/IEEE 142 for service ground electrode resistance (5 ohms).
2. Ground electrode resistance at transformers (10 ohms)
3. ASTM B 8 stranded conductors
4. ICEA S-61-402/NEMA WC 5 - Thermoplastic insulated cables 0-2000 volt
5. UL Standard 62 and 83 – Thermoplastic insulated cable
7. UL VW-1 Flame Test for sizes #12 through #1
8. National Electric Code (NFPA 70) – Latest edition
9. UL listing is required

B. Manufacturers shall be engaged in the manufacturing of industry accepted quality grounding connectors for a period of no less than 5 years for all types and sizes required.

1.5 SUBMITTALS:

A. None required.

PART 2 - PRODUCTS

2.1 GROUNDING CONNECTORS AND GROUND RODS:

A. ACCEPTABLE MANUFACTURERS: Subject to compliance with all requirements, provide products of one of the following manufacturers for grounding connectors or ground rods:

1. Chance/Hubbell
2. Copperweld Corporation
3. Erico Inc., Electrical Products Group
4. Burndy Electrical
5. Kearney/Cooper Power Systems
6. O-Z/Gedney Co
7. Raco/Hubbell
8. Thomas & Betts Electrical

B. Provide products of a quality manufacturer located within the continental North American market. Grounding connectors made in Europe, Asia, South America, Africa, or other overseas markets are not acceptable.

C. Provide products that are listed and labeled by UL for all applications used, and for specific types, sizes and combinations of conductors and other items connected.

D. For buried connections, provide crimp style connections or welded type connections. For accessible connections, provide bolted pressure-type, torque as per manufacturers recommendations.

E. Substitutions: Equivalent manufacturers are allowed at contractor’s option, no submittals or prior approvals are necessary if ground connectors and rods meet specifications.

2.2 CONDUCTORS:

A. Provide copper or tinned-copper wire and cable insulated for 600 volt unless otherwise required by applicable code or authorities with jurisdiction.

B. Provide minimum of #6 AWG copper stranded grounding electrode conductor for the portion of the conductor which is the sole connection to the ground rod grounding electrode. Where this conductor is not the sole connection to a single ground rod (for example if the conductor connects multiple grounding electrodes in series), then the minimum conductor size shall comply with NEC table 250.66.

C. The grounding electrode conductor for the portion of the conductor which is the sole connection to a ground ring grounding electrode shall be no smaller than the conductor used for the ground ring. Where this conductor is not the sole connection to the ground ring grounding electrode only (for example if the conductor connects multiple grounding electrodes in series), then the minimum conductor size shall comply with NEC table 250.66.

D. Provide No. 4 and/or No. 6 AWG stranded conductor for bonding conductors.

E. Bonding Jumper: Provide copper tape, braided copper conductors, terminated with copper ferrules, 1-5/8 inches wide and 1/16 inch thick.

PART 3 - EXECUTION

3.1 GROUNDING INSTALLATION:

A. Ground all electric equipment, raceways and enclosures in accordance with code rules and established safety practices. All grounding systems inside the building must be bonded to the main power service ground, including telecomm closets, TV cabling entrances, lightning protection systems, and computer data center grounds.

B. Install insulated equipment grounding conductors in all types of raceways for all power feeders and branch circuits

C. Route grounding electrode conductors along the shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subject to strain, impact, or damage.

D. Grounding electrode conductors and bonding jumper connections to grounding electrodes shall be accessible (unless allowed by NEC 250.68(A) exceptions) and provide a continuous effective grounding path.

E. Where ground connections are made underground or in inaccessible locations, they shall be made using an exothermic weld process, Cadweld or equivalent, or Ampact pressure connectors.

F. Install main grounding electrode conductors in approved metallic raceways unless specifically shown or specified otherwise. Bond at each end and at all intervening boxes and enclosures between the service equipment and grounding electrode.

G. No. 8 and smaller grounding conductors shall have green insulation. No. 6 and larger shall be marked with green colored tape at each end and at every box, panel, switchboard, or point where conductor is accessible.

H. Provide bonding jumpers to steel structure as indicated on the plans. Use exothermic welded connectors for steel connections below slab, and/or bolted clamp connections where accessible above slab.

I. For equipment subject to vibration, install bonding jumper so that vibration is not transmitted through the grounding connection.

3.2 GROUND RODS

A. Grounds rods shall be installed where accessible for future inspection and servicing, located in a “ground rod well” where located exterior. Install Ground rod well flush with grade.

3.3 CONNECTIONS

A. For equipment grounding connections #10 and smaller, grounding conductors may be terminated with appropriate winged pressure type connectors (wirenuts). For #8 and larger, use pressure-type grounding lugs.

B. For Service metal conduits, and where metallic raceways terminate at metal housings without appropriate electrical connection to housing, terminate each conduit with an

insulated throat grounding bushing. Connect grounding bushing with a bare copper grounding conductor to grounding bus and/or grounding terminal electrically bonded to housing.

B. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturers published torque-tightening values. If manufacturers data is not available, tighten according to UL468A.

C. For compression type connections, use hydraulic compression tools and dies to provide the correct circumferential pressure for all connectors. Use only tools and dies as recommended by the connector manufacturer. Provide embossing die code or other standard method to make a visible, permanent indication that a connector has been adequately compressed onto the grounding conductor.

3.4 EXISTING GROUND SYSTEMS

A. Connect existing ground connections from existing rods, UFER, structural steel, and water pipes to new grounding electrode system.

3.5 COMMISSIONING AND TESTING:

A. Contractor shall provide a time for access and inspection of grounding system for the Engineer, and the owner. Correct all defects and flaws found prior to testing.

B. Test all grounding systems per NETA 7.13 Inspection and Test Procedures.

C. Test the electrical service entrance ground and ensure that it does not exceed 5 ohms. Test grounding measurements at medium voltage switchgear and switches, pad-vaults, and manholes and ensure they do not exceed 5 ohms. Test the grounding at transformers and ensure they do not exceed 10 ohms.

D. If measurements exceed allowed values, notify the Engineer and provide additional electrode conductor, ground rod extension to 20 feet, additional ground rods, chemical rods, and other mitigation methods to ensure that readings are below requirements. Retest after mitigation and report both the initial test readings, the mitigation efforts made, and the final readings in test reports. Include test reports in the O&M manual.

E. Demonstrate electrical continuity at selected connections to the commissioning agent using an electrical ohmmeter. Point to point resistance values shall not exceed 0.5 ohms. Provide additional bonding as necessary to ensure these resistance values are less than 0.5 ohms.

END OF SECTION

SECTION 26 05 33 - RACEWAYS

PART 1 - GENERAL

1.1 WORK INCLUDED:

A. Provide all raceways, wireways, and associated fittings as herein specified and shown on the associated drawings.

1.2 APPLICATION:

A. Electric metallic tubing (EMT), galvanized rigid conduit (GRC), intermediate metal conduit (IMC), flexible metal conduit, and PVC conduit may be used.

B. Schedule 40 PVC conduit may only be used below grade and below slabs on grade. PVC shall not be used above grade. Conduits larger than 1 inch may be run below the slab. Type EB and DB utility duct shall not be substituted for Schedule 40 PVC.

C. GRC and IMC shall be used in locations subject to mechanical injury, for penetrations of building and manhole walls, and for service conduit under concrete slabs. GRC and IMC may be used: outside, where exposed to weather, in wet locations, in hazardous locations (as approved by code). Schedule 80 PVC may not be substituted for GRC and IMC.

D. EMT may be used only in dry and protected locations and in suspended slabs. EMT may not be used: outside, where exposed to weather, in hazardous locations or where subject to mechanical injury.

E. Flexible metal conduit (FMC) will be permitted only where flexibility is necessary. FMC may be used only where flexibility is necessary in dry protected locations, such as: connections to recessed light fixtures, work fished into existing concealed dry locations, wood frame construction. Flexible metal conduit shall be used for connection to all equipment subject to movement or vibration such as motors and transformers. Length shall not exceed 6 feet unless fishing in existing construction.

F. Liquid-Tight Flexible Metal Conduit (LFMC) shall substitute only in those locations where flexible metal conduit is required and additional moisture protection is desired or needed. LFMC may be used: for connections to motors or fixed equipment where subject to moisture or weather and subject to movement or vibration. Length shall not exceed 6 feet unless specified otherwise.

G. Drawing notes requiring a specific type of raceway shall take precedence over the specifications.

H. Surface metal or Plastic raceways (Wiremold) shall not be used.

I. Electrical wiring shall be in U.L. approved raceways and enclosures throughout.

J. 4" and larger conduits intended for use on primary services shall have minimum 36" radius sweep on all bends.

1.3 RELATED WORK SPECIFIED ELSEWHERE:

A. Basic Material & Methods – Section 26 05 00.

B. Wires and cables (600V) – Section 26 05 19.

C. Seismic Restraint for Electrical – Section 26 05 48

1.4 QUALITY ASSURANCE:

A. All installation of conduits and raceways shall meet or exceed the following standards:

1. Polyvinyl Chloride (PVC): in accordance with ANSI C80.1 and NEMA Std. Pub. No. RN 1.
2. Rigid Metal Conduit (RMC): in accordance with ANSI C80.1.
3. Electric Metallic Tubing (EMT): in accordance with ANSI C80.3.
4. Seismic Bracing: ASCE 7-10, Section 13.6, latest edition
5. National Electric Code (NFPA 70) – Latest edition
6. UL listing is required

B. Manufacturer's shall be engaged in the manufacturing of industry accepted quality raceway for a period of no less than 5 years for all types and sizes required.

1.5 SUBMITTALS:

A. Conduit and conduit fitting product data submittals are not required.

B. Submit seismic bracing calculations, bracing and anchoring products, and bracing designs for suspended conduits and conduit racks as a deferred submittal as required per section 26 05 48. Submittal shall be as early as possible in the contract and prior to installing suspended conduits and conduit racks. Installation shall comply with the deferred submittal including all components and anchors used.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Provide products of a quality manufacturer located within the continental North American market. Conduit and Raceways and Fittings made in Europe, Asia, South America, Africa, or other overseas markets are not acceptable.

B. Substitutions: Equivalent manufacturers are allowed at contractor's option, no submittals or prior approvals are necessary if conduit and fittings meet specifications.

2.2 RACEWAYS:

A. Galvanized Rigid Metal Conduit (GRC): Provide zinc-coated, hot-dipped galvanized, rigid metallic conduit in sizes indicated on the drawings. Provide RMC in ¾ inch minimum size.

B. Intermediate Metal Conduit (IMC): Provide hot-dipped galvanized, intermediate metal conduit in sizes indicated on the drawings. Provide IMC in ¾ inch minimum size.

C. Electric Metallic Tubing (EMT): Provide electric metal tubing in sizes indicated on the drawings. Provide EMT in ¾ inch minimum size.

D. Liquid-Tight Flexible Metal Conduit: Provide liquid-tight, flexible metal conduit, constructed of single strip, flexible continuous, interlocked, and double-wrapped steel, galvanized inside and outside, coated with liquid-tight jacket of flexible Polyvinyl Chloride (PVC). Provide Liquid-Tight Flexible conduit in ¾ inch minimum size.

E. Provide Schedule 40 PVC conduit (where installed below grade or below slab on grade) in one inch minimum size.

F. Aluminum conduit is not acceptable.

2.3 FITTINGS:

A. Provide listed fittings and connectors that are suitable for the application and the environment installed. Use concrete tight fittings where EMT is installed in suspended slabs or in concrete. Fittings that can be made concrete tight by taping are acceptable in this application.

B. For Service Entrance switchboards and disconnects, use insulated throat grounding bushings for all service conduit entries. Tie ground jumpers to the equipment grounding bus inside the switchboard or panelboard.

C. EMT Connectors and couplings shall be steel, set screw type for interior application. EMT connectors and couplings where located outside in protected locations or where subject to damp environments shall use compression type connections.

D. For EMT connections to panelboards and boxes that exceed one inch size, or where #4 or larger conductors are pulled, or for any size conduit where subject to vibration, provide with insulated throats on connectors or other identified fitting providing a smoothly rounded insulating surface integral to the fitting. Use insulated throat set-screw connectors for smaller conduit sizes up to one inch, and use O-Z/Gedney type SBT/SB insulated bushings or equal selected by the contractor for sizes 1-1/4 inch and larger.

E. Aluminum fittings, Die-cast fittings or fittings made from pot metal shall not be allowed. Indenter type fittings are not acceptable.

F. Plastic only bushings are not to be used on power conduits.

G. GRC and IMC shall be coupled and terminated with threaded fittings. Provide fully-threaded, malleable steel fittings, rain-tight and concrete-tight as applicable. Provide double locknuts and metal bushings with insulated throat at all conduit terminations at boxes, panels, cabinets, switchboards, and stub-outs Fittings of O-Z/Gedney type B or equal. As selected by the contractor are acceptable for these applications.

I. PVC shall be provided with matching schedule 40 fittings.

J. FMC and LFMC fittings shall be in accordance to industry standards.

K. Sealing bushings are to be provided equal to O-Z/Gedney Type FSK, WSK or CSMI as required by application. Provide equal to O-Z/Gedney Type CSB for internal sealing bushings.

2.4 SUPPORT AND SEISMIC BRACING COMPONENTS

A. Provide C clamps, beam clamps, and other type clamps for direct installation on structural beams or wall structures.

B. For suspended conduits, refer to section 26 05 48 for required deferred submittals and seismic bracing design requirements. Provide rigid support for all conduits, tie wire and systems that utilize wire as main vertical support are not allowed, wire may be used for horizontal and longitudinal bracing only if calculated and detailed in the contractors deferred submittal and approved by the shop drawing process.

C. As necessary and as shown in deferred submittal for suspended conduits, provide the following components for vertical support and lateral/longitudinal seismic bracing:

1. Strut: Unistrut (or equal) P1000 Metal Framing Channel
2. Allthread: Stainless Steel, 3/8 minimum size
3. Angles/Hinges: Bline B335-2 or Mason Industries SCB Swivel Anchor
4. Expansion anchors: Hilti Kwik Bolt II (or equal) minimum 3/8 inch x 2-1/4 inch depth
5. Hardware: Miscellaneous cap screw/spring nuts and other hardware required for a complete system.
6. Other hardware as designed in the contractors deferred submittal per section 26 05 48.

2.5 BOXES

A. Refer to section 26 05 00 for appropriate boxes.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Provide pull boxes where shown or required to limit the number of bends in any run to not more than three 90 degree bends. Use code gauge galvanized sheet steel boxes of code required size with removable covers, installed so that covers will be accessible after work is completed. Verify with the Architect any locations in finished areas.

B. Exposed raceways shall be parallel to structural lines and location must be approved by Engineer prior to installation.

C. Do not place conduits within 1-1/2 inches of the upper flutes of roof decking.

D. Maintain a minimum of 6 inches spacing from water lines. Do not support conduit from other utility services.

E. Conceal all raceways and wiring in finished spaces.

F. All conduit leaving building envelope (e.g. site circuits, BAS, etc.) to be one inch minimum.

G. Field bends and offsets shall be made without flattening, kinking, rippling or destroying the smooth internal bore or surface of the conduit and to not less than NEC minimum radius. Conduit that shows signs of rippling or kinking shall not be installed. Any conduits installed with wrinkles or kinks or otherwise in an unworkmanlike manner shall be replaced at no additional cost to owner.

H. Precaution shall be exercised to prevent accumulation of water, dirt, concrete, or other foreign matter in the conduits during the execution of the project. Conduits in which water or foreign matter has been permitted to accumulate shall be thoroughly cleaned or the conduits runs replaced where such accumulation cannot be removed by methods approved the engineer.

I. Permanently cap all spare conduits. Cap or plug conduit ends during construction to prevent entrance of foreign material.

J. For metal conduit systems, provide electrically continuous conduit systems throughout.

K. Where drilling through existing floors or walls, use x-ray or penetrating location device to identify steel elements prior to drilling. Avoid cutting existing reinforcing bars. If nicked or damaged, consult with a licensed structural engineer for repair and support methods and provide required materials and repair.

L. Provide ground wire within all conduits sized per NEC code.

3.2 SUPPORT AND SEISMIC BRACING INSTALLATION:

A. Individual suspended conduits and conduit racks shall be adequately braced for Seismic Restraint, as required per ASCE 7-10, section 13.3, latest edition. All life safety conduits, all conduits 2 inches and larger exceeding 12 inch suspension, and all multi-conduit racks exceeding 12 inch suspension shall be calculated and braced using the calculations methods of the ASCE and reviewed by the Architect/Engineer. Contractor shall perform the required calculations as early as possible in the contract and prior to installing suspended conduit racks.

B. For 3 or more conduits install conduit racks with trapeze style hanging system, with stainless steel 3/8 inch all-threads hanging down to a Galvanized steel strut assembly. Provide conduit clips to rigidly clip conduit to strut.

C. Provide a diagonal lateral seismic restraint braces at maximum 10 foot intervals (alternating directions), and a longitudinal brace (alternating directions) at maximum 30 foot intervals. Braces must be made of strut or similar rigid material, and will be tied directly to trapeze strut with hinges or rigid angles. Wire ties for bracing will not be acceptable. All hardware made for bracing shall be seismically rated.

D. If a large number of suspended conduit feeders (more than 12 each exceeding 2-1/2 inches in size) are grouped together, the contractor shall review the layout with the structural engineer, provide estimated weights, and obtain approval for the proposed layout.

E. Hanger rods shall be fastened to structure in an approved manner. Pullout resistance shall have a safety factor of 4.

F. Support individual suspended feeder conduits by metal ring or trapeze hangers with threaded steel rods.

G. Support spacing shall be in accordance with the following table, in addition to these maximum spacing requirements the seismic support and bracing may require additional support and/or spacing supports less than the maximum distance indicated below; the most stringent requirement and shortest spacing distances shall be enforced.

Conduit Type:	Conduit Size:	Maximum Distance Between Conduit Supports:	Maximum Distance From outlet box, junction box, cabinet, fitting, conduit termination or bends larger than 22 degrees.
IMC/GRC	½" to ¾" 1" 1.25" to 1.5" 2" to 2.5" 3" and larger	10 feet 12 feet 14 feet 16 feet 20 feet	3 feet for all sizes
EMT	All Sizes	10 feet	3 feet
FMC	All Sizes	4.5 feet	1 foot
LFMC	All Sizes	4.5 feet	1 foot

3.3 FIELD CUTS AND THREADS:

A. Cut all conduits perpendicular and square. Remove all sharp or rough edges and ream all burrs, inside and outside.

B. Provide clean sharp threads on RMC and IMC. Engage at least five full threads on all RMC and IMC fittings.

C. Before couplings or fittings are attached, apply one coat of red lead or zinc chromate to male threads of RMC or IMC.

D. Apply coat of red lead, zinc chromate or special compound recommended by manufacture to conduit where conduit protective coating is damaged.

3.4 CONDUITS BURIED BELOW GRADE (SINGLE CONDUITS LESS THAN 3 INCHES)

A. Elbows larger than 30 degrees and one inch shall be galvanized rigid conduit, wrapped with PVC tape.

B. Provide a ground wire sized per code in all PVC conduits intended for power circuits when pulling wire. Conductor quantities indicated in conduits do not include ground wires unless otherwise noted.

C. Provide trenching, backfilling, compaction, re-paving or other site restoration as required by the work done in this division. Minimum trench depth shall be as required to install conduit at 24" below grade to top of conduit unless otherwise noted.

D. Install a detectable 6 inch wide yellow vinyl tape with letter "Caution: Buried Electrical Line Below" 12 inches above all buried service conduit and wire not under structures.

E. Backfill material against the conduit for all trenches under paved areas shall be coarse sand or crushed 3/8 inch minus rock for 6 inches. After that, screened native backfill is acceptable, installed in layers not to exceed eight inches and compacted to 96% of maximum density at optimum moisture content to preclude subsequent settlement. Compaction by water method is not allowed. If compaction cannot be obtained with native clay soils where access roads surround the pump building, imported fill shall be brought in.

F. Conduits piercing a building waterproof membrane shall be provided with flanges, using two neoprene washers, one washer on each side of membrane, between each flange and membrane.

G. All underground conduits which enter the building shall be sloped to drain away from the building and shall be water sealed to prevent moisture from passing through the conduit into the building. All joints to be threaded and taped or glued to prevent entry of water into the conduits.

3.6 CLEANING:

A. Pull a mandril and swab through all conduits before installing conductors. Raceways shall be left clean and free of debris.

B. Provide a pull string in all empty conduits.

3.7 COMMISSIONING AND FINAL INSPECTION:

A. Contractor shall provide a time for access and inspection of raceway system for the Engineer, and owner. Correct all defects and flaws found prior to wall and ceiling installation and prior to cabling installation.

B. Demonstrate electrical continuity at selected joints to the Engineer and owner using an electrical ohmmeter.

C. Demonstrate rigid seismic bracing to ensure minimal movement of the raceways on suspended racks in a seismic event. Demonstration shall be by pushing with at least 25 pounds force laterally and longitudinally at selected (mid-span) locations along the length of the suspended raceway rack. Rack shall not move more than 2 inches during these demonstrations.

END OF SECTION

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SECTION 26 05 48 – SEISMIC RESTRAINT FOR ELECTRICAL WORK

PART 1 - GENERAL

1.1 WORK INCLUDED:

A. This section includes seismic anchoring, and seismic bracing and restraints and other earthquake damage reduction measures for electrical systems, and electrical components. It complements seismic construction requirements located in other sections of the specification.

B. Provide seismic bracing and support Design for all electrical and life safety components for the facility. Provide structural design of all components by a licensed Structural Engineer in the State of Utah, qualified as indicated in Quality Assurance section 1.5 below. All calculations and designs shall have a professional engineering stamp. The licensed structural engineer shall be hired by the Contractor as a payed consultant on the project upon bid award, and shall visit the project site during construction to verify the installation meets the calculations prepared by the Engineer.

C. The 2015 IBC Chapter 16, section 1613.1; and the ASCE 7-10 American Society of Civil Engineering “Minimum Design Loads for Buildings and Structures”, section 13, shall define the minimum requirements for seismic design of nonstructural systems.

D. Submit calculations and Shop drawings showing design intent, anchors, materials to the Engineer and the Authority Having Jurisdiction as a deferred submittal.

E. It should be noted that the design of the seismic bracing depends heavily on the Contractor purchased components and manufacturers purchased in the various electrical divisions. Other electrical divisions will need to have approved submittals prior to completing the submittals for this section. Time is of the essence in providing submittals promptly to avoid construction delays.

F. Provide all seismic supports, and associated fittings as herein specified and shown on the associated drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE:

A. Basic Material & Methods – Section 26 05 00.

B. Raceways – Section 26 05 33.

1.3 REFERENCES

A. International Building Code, Current Edition in use by Jurisdictional Authority.

B. NFPA Bulletin 90A, Current Edition.

C. UL Standard 181.

1.4 SYSTEM DESCRIPTION

A. The Division 26 Contractor shall be responsible for supplying and installing equipment, vibration isolators, flexible connections, rigid steel frames, anchors, inserts, hangers and attachments, supports, and bracing to comply with the following:

1. Short period design spectral response acceleration coefficient S_{DS}= _____. Reference USGS site mapping tool for specific latitude and longitude of the site: https://earthquake.usgs.gov/hazards/designmaps/ https://seismicmaps.org/
2. One-second period design spectral response acceleration coefficient S_{D1}= _____.
3. Site Class E as shown in the Geotechnical Report.
4. Seismic Design Category <A> <B> <C> <D>.

B. Other Component Importance Factor (increased for components needed for continued operation of the facility whose failure could impair the continued operation of the facility): factor I_P of 1.25. This is defined as all areas within, supporting, and surrounding the pump station

1.5 QUALITY ASSURANCE

A. All supports, hangers, bases, anchorage and bracing for all isolated equipment and non-isolated equipment shall be designed by a Professional Engineer licensed in the state where the project is located, qualified with Seismic experience in bracing for electrical equipment, and referred to as the Seismic Engineer. Shop drawings included with deferred submittal for earthquake bracing and anchors from the restraint manufacturer shall bear the Engineer's signed professional seal. All calculations/design work required for the seismic anchorage and restraint of all Division 26, 27, and 28 equipment and systems shall be provided by a single firm.

B. The above qualified Seismic Engineer shall determine specific requirements for equipment anchorage and restraints, locations and sizes based on shop drawings for the electrical equipment which have been submitted, reviewed and accepted by the Architect/Engineer for this project.

C. The Seismic Engineer shall field inspect final installation and certify that bracing and anchorage are in conformance with the Seismic Engineer’s design, the requirements of this specification section, and all seismic restraint requirements of the building code. Provide a certificate of compliance stating all Division 26, 27, and 28 raceway systems and equipment have been anchored and restrained in accordance with the requirements of the building code and ASCE 7. The certificate of compliance shall include the Seismic Engineer’s signed Professional Engineer’s seal. Include a copy of the certificate in each copy of the Operation and Maintenance Manual.

D. The Division 26 Contractor shall require all equipment suppliers to furnish equipment that meets the seismic code, with bases/skids/curbs designed to receive seismic bracing and/or anchorage. All isolated and non-isolated electrical equipment bracing to be used in the project shall be designed from the equipment submittals and certified to be code-compliant by the equipment manufacturer for seismic description loads defined above, with direct anchorage capability.

E. Manufacturers shall be engaged in the manufacturing of industry accepted quality supports for conduits and raceways for a period of no less than 5 years for all types and sizes required.

1.5 SUBMITTALS:

A. Deferred Submittals: Provide Seismic Certificate from manufacturer of all electrical equipment indicating that the equipment will withstand the forces, and has been tested using the IEEE method or calculated with the ASCE method using appropriate site acceleration and importance factors for the installed location and occupancy classification expected. Simply labeling it “Seismic Zone 4” under the old Uniform Building Code or “California Seismic approved” is not acceptable and will be rejected. Certificate shall be by an independent testing laboratory or licensed structural engineer. OSHPD certification may be substituted for independent certification, but must show on each component of the equipment with exact model number.

B. Deferred Submittals: Provide drawings and details showing sizes, types, and assemblies of all seismic bracing and anchoring in sufficient detail to submit to the authority having jurisdiction at the State of Utah. Include stamped and signed calculations from a professional structural engineer licensed in the State of Utah.

C. Product Data: Submit product data that illustrates and indicates type, styles, materials, strength rating, fastening provisions, and finish for each type and size of seismic restraint component used.

1. Anchor bolts and studs: Tabulate types and sizes, complete with report numbers and rated strength in tension and shear as evaluated by an independent agency.
2. Cable and wire rope assemblies: Tabulate types and sizes, complete with report numbers on rated strength in tension and shear as evaluated by an independent agency.
3. Details: Contractor shall provide details of assembly arrangement, including attachment to differing types of structures. Show attachment locations, methods, spacing’s, identifying components and listing their strengths. Indicate direction and value of forces (calculated or tested) transmitted to structure during seismic events.
4. The support seismic – restraint designs must be signed and sealed by a qualified professional structural engineer, licensed in the State of Utah, paid for by the contractor.

D. Coordination Drawings: Show coordination of seismic bracing of electrical components with other systems and equipment in the vicinity, including mechanical ductwork and piping. Show bridging elements to assure that all electrical components anchor to the structure, rather than into ductwork or piping supports.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Provide products of a quality manufacturer located within the continental North American market. Supports made in Europe, Asia, South America, Africa, or other overseas markets are not acceptable. The following manufacturer’s products may be incorporated into the work:

1. Amber/Booth Company, Inc.
2. B-Line Systems, a division of Cooper
3. Erico, Inc.

4. California Dynamics Corporation
5. Caldyn
6. Eaton B-Line
7. Embelton
8. Hilti, Inc.
9. Flexonics
10. Kinetics RQ
11. Loos&Co: Seismic Earthquake Division
12. Mason Industries
13. Tech Products
14. TOLCO Incorporated; a brand of NIBCO Inc
15. Unistrut; Tyco International, Ltd.
16. GS Metals Corp.
17. Powerstrut
18. Thomas and Betts Corp.
19. Vibro Acoustics
20. Vibrex

B. Substitutions: Equivalent manufacturers are allowed at contractor's option, no submittals or prior approvals are necessary if supports meet specifications and are detailed in the deferred submittal by the licensed structural engineer.

2.2 COMPONENTS:

A. Rigid Channel Support Systems: Shop or field fabricated assembly made of slotted steel channels with accessories for attachment to braced component at one end and to the building structure on the other end. Provide corrosion resistant coating.

B. Restraint Cables: ASTM A 603 galvanized steel cables with end connections made of thimbles, brackets, swivels, and bolts designed for restraining cable service, and with a minimum of two clamping bolts for cable engagement.

C. Hanging rod Stiffener: Steel tube or steel slotted channel support systems sleeve with internally bolted connections to hanger rod. Do not weld stiffeners to rods.

D. Bushings for Floor Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.

E. Bushing Assemblies for Wall Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices.

F. Resilient Isolation Washers and Bushings: One-piece, oil resistant, water resistant, molded neoprene, with a flat washer face.

2.3 ANCHOR BOLTS:

A. Mechanical Anchor: Drilled in and stud-wedge or female-wedge type in zinc-coated steel for interior applications. Provide Stainless steel for exterior applications. Select anchors with strength required for anchor and as tested in accordance with ASTM E 488. Minimum length shall be eight times the diameter.

B. Adhesive Anchors: Drilled in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injection polymer or hybrid mortar adhesive. Verify that Adhesive meets all LEED requirements. Provide anchor bolts in zinc-coated steel for interior applications. Provide stainless steel for exterior applications. Select anchors with strength required for anchor and as tested in accordance with ASTM E 488.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Install seismic restraints in accordance to applicable codes and regulations as approved by authorities having jurisdiction.

B. Examine structure for reinforcing and avoid structural reinforcing in concrete before drilling. Where depth and location is unknown, employ X-ray and/or radio frequency locating prior to drilling.

3.2 SUPPORT AND SEISMIC BRACING INSTALLATION:

A. Conduit racks and suspended conduits shall be adequately braced for Seismic Restraint, as required per ASCE 7-10, latest edition.

B. Install conduit racks with trapeze style hanging system, with stainless steel 3/8 inch all threads hanging down to a Galvanized steel strut assembly. Provide conduit clips to rigidly clip conduit to strut.

C. Provide a diagonal lateral seismic restraint braces at maximum 10 foot intervals (alternating directions), and a longitudinal brace (alternating directions) at maximum 30 foot intervals. Braces must be made of strut or similar rigid material, and will be tied directly to trapeze strut with hinges or rigid angles. Wire ties for bracing will not be acceptable. All hardware made for bracing shall be seismically rated.

D. If a large number of suspended conduit feeders (more than 12 each exceeding 2-1/2 inches in size) are grouped together, the contractor shall review the layout with the structural engineer, provide estimated weights, and obtain approval for the proposed layout.

E. Hanger rods shall be fastened to structure in an approved manner. Pullout resistance shall have a safety factor of 4.

F. Support individual suspended feeder conduits by metal ring or trapeze hangers with threaded steel rods.

3.7 COMMISSIONING AND FINAL INSPECTION:

A. Contractor shall provide a time for access and inspection of seismic support system for the Engineer, the Seismic Engineer they hired, and the Owner. Correct all defects and flaws found prior to ceiling installation and prior to cabling installation.

B. Demonstrate rigid seismic bracing to ensure minimal movement of the raceways on suspended racks in a seismic event. Demonstration shall be by pushing with at least 25 pounds force laterally and longitudinally at selected (mid-span) locations along the length of the suspended raceway rack. Rack shall not move more than two inches during these demonstrations.

END OF SECTION 26 05 48

SECTION 26 09 13 – ELECTRIC POWER MONITORING

PART 1 - GENERAL

1.1 WORK INCLUDED:

A. Provide a power metering/monitoring system including CT's, PT's, meters, communication equipment, and programming capable of a graphical presentation for metering/monitoring equipment in the facility.

1.2 QUALITY ASSURANCES:

A. Provide all components and accessories with UL listing.

1.3 SUBMITTALS:

A. Submit complete and descriptive product data indicating dimensions and compliance with specifications herein. Submit data on GUI, including screen prints of typical graphic screens showing how the graphic representation of the metered load is represented.

B. Submit shop drawings, including network wiring diagrams, showing interconnecting wiring between individual monitors and the BAS. Include all wiring required. BAS contractor to provide all programming for full operation and reporting of metered loads.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with all requirements, provide metering equipment from one of the following:

1. Square D
2. Siemens
3. General Electric

B. Requests for substitution of other products will be considered if submitted in accordance with the General Conditions, Division 1, and Section 26 05 00.

2.2 METERS LOCATED AT MAIN SWITCHBOARDS (SERVICE ENTRANCE):

A. Provide digital metering Square D Power Logic Circuit Monitor, Class 3000, Model CM-3350 with VFD Display, or equivalent, integrally mounted in service switchboard, completely wired with current transformers, potential transformers, control power transformer, and fusing. For new board on PH5, integrate the meter within the board. For existing board at PH9, place cabinet for meter on the outside of the switchboard, and

intercept new cables coming into the board for CT's. Where necessary for wiring space, place CT's in outside box near the ATS and meter inside next to the switchboard.

B. Provide meter with the following features:

1. Front panel features:

    a. LCD electronic display
    b. Kilo/Mega units LEDs
    c. Meter indication LEDs
    d. Setup/rest parameters
    e. Phase indication LEDs
    f. Phase select button
    g. Select meter buttons
    h. Mode indication LEDs
    i. Mode select button
    j. communications port

2. True RMS Metering
3. Accepts standard CT and PT inputs
4. 0.2% accuracy, current and voltage
5. Min/Max displays for metered data
6. On-board clock/calendar
7. RS-485 Communications standard
8. Setpoint controlled alarm/relay functions
9. On-board event and data logging
10. Waveform capture
11. High-speed, triggered 12-cycle event capture
12. Date/time for each Min/Max
13. Optional voltage/power module, where required, for direct connection to 480Y/277 V systems.
14. Non-volatile memory to retain demand readings during power bumps

C. Provide meter with instrumentation to displaying the following information:

1. Real-time readings:

    a. Current (per phase, N, G, 3 phase)
    b. Voltage (L-L, L-N).
    c. Real power (per phase, 3 phase)
    d. Reactive Power (per phase, 3 phase)
    e. Apparent power (per phase, 3 phase)
    f. power factor (per phase, 3 phase)
    g. Frequency
    h. THD (current and voltage)
    i. K-factor (per phase)

2. Demand Readings:

    a. Demand current (per-phase present, peak)
    b. Average power factor (3 phase total)
    c. Demand real power (3 phase total)
    d. Demand apparent power (3 phase total)

3. Energy Readings:

   a. Accumulated energy, real
   b. Accumulated energy, reactive

4. Power Analysis Values:

   a. Crest factor (per phase)
   b. K-factor demand (per phase)
   c. Displacement power factor (per phase, 3 phase)
   d. Fundamental voltages (per phase)
   e. Fundamental currents (per phase)
   f. Fundamental real power (per phase)
   g. Harmonic power
   h. Unbalance (current and voltage)
   i. Phase rotation

PART 3 – EXECUTION

3.1 INSTALLATION:

A. All cable routing shall be done in a neat and workmanlike manner consistent with recognized good practice and in accordance with the manufacturer's instructions.

B. The Contractor is responsible to have checked all plans and specifications for possible interference with other trades before installing System components, and to coordinate as required to provide an acceptable installation.

3.2 MANUFACTURER'S ASSISTANCE:

A. The System manufacturer shall provide the services of a trained "factory representative" to assist and instruct the electrical contractor in the proper installation of the components and system.

3.3 COMMISSIONING

A. Demonstrate metered data at each individual monitor, and at the central BAS system, indicating a properly working system. Include test data for current, voltage, and power measurements.

B. Provide owner training, by a trained factory expert, consisting of two independent sessions, minimum of 2 hours each session, demonstrating system programming and monitoring functions. Include all training time and travel expenses in original bid. The 2nd Owner training session shall be videotaped for future owner use.

C. All testing and training shall be performed in the presence of the owner and/or Engineer.

END OF SECTION

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SECTION 26 22 00 - TRANSFORMERS

PART 1 - GENERAL

1.1 WORK INCLUDED:

A. Provide all transformers as herein specified and shown on the Drawings.

1.2 SUBMITTALS:

A. Submit complete and descriptive shop drawings indicating dimensions and compliance with the specifications herein. Submit in accordance with the General Conditions, Division 01, and Section 26 05 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. ACME, Cutler Hammer, Federal Pacific, General Electric by ABB, Hammond Power Solutions, MGM Transformer Company, Siemens, Square D.

B. Requests for substitution of other products will be considered if submitted in accordance with the General Conditions, Division 01, and Section 26 05 00.

2.2 TRANSFORMERS – BASIC REQUIREMENTS:

A. KVA and voltage ratings shall be as specified on the Drawings.

B. Transformers of the size and type covered by U.L. Specification 506 shall be so labeled and listed. All transformers must be constructed and rated in accordance with all applicable ANSI, NEMA, and U.L. standards. Minimum 4% impedance.

C. Transformers 37-1/2 KVA three phase and larger shall incorporate a U.L. recognized Class 220 degree C insulating system. Transformer temperature rise shall not exceed 80 degree C. in a 40 degree C. ambient unless shown otherwise on the drawings.

D. Transformers 5 KVA and larger shall be capable of meeting the overload requirements of ANSI Standard C57.12.

E. Transformers 15 KVA and larger shall have NEMA standard taps.

F. Dry Type Transformers 15 KVA and larger shall meet the NEMA TP-1-2002 energy efficient standards and/or be Energy Star rated.

G. Sound levels shall be equal or lower than those established in ANSI Standard C89.2.

H. Transformers shall have copper windings.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Transformers shall be installed with special consideration given to the transmission of hum noise through structure or conduit system. Provide 1-1/2" neoprene vibration isolation dampers under each corner of transformer, equal to Mason Industries type “ND”.

B. Flexible conduit to be installed between the conduit system or panel and transformer. Provide slack in flex conduit to reduce noise and vibration transmission. This contractor shall be responsible for correction of excessive hum conditions.

C. Transformer taps are to be adjusted to the proper voltage after system is in operation.

D. Measure clearance from venting openings to wall and ensure compliance with manufacturers published requirements. Where published requirements are not available, ensure typical clearance is 6 inches minimum for transformers 225 KVA and less, and 12 inches for transformers 300 KVA and higher.

E. Anchor transformers to wall structure as calculated in section 26 05 48 Seismic Restraint for Electrical Work. Deferred submittals shall be approved prior to installing anchors.

F. Vacuum dirt and debris inside, around, and under the installed transformer. Do not used compressed air for cleaning. Wipe outside of transformer clean.

3.2 CONNECTIONS:

A. Ground equipment per NEC 250 and Division 26 section 26 05 26 Grounding and Bonding.

B. Tighten electrical connectors and terminals according to manufacturers published torque tightening values. If manufacturing torque values are not available, use the values specified in UL 468A and/or UL 468B.

3.3 LABELING:

A. Provide a permanent engraved label with a center white ply and outer black ply (black label with white lettering) for all transformers on the outside of the transformer enclosure including the following information:

1. Transformer Name
2. Source feeding the transformer and the load supplied equipment
3. Size (KVA), Primary Voltage, and Secondary voltage

3.4 TESTING:

A. Perform field tests and inspections and prepare testing reports. Engage a technician skilled in performance of transformer testing.

B. Perform visual and mechanical inspection and provide electrical test as stated in NETA Acceptance Testing Specification guidelines. Document compliance with test parameters.

C. Perform spot voltage measurement using typical building daytime running load of approximately 40-60% of transformer capacity. A combination of building load and load bank may be used for this test. Record actual load and output voltage for O&M manual. If voltage is below nominal value by at least 3%, adjust tap settings, and retest voltage. Note any adjustments made in O&M test report.

D. All current carrying devices and terminations within this section shall be inspected by performing a thermographic survey with normal load conditions applied to the system.

E. Inspect distribution systems with thermal imaging equipment capable of detecting a minimum temperature difference of 1° C at 30° C.

E. Equipment shall detect emitted radiation and convert it to a visual signal.

F. Perform thermographic survey during periods of maximum possible loading. Provide a load bank to load the transformer to the maximum recommended capacity.

G. Perform actions to correct any and all deficiencies.

H. Provide a certified report including the following:
1.
2. Equipment to be tested
3. Any and all discrepancies
4. Temperature difference between concern area and reference area
5. Probable cause of temperature difference
6. Areas inspected, any areas and equipment which are unobservable
7. Actual load conditions at time of inspection
8. Provide photographs and thermograms of the deficient area
9. Action to correct deficiencies

END OF SECTION

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SECTION 26 24 13 – SWITCHBOARDS 600 VOLTS & BELOW

PART 1 - GENERAL

1.1 WORK INCLUDED:

A. Furnish and install the service entrance switchboard and distribution switchboards as herein specified and shown on the associated electrical drawings.

1.2 SUBMITTALS:

A. Submit complete descriptive shop drawings indicating bus arrangement, overcurrent devices, labeling, dimensions, ratings and other pertinent data.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Square D, General Electric, Siemens, Cutler-Hammer/Westinghouse

B. Requests for substitution of other products will be considered if submitted in accordance with the General Conditions, Division 1, and Section 26 05 00.

2.2 EQUIPMENT:

A. Each distribution board section shall be free standing and have an open bottom. Top and bottom conduit area is to be clearly shown and dimensioned on the shop drawings. All front plates used for mounting meters, selector switches or other front mounted devices shall be hinged with all wiring installed and laced with flexibility at the hinged side. All closure plates shall be screw removable and small enough for easy handling by one man. The paint finish shall be gray enamel over a rust-inhibiting phosphate primer.

B. Overcurrent devices shall be of size and type as indicated on the drawings. Series rated equipment will not be permitted as a substitute for the interrupting capacities stated on the one line diagram.

C. Main lugs shall be tool applied compression type if aluminum wire is used. The bus bars shall be rigidly braced for 100,000 amps and sized as indicated on the drawings.

D. The bus bars shall be Copper only.

E. Operating handles shall be mounted on the unit doors and interlocked with the overcurrent device to prevent opening of the door when the switch is "ON". A concealed "defeater" shall be provided so that authorized personnel may open door without interrupting power.

F. All extra space in distribution boards shall be bussed for future use.

G. Prior to bidding, confirm that equipment will fit within the physical space allocated on the drawings for switchgear. Do not attempt to use equipment which does not fit within the space allotted. Do not use space identified for future use.

H. Provide ground-fault protection integral with each circuit breaker rated 1000 amps or more and operating above 150 volts phase-to-ground but below 600 volts phase-to-phase regardless of what is shown on the drawings.

2.3 PROTECTIVE DEVICE TIME-CURRENT AND ARC FLASH COORDINATION ANALYSIS

A. The electrical equipment manufacturer shall perform protective device time-current coordination analysis of the specified electrical power distribution system. This analysis shall include:
   1. A determination of settings, ratings, or types for the overcurrent protective devices supplied. Where necessary, an appropriate compromise shall be made between system protection and service continuity with system protection and service continuity considered to be of equal importance. The time-current coordination analysis shall be performed with the aid of computer.
   2. Computer generated log-log plots containing the time-current characteristics of series connected overcurrent devices. A sufficient number of log-log plots shall be provided to indicate the degree of system protection and coordination. The log-lot plots shall include transformer ANSI withstand points and inrush currents of transformers where appropriate.
   3. Computer printouts to accompany the log-log plots containing descriptions for each of the devices shown on the plot, setting of the adjustable devices, device numbers to simplify location of the devices on the system one-line diagram, and short-circuit currents where known.
   4. A tabular computer printout of the suggested settings of the adjustable overcurrent protective devices, the equipment where the device is located, the device number corresponding to the device on the system one-line, diagram, and the number of the time-current log-log graphs where they are illustrated.
   5. A computer generated system one-line diagram clearly identifying individual equipment basics, the bus numbers, the device numbers, and the maximum available short-circuit current at each bus which shall include short-circuit current motor contribution.
   6. A discussion section evaluating the degree of system protection and service continuity with overcurrent devices, with recommendations as required for increased protection or coordination.
   7. Any inadequacies shall be called to the attention of the Architect, and recommendations made for improvements.
   8. Provide Six (6) bound copies of the completed protective device time-current coordination analysis for the Architect.
   9. Provide ARC FLASH stickers and apply to all equipment.
   10. Electrical distribution equipment SHALL NOT BE RELEASED FOR MANUFACTURING until AFTER the Analysis has bee reviewed by the Engineer. If the Contractor fails to abide by this requirement, the Contractor will be responsible for the cost of any and all required changes to the distribution equipment resulting from findings within the Analysis.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Distribution boards shall be free from surface and finish defects, and cleaned of dust and construction debris.

B. All nameplates, labels, screws, bolts, or other hardware shall be in place prior to acceptance.

C. Prior to installation of switchgear and transformers, layout the electrical rooms and obtain approval of the layout from the code authority having jurisdiction.

D. Switchboards shall not be installed under piping or ductwork. Meet all requirements of NEC article 110 for Dedicated Electrical Space and Working space about equipment.

3.2 LABELING:

A. Where changes are made in existing switchboards, distribution boards, etc., provide new labeling and schedules to accurately reflect the changes; hand written revisions will not be acceptable.

B. Provide an engraved permanent master nameplate at the main distribution to identify the project, the Engineer and the date.

C. Provide engraved nameplate for all switchboards permanently mounted on the outside face of switchboard; include the following minimum information:

1. Text stating “Main Building Disconnect” (if applicable)
2. Switchboard name
3. Source feeding switchboard
4. Voltage, Size (amps), number of phases, number of wires, and AIC rating
5. Arc Flash sticker showing incident energy and calories for PPE

D. Provide engraved nameplates to clearly label each switchboard breaker to identify each load served, each spare breaker, and each space (size in amps and phase).

E. Engraved nameplates shall be have a black back ply, an inner white ply with outer colored ply as follows: Black for normal power, Red for Emergency (Legally Required or Optional Standby) power, Orange for UPS power.

F. Provide a permanent engraved label indicating the conductor insulation color for: (1) all ungrounded conductors (2) grounded conductor (3) equipment grounding conductor. This shall be documented at each switchboard in a readily visible location; refer to Wires and Cables Section 26 05 19 for conductor color coding.

3.3 PERFORMANCE TESTING:

A. Provide ground-fault protection system testing prior to Owner’s acceptance and provide written record of testing and proper operation to the A/E team, Owner and Authority Having Jurisdiction (AHJ). Ground-fault protection system testing shall be done in accordance with the manufacturer’s instructions.

B. Verify that all overcurrent device settings match the recommended settings defined in the time current coordination analysis report and provide written proof that the overcurrent devices have been set properly. Fix any improperly set overcurrent devices prior to acceptance and written proof of correct setting.

C. All current carrying devices within this section shall be inspected by performing a thermographic survey with normal load conditions applied to the system.

D. Inspect distribution systems with thermal imaging equipment capable of detecting a minimum temperature difference of 1° C at 30° C.

E. Equipment shall detect emitted radiation and convert it to a visual signal.

F. Perform thermographic survey during periods of maximum possible loading.

G. Perform actions to correct any and all deficiencies.

H. Provide a certified report including the following:

1. Equipment to be tested
2. Any and all discrepancies
3. Temperature difference between concern area and reference area
4. Probable cause of temperature difference
5. Areas inspected, any areas and equipment which are unobservable
6. Actual load conditions at time of inspection
7. Provide photographs and thermograms of the deficient area Action to correct deficiencies

END OF SECTION

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 WORK INCLUDED:

A. Provide all branch circuit panelboards as herein specified and shown on the drawings.

1.2 SUBMITTALS:

A. Submit complete and descriptive shop drawings indicating dimensions and compliance with the specifications herein. Submit in accordance with the General Conditions, Division 01, and Section 26 05 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Breaker Panels: Square D, Siemens, General Electric by ABB, Cutler-Hammer/Westinghouse,

B. Requests for substitution of other products will be considered if submitted in accordance with the General Conditions, Division 01, and Section 26 05 00.

2.2 EQUIPMENT:

A. Panels shall be factory pre-assembled using bolt-on circuit breakers, equivalent to Square D NQOD series. Separate feeder lugs shall be provided for each feeder conductor.

B. Breakers in branch panelboards shall be not less than 3/4 inch on centers. Each breaker shall be securely fastened to prevent movement and trims shall fit neatly and tightly to the breaker assembly. Two and three pole breakers shall be single breaker assembly rather than two or three single pole breakers with the handles tied together externally.

C. Panel finish shall be a flat, light gray finish suitable for painting over or being left with factory finish. Trims to be separately packed and protected from scratching and marring. Refer to labeling requirements in 26 05 00 Basic Materials and Methods.

D. Panel covers to be “Door in Door” or “Hinged Trim Front” style to permit authorized personnel to open the outer door and have access to the entire interior of the can. The inner door shall access only the breaker handles. Provide flush stainless steel cylinder lock with catch and coil spring loaded door pull. All panels shall be keyed alike, but inner and outer doors shall not be keyed alike.

E. Where grounding conductors are shown or specified, provide each panel and distribution center with grounding bus to which the grounding conductors shall be connected, each having its own terminal or lug.

F. Panelboards rated 400 amps or less shall not exceed 6" depth.

G. Provide Fully rated equipment greater than or equal to the interrupting capacities indicated on the drawings.

H. Provide all copper bus bars, 100% rated neutral bus, ground bus and isolated ground bus where indicated. Lugs shall be rated for copper only, CU-AL rated lugs shall be allowed.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Breaker handle guards shall be provided on each circuit supplying obviously constant loads to prevent accidental shutting off. Such loads are freeze protection, etc.

B. Group the ungrounded and grounded conductors for multiwire branch circuits in at least one location inside the panelboard with wire ties or similar means per NEC 210.4 (D).

3.2 LABELING:

A. No brand labels or other marking shall be on the outside of the panels. Where changes are made in existing panels, distribution boards, etc., provide new labeling and schedules to accurately reflect the changes; hand written revisions will not be acceptable.

B. Provide engraved nameplate for all panelboards permanently mounted inside door for flush panels and on the outside face of the door for surface panels; include the following minimum information:

1. Text stating “Main Building Disconnect” (if applicable)
2. Panelboard name
3. Source feeding panel
4. Voltage, Size (amps), number of phases, number of wires, and AIC rating

C. Engraved nameplates shall be have a black back ply, an inner white ply with outer colored ply as follows: Black for normal power, Red for Emergency (Legally Required or Optional Standby) power.

D. Provide typewritten branch panel schedules with protective clear, transparent covers accounting for every breaker installed. Use actual room designations assigned by name or number near completion of the work, and not the designations shown on drawings.

E. Provide a permanent engraved label or include with the panel schedule information indicating the conductor insulation color for: (1) all ungrounded conductors (2) grounded conductor (3) equipment grounding conductor. This shall be documented at each panelboard in a readily visible location; refer to Wires and Cables Section 26 05 19 for conductor color coding.

3.3 PERFORMANCE TESTING:

A. All current carrying devices and terminations within this section shall be inspected by performing a thermographic survey with normal load conditions applied to the system.

B. Inspect distribution systems with thermal imaging equipment capable of detecting a minimum temperature difference of 1° C at 30° C.

C. Equipment shall detect emitted radiation and convert it to a visual signal.

D. Perform thermographic survey during periods of maximum possible loading.

E. Perform actions to correct any and all deficiencies.

F. Provide a certified report including the following:

1. Equipment to be tested
2. Any and all discrepancies
3. Temperature difference between concern area and reference area
4. Probable cause of temperature difference
5. Areas inspected, any areas and equipment which are unobservable
6. Actual load conditions at time of inspection
7. Provide photographs and thermograms of the deficient area
8. Action to correct deficiencies

G. Re-test all areas with deficiencies that have been adjusted to verify acceptable temperature differences.

END OF SECTION

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SECTION 26 27 26 – WIRING DEVICES

PART 1 - GENERAL

1.1 WORK INCLUDED:

A. Provide all switches, receptacles, and other devices as herein specified and shown on the associated drawings.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Bryant, Arrow-Hart, Eagle, LeGrand, General Electric, Leviton, Hubbell are acceptable.

2.2 MATERIALS:

A. The following list of wiring devices covers the most commonly specified items and establishes the grade of device. Should the Drawings indicate a device other than those listed herein without reference to catalog number, such device shall be of the same grade and manufacturer as like devices.

Single Pole Switches	Hubbell #1221
Duplex Receptacles - 20 amp	Hubbell #5362
GFCI Receptacles – 20 amp	Hubbell

B. All wiring devices and plates to be specification grade. Receptacles shall be mounted vertically with the ground pin down unless otherwise noted.

C. Color of devices and plates to be selected by Engineer. Provide galvanized steel plates. Receptacles fed by emergency circuits shall have red devices with "EMERGENCY POWER" label with panel and circuit designation on plate.

D. Wet location and/or weatherproof receptacles shall be in a weatherproof enclosure, the integrity of which is not affected when the receptacle is in use (attachment plug cap inserted), UL labeled and listed “Suitable For Wet Locations While In Use”. Provide enclosure with stainless steel screws, gasket between enclosure and mounting surface and between cover and base, clear impact resistant UV stabilized polycarbonate as manufactured by TayMac Corporation or accepted equivalent.

E. Receptacles installed outdoors in a wet/damp location shall be listed weather-resistant type.

PART 3 - EXECUTION

3.1 GENERAL:

A. Coordination with General Contractor and Other Trades:

1. Take steps to insure that devices and their boxes are protected. Keep outlet boxes free of mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables. Clean before device and coverplate installation.
2. Install wiring devices after all wall preparation, including painting, is complete.

B. Provide a separate GFI type receptacle for each receptacle noted on plans as GFI. Standard receptacles fed from an up-steam GFI type receptacle are not acceptable.

C. Install outlets and switches in a neat manner with plates covering all gaps between box and adjacent wall surface.

D. Faceplates, devices, and boxes shall be square with floor, and door lines. Outlet plates of adjacent outlets shall be vertically aligned to within 1/16 inch.

E. Bond ground terminal of each receptacles to equipment ground conductor, and provide green bonding jumper to box grounding screw when used with metal boxes in dry wall type construction.

F. Devices to be installed flush with faceplate. Do not overtighten or warp the coverplate.

3.2 DEVICE INSTALLATION:

A. Replace all devices that have been in temporary use during construction or that show signs of where or damage, that they were installed before building finishing operations were complete.

B. Keep each wiring device in its package or otherwise protected until it is time to install and connect conductors.

C. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.

D. Provide pigtails to connect building branch circuits to devices using pigtails that are not less than 6 inches in length.

E. Side wiring to binding-head screw is the required method of termination when available. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw and torque as recommended by the manufacturer.

F. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.

G. Tighten unused terminal screws on the device to minimize risk of accidental shock.

H. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

I.

J. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

K. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening

3.3 LABELING:

A. Provide self-adhesive labels for all switches and receptacles in compliance with Part 3.3 of Section 26 05 00.

B. Where switches control remote lighting or power outlets, or where switches in the same outlet (two or more) serve different purposes, such as light, power, intercom, etc. or different areas, such as corridor and outside, provide self-adhesive labels clearly indicating the function of each switch or outlet.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or plug in device with illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:

1. Using the test plug of the testing instrument, verify that the device and its outlet box are securely mounted.
2. Test 100 percent of installed receptacles with instrument or testing device and write down results for O&M manuals. The tests shall be diagnostic, indicating potential damaged or misconnected conductors, poor connections, inadequate ground current path, defective devices, or similar problems.
3. Line Voltage: Where testing instrument or device indicates problems, test the actual voltage to the device. Acceptable range is 107 to 127 V.
4. Ground Impedance: Where test instrument or device shows ground issues, test the value of ground resistance. Values of up to 5 ohms are acceptable.
5. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
6. Where specified, test Arc fault receptacles and circuits for proper operation.

C. Correct circuit conditions after testing, remove malfunctioning units and replace with new ones, and retest as specified above.

D. Provide device testing report in O&M manuals. Indicate pass/fail results and actual values before and after corrections.

END OF SECTION

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SECTION 26 29 00 – MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 WORK INCLUDED:

A. Extent of motor controller and starter work is indicated by drawings, schedules and specified herein.

B. Work includes the complete installation, electrical connections, testing, and commissioning of starters and combination disconnect/starters.

C. Verify compatibility of motor controllers and starters with motors supplied under Division 22 and 23. Review Division 22 and 23 specifications, plans, schedules, etc., to issue compatibility.

1.2 QUALITY ASSURANCE:

A. Comply with NEC, and NEMA Standards as applicable to wiring methods, construction and installation of motor controllers, starters, and combination disconnects/starters. Provide complete packaged units which have been UL-listed and labeled by Underwriters Laboratory or ETL Testing Laboratories, Inc. Note: The entire unit shall carry the label, not just components.

1.3 SUBMITTALS:

A. Submit complete and descriptive shop drawings indicating dimensions and compliance with the specifications herein. Submit manufacturer's installation instructions under provisions of general conditions.

B. Submit dimensions of all units.

C. Equipment list and ratings: list motors to be controlled, with motor identification, function and location, starter characteristics, size, voltage, phase and current ratings, control equipment and accessories as specified, scheduled or noted.

D. Coordinate all motor starter sizes and requirements with Division 22 and 23 Contractor prior to submittal for approval.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. COMBINATION STARTER/DISCONNECTS – STAND ALONE UNITS: Subject to compliance with requirements, provide products manufactured by one of the following:

1. Square D
2. GE by ABB
3. Siemens
4. Cutler Hammer

2.2 COMBINATION STARTERS

A. Starters: combination type with fused disconnect switch with time delay dual element, 3 pole, UL Class RK-5 fuses as scheduled; full voltage, non-reversing magnetic starter unless otherwise shown or noted. Provide quick make, quick break disconnect. Starters shall have electronic resettable thermal overload elements for all three phases with settings sized for the actual final motor nameplate full load current. Minimum starter size shall be NEMA 1. For sizes 4 and above, provide electronic soft start system starter.

2.3 STARTERS

A. Each magnetic starter shall include:

1. Hand-Off-Automatic selector switch unless otherwise shown or noted. HOA switch to be of a type that is field convertible to "On/Off" or "Auto/Off".
2. A thermal element reset button.
3. A red transformer type pilot light to indicate when the motor is running.
4. A 120V holding coil.
5. A 480/120V control transformer with primary and secondary fuse protection; of sufficient VA to handle the holding coil and associated controls. One leg of the transformer secondary shall be grounded.
6. Two normally open and two normally closed auxiliary contacts.
7. A nameplate engraved with motor identification and Horsepower, Nameplate, HOA switch, reset button and pilot light shall be mounted in cubicle door. A door mounted keypad display with indicators, allowing user to program

B. Each fractional HP manual starter shall include:

1. The manual starter shall be single phase 1 or 2 pole fractional horsepower motor starter rated 300 volts. Provide thermal overload relays with adjustable overload heater rating.
2. Provide green pilot light and a lock off toggle operated handle.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Motor Controllers and Starters shall be installed level, plumb and anchored to the mounting surface in accordance with the manufacturer's instructions. The equipment shall be protected if stored during construction.

B. Seismic restraints: Provide anchor bolts, angle irons and fasteners to attach the combination starters rigidly to the building structure per IBC seismic requirements.

C. Inspect operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.

D. Touch-up scratched or marred surfaces to match original finish.

E. Clean interiors of motor controllers and starters prior to energization.

3.2 LABELING:

A. Where changes are made to existing motor controllers, provide new labeling to accurately reflect the changes; hand written revisions will not be acceptable.

B. Provide engraved nameplate for all motor controllers mounted on the outside face of the Controller; include the following minimum information:

1. Name of Motor or Equipment Controlled
2. Source feeding Motor Controller
3. Voltage, NEMA starter size, number of phases
4. Disconnect size in amps (where applicable), fuse size in amps (where applicable)

C. Engraved nameplates shall be have a black back ply, an inner white ply with outer colored ply as follows: Black for normal power, Red for Emergency (Legally Required or Optional Standby) power.

3.3 TESTING:

A. When all motors are connected and the pre-energizing tests have been completed, the contractor shall operate the equipment to demonstrate that all control equipment and overcurrent protective devices perform as specified. Any deficiencies found shall be corrected and tests repeated. All test results and dates shall be recorded and submitted to the Engineer and the Owner's Representative with statement certifying that the equipment is safe and ready for use.

END OF SECTION

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SECTION 26 29 23 – VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 WORK INCLUDED:

A. Extent of adjustable speed motor controller work is indicated by drawings, schedules and specified herein.

B. Work includes the complete installation, electrical connections, testing, and commissioning of Adjustable Speed Drive (ASD) Systems.

C. Verify compatibility of ASD with motors supplied under Division 22 and 23. Review Division 22 and 23 specifications, plans, schedules, etc., to issue compatibility.

D. ASD harmonic mitigation shall be included as part of the drive package.

1.2 QUALITY ASSURANCE:

A. Comply with the following codes and standards as applicable to wiring methods, construction and installation of variable frequency drives:

1. NEC (NFPA 70) – National Electric Code
2. ANSI/NEMA ICS 6 – Enclosures for Industrial Controls and Systems
3. NEMA AB 1 – Molded Case Circuit Breakers
4. NEMA ICS 2 – Industrial Control Devices, Controllers, and Assemblies
5. IEEE Standard 519-1992 – Recommended Practices for Harmonic Control in Electrical Power Systems
6. ANSI C37 – Standards for Circuit Breakers, Switchgear, Relays, Substations and Fuses
7. ANSI C57 – Distribution, Power, and Regulating Transformers. (Includes Reactors)
8. Drive Manufacturer must be an ISO-9001 certified facility; manufacturing all products to ISO-9001 quality standards.

B. Comply with applicable requirements of UL 508, "Power Conversion Equipment". Provide complete packaged units which have been UL-listed and labeled by Underwriters Laboratory or ETL Testing Laboratories, Inc. Note: The entire unit shall carry the label, not just components.

1.3 SUBMITTALS:

A. Submit complete and descriptive shop drawings indicating dimensions and compliance with the specifications herein. Submit manufacturer's installation instructions under provisions of Division 01.

B. Submit qualifications and name of engineering and technical support personel responsible for support, testing, and warranty for this project.

C. Submit front elevation, plan and section drawings; include wiring diagrams. Include conduit entry and exit dimensions.

D. Equipment list and ratings: list motors to be controlled, with motor identification, function and location, starter characteristics, size, voltage, phase and current ratings, control equipment and accessories as specified, scheduled or noted.

E. Submit detailed information on filtering equipment, with sample graphs and data that shows the equipment will meet specified limits for voltage and current distortion.

F. Coordinate all motor starter sizes and requirements with Division 22 and 23 Contractor prior to submittal for approval.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. ASD VENDORS/MANUFACTURERS: Subject to compliance with requirements, provide products manufactured by and supplied by one of the following vendors:

ASD LOCAL VENDOR	ASD MANUFACTURER
Midgley-Huber	ABB

B. ASD LOCAL VENDOR REQUIREMENTS:

1. Must be actively engaged in manufacturing and supplying pulse width modulated adjustable speed (variable frequency) drives and custom built up systems, and must have a minimum of two years of experience in supply and manufacture.
2. Must maintain full time service personal on call 24 hours/day as well as authorized parts and service facilities within 250 miles of the project with demonstrated record of service for at least the last two years.
3. Must have UL 508C or ETL certification if project requires "built-up" assemblies which are not "factory-standard" products.

2.2 PRIOR APPROVAL TO BID

A. Vendors requesting approval by addendum must meet the above minimum requirements, and submit prior to 10 calendar days of the bid. Only vendors listed, or approved in writing by addendum, are approved to bid the project.

B. Alternative vendors must provide products that meet a narrow profile to allow installation in a narrow, confined wall space.

2.3 SYSTEM DESCRIPTION

A. The ASD system shall be supplied as a complete, pre-integrated, stand-alone package produced by a single manufacturer regularly engaged in the production of same and who maintains full system support responsibility.

1. The ASD system manufacturer shall integrate all components and equipment required to meet these specification features and functions as a single UL (or equivalent) labeled system. Vendors providing equipment requiring panel shop or job site modifications or additions that would not be valid under the original equipment manufacturer's (OEM's) safety labeling will not be acceptable.
2. Pre-integrated equipment shall include but not be limited to rectifier units, inverter units, control circuitry, operator interfaces, protective equipment, and other

accessories and auxiliary items necessary to meet the highest standards for the type of service specified herein.

2.4 CONSTRUCTION

A. SPACE and ENVIRONMENT:

1. All ASD system components shall be housed in a grounded, dead front, free-standing or wall mounted, narrow profile NEMA 1 enclosure. The ASD system size shall not exceed the size allotments specified on the drawings nor shall any portion of the system exceed a height of 90 inches. Entry shall be provided for incoming line and load cables as required or as shown on the drawings.
2. ASD systems mounted indoors shall be properly ventilated and sized to operate continuously at the job site elevation in an ambient environment of 0^{O}C to 40^{O}C, 0-90% RH.
3. The narrow profile shall fit in the confined wall space available on the site.

B. SUPPLY POWER:

1. All components of the ASD system shall be selected to operate continuously without any system trip or damage based on the nominal power specifications and requirements shown on the drawings or schedules. The above conditions must be maintained under the following expected variations:

    a. Plus or minus 10% voltage fluctuation.
    b. Plus or minus 3% frequency variation (5% if served by a back-up generator).
    c. Distorted voltage waveform with up to 7% total voltage harmonic distortion.

2. The ASD system shall employ voltage sag ride-through coordination under normal operating (average load) conditions to prevent nuisance trips with the following utility interruptions (based on preliminary IEEE working group P1346 data):

    a. 0% voltage for 1 cycle.
    b. 60% voltage for 10 cycles.
    c. 87% voltage continuous.

C. DEVICES and WIRING:

1. The ASD system shall employ door mounted industrial control operator devices, programming unit, and other devices per the layout shown on the drawings and as required to meet all functional and feature requirements of this specification. Operator pilot lights, switches and pushbuttons (if required) shall be industrial oil tight industry standard devices.
2. Control voltages shall be 120 volts or less supplied by machine tool type transformers employing both primary and secondary fusing. ASD control transformer VA sizes shall be increased by 10% or as necessary to accommodate external impedances when plans show connections to external safety interlocks or other control devices.
3. The ASD system factory wiring shall be permanently marked with hot emboss stamping or an equivalent marking system. All devices shall be labeled and identified with correct setting selections. All component identification and wiring shall be documented in the operation and maintenance manual.

D. LOAD:

1. The ASD system shall be capable of starting and continuously driving the specified maximum motor load as identified on the drawings and schedules.
2. ASDs driving variable torque loads shall be programmed to optimize load patterns which maximize system efficiency and minimize motor heating and stresses. ASDs driving constant torque or other loads shall be programmed to optimize load patterns for system or process performance as required.
3. All ASD systems shall have an overload capacity of a minimum of 110% for one minute.

E. EFFICIENCY and POWER FACTOR:

1. The ASD solid state converter and inverter power switching components and control shall be selected to achieve a 95% efficiency or better at full load and speed. Other auxiliary devices required on the drawings or in these specifications including filters, line reactors, cooling or heating devices etc. shall be of a design to optimize efficiency as intended under this specification.
2. The entire true system power factor (as measured at the input to the ASD system) shall be 95% or better across the operational speed range. Power factor that becomes leading under light load conditions (due to PF correction) is acceptable only if voltage rise is prevented from backfeeding to the rest of the system (meaning PF correction must act like a synchronous condenser). The voltage tolerance at the main ASD system input terminals (as specified in section 2.03 B1a.) shall not be compromised as a result of power factor correction techniques.

F. PROTECTION:

1. Short circuit protection shall be provided to the ASD system through an externally operated, door interlocked fused disconnect, circuit breaker or motor circuit protector (MCP) rated at 65,000 AIC minimum. The door interlocked handle must be capable of being locked off to meet NEC.
2. Overcurrent protection shall be provided in the ASD system through electronic motor overload (MOL) circuits with instantaneous trip, inverse time trip, and current limit functions. These shall be adjustable and optimized for the application.
3. In addition to the overcurrent protection above, the ASD system shall provide over and under voltage protection, overtemperature protection, ground fault protection, and control or microprocessor fault protection. These protective circuits shall cause an orderly shutdown of the ASD, provide indication of the fault condition, and require a manual reset (except undervoltage) before restart. Undervoltage from a power loss shall be set to automatically restart after return to normal. The history of the previous three faults shall remain in memory for future review.
4. External protective faults including safeties or motor overtemperature may be interfaced to the ASD system and annunciated if shown on the drawings.
5. Provide surge suppressors for the line side conductors feeding each variable frequency drive. Locate surge suppressors inside the built up drive enclosure.

G. SYSTEM CONTROLS and INTERFACE TERMINATIONS:

1. Provide appropriate integrated transducers, controllers, sequencers, bypass methods, filters and communication interfaces to match and mate with the mechanical equipment. Such devices shall be completely pre-integrated requiring the contractor to make only the typical field connections required as customer connections.
2. The ASD system customer terminations shall be clearly identified with terminal numbers and a permanent wiring diagram located in the ASD system enclosure.

2.5 FEATURES

A. The following operator control and indication features shall be provided standard as part of each ASD system:

1. Hand-Off-Auto (local start at ASD, remote start with contact closure).
2. Local-Remote speed control (local speed control at ASD, remote speed control through speed reference signal).
3. Frequency (speed) indication.
4. Motor voltage indication.
5. Motor current indication.
6. ASD run indication.
7. ASD fault and diagnostic indication.
8. Maintenance Bypass Circuit Selector.

B. The following customer connections and interface terminations shall be provided standard as part of each ASD system:

1. ASD remote start/stop connection.
2. External safeties connection.
3. ASD run annunciation.
4. ASD fault annunciation.
5. ASD speed reference input connection (4-20mA or as shown on drawings).

C. The following parameter adjustments shall be available to tune the ASD system:

1. Minimum and maximum speeds.
2. Acceleration and deceleration times.
3. Overcurrent trip point.
4. Current limit response to overload.
5. Maximum base motor voltage.
6. Input speed reference signal gain and bias.
7. Output speed reference signal gain and bias.

D. The ASD shall be capable of starting into a rotating motor at any speed.

E. The ASD shall auto restart after a power failure.

F. For maintenance purposes, the ASD system shall be capable of starting, stopping, and running with stable operation with the motor completely disconnected (no load).

2.6 QUALITY ASSURANCE

A. The ASD system manufacturer shall have a quality assurance program acceptable to the engineer.

B. Prior to shipping any equipment, the manufacturer shall individually test and certify each unit to document compliance. This certification report shall be submitted as part of the operation and maintenance manual and include the following minimum testing:

1. A visual inspection shall be made consisting of all system components, wiring connections, and safety mechanisms.
2. High pot testing shall be conducted on the completed ASD system including all accessory power components as a complete package. This test shall be conducted per

UL 508 (two times the rated voltage plus 1000 volts AC for 60 seconds) using regularly calibrated high pot test equipment.

3. A system run test shall be conducted using an actual motor accelerated and decelerated through the entire speed range.
4. All control panel devices, including switches, pilot lamps, keypad and special control devices shall be functional tested.
5. Special tests shown on the drawings or schedules or as later required by the engineer to demonstrate compliance with any specification herein shall be conducted upon request (either witnessed or not) at no additional cost.

2.7 HARMONIC DISTORTION FOR MOTORS

A. Harmonic Control in Electrical Power Systems shall be a requirement of this project. Harmonic filters (passive or active), phase multiplication devices, or any other components required to mitigate harmonic voltage THD to 5% and current THD to 15% maximum levels shall be an integral part of the ASD system. Designs which are not pre-integrated and factory wired as part of the UL (or equal) labeled ASD system shall not be acceptable under this specification.

1. Designs which employ shunt tuned filters must be designed to prevent the importation of outside harmonics which could cause system resonance or filter failure. Calculations supporting the design, including a system harmonic flow analysis, must be provided as part of shunt tuned filter design documentation.
2. Designs which cause voltage rise at the ASD terminals must document compliance with the total system voltage variation of plus or minus 10%.

B. Designs which do not provide both true and displacement power factor (measured at the ASD system input terminals) of at least 95% or better at full load are not acceptable. Designs that allow leading power factor at minimum loads to create voltage rise on the line side of the ASD system are not acceptable.

C. Documentation of Power Quality compliance shall be part of the performance testing required by the ASD supplier. Actual job site measurement testing shall be conducted at one half and full load and documented in the operation and maintenance manuals. Reports shall include the following data:

1. Data (text and graphical) shall be supplied showing voltage and current waveforms, THD (or TDD) and individual harmonic spectrum analysis in compliance with the above standards.
2. Power quality reports including true and displacement power factor, and voltage and current imbalance reports shall also be supplied.

D. All ASD suppliers shall obtain pre-approval based on satisfactory completion of previous ASD projects meeting the above requirements. Pre-approval requests to bid shall include calculations, test reports and other sufficient data to show the owner/engineer how compliance to Power Quality requirements have been met on previous projects and how compliance will be accomplished on this project.

2.8 HARMONIC DISTORTION FOR MOTORS 50 HP AND LARGER:

A. Provide a minimum of 12 pulse type ASD. Harmonic Control in Electrical Power Systems shall be a requirement of this project. Harmonic filters (passive or active), phase multiplication devices, or any other components required to mitigate harmonic individual frequency voltage THD to 3% of the fundamental, system voltage THD to 3%, and current THD to 12% maximum levels shall be an additional add on part of the ASD system in a separate wall cabinet located above the VFD.

1. Designs which employ shunt tuned filters must be designed to prevent the importation of outside harmonics which could cause system resonance or filter failure. Calculations supporting the design, including a system harmonic flow analysis, must be provided as part of shunt tuned filter design documentation.
2. Designs which cause voltage rise at the ASD terminals must document compliance with the total system voltage variation of plus or minus 10%.
3. The harmonic filter cabinet shall be controlled with an automatic contactor so that it will only be powered on and active when the drive is on and running. When the motor is not running the filter shall be shut off with the contactor. Provide all interconnecting wiring to ensure that this requirement is provided.

B. Designs which do not provide both true and displacement power factor (measured at the ASD system input terminals) of at least 95% or better at full load are not acceptable. Designs that allow leading power factor at minimum loads to create voltage rise on the line side of the ASD system are not acceptable.

C. Documentation of Power Quality compliance shall be part of the commissioning required by the ASD supplier. Actual job site measurement testing shall be conducted at one half and full load and documented in the operation and maintenance manuals. Reports shall include the following data:

1. Data (text and graphical) shall be supplied showing voltage and current waveforms, THD (or TDD) and individual harmonic spectrum analysis in compliance with the above standards.
2. Power quality reports including true and displacement power factor, and voltage and current imbalance reports shall also be supplied.

D. All ASD suppliers shall obtain pre-approval based on satisfactory completion of previous ASD projects meeting the above requirements. Pre-approval requests to bid shall include calculations, test reports and other sufficient data to show the owner/engineer how compliance to Power Quality requirements have been met on previous projects and how compliance will be accomplished on this project.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. ASD’s shall be installed level, plumb and anchored to the mounting surface in accordance with the manufacturer's instructions. The equipment shall be protected if stored during construction.

B. Seismic restraints: Provide anchor bolts, angle irons and fasteners to attach the ASD’s rigidly to the building structure per IBC seismic requirements.

C. The ASD system equipment shall be installed and tested under the direction of factory trained personnel. The installation shall be certified by the local vendor.

D. Properly sized overload elements, fuses, circuit breakers, etc. shall be installed and verified by the electrical contractor for actual motor and circuit protection and documented.

E. Required interlock wiring and connections between the ASD system, motor disconnect switches (if required) and safety devices shall be the responsibility of the electrical contractor.

3.2 LABELING:

A. Where changes are made to existing ASD's (VFD's), provide new labeling to accurately reflect the changes; hand written revisions will not be acceptable.

B. Provide engraved nameplate for all ASD's mounted on the outside face of the ASD; include the following minimum information:

1. Name of Motor or Equipment Controlled
2. Source feeding the ASD
3. Voltage, number of phases
4. Disconnect size in amps (where applicable), fuse size in amps (where applicable)

C. Engraved nameplates shall be have a black back ply, an inner white ply with outer colored ply as follows: Black for normal power, Red for Emergency (Legally Required or Optional Standby) power, Orange for UPS power.

3.3 SYSTEM PERFORMANCE TESTING and CERTIFICATION

A. The ASD system start-up shall be performed by a service technician or engineer certified by the manufacturer. The following adjustments and tests shall be performed as a minimum with certified copies included in the maintenance and operation manual:

1. Verify that the input voltage is within the manufacturer's specification tolerances.
2. Verify that the motor rotation is correct in all modes of operation.
3. Verify all operator devices, programming and monitoring functions to be fully operational.
4. Verify operation of all field signal control connections.
5. Measure and record system output voltage and current at 50% and 100% speed. Tune the output voltage to correspond to motor nameplate rating at full speed. Check full load current measurements against nameplate data.
6. Make all parameter adjustments to tune and optimize the ASD system to the application. Record all configuration values as part of this report.
7. Conduct harmonic tests as identified in Sections 2.7 and 2.8. Measurements shall be recorded for each unit with the ASD system off, running at 50% speed, and running at full speed and load.

B. Owner training shall be provided for each model and type of ASD system provided. Training shall consist of both classroom and actual equipment hands-on training. The training shall be certified and included in the operation and maintenance manuals.

3.4 DOCUMENTATION

A. The ASD system vendor shall supply certified as-built drawings based on the required drawings and approved drawing formats.

1. The drawings shall be included as part of the operation and maintenance manual and be of a reproducible quality.
2. Autocad format files of each drawing shall also be included on a DVD disk or jump drive.

B. The operation and maintenance manuals shall consist of the following instructions and information:

1. Unloading, handling, installation, and special consideration instructions.
2. Operating functional descriptions and operating instructions.
3. Bill of materials with all spare parts ordering information and availability.
4. Factory test reports.
5. Start-up and system commissioning reports.
6. Training certification.
7. Power quality and harmonic test reports.

3.5 WARRANTY

A. The ASD system vendor shall supply a complete parts and labor warranty (including travel expenses) for 1 year from the date of start-up or 1.5 years from the date of shipment (which ever comes first).

1. The warranty shall cover the entire ASD system including power devices, controllers, filters etc. enclosed as part of the system package.
2. For equipment or components manufactured by other than the complete ASD system manufacturer, (which comprises more than 25% of the cost of the ASD system), the original equipment manufacturer shall be identified with it's nearest office and warranty obligation.

B. In place of the one year warranty, a two year warranty/service contract shall be quoted as an option at bid time. This service contract shall be renewable in two year increments thereafter. The service contract shall be executable by the owner at the fixed bid price anytime during the first 6 month of operation after start-up.

1. The extended warranty/service contract shall include necessary repairs or loaner replacement assuring complete restoration of operation within 24 hours from the time a service call is requested. A $100.00 per day penalty shall be applied for failure to comply after the acknowledged service request.
2. The extended warranty/service contract shall include job site visits twice yearly to inspect, clean, tune (optimize parameters) and repair (if necessary) each ASD system supplied under this contract.
3. The extended warranty/service contract shall include basic orientation and operator training review with the owner's designated personal as part of this visit.
4. The extended warranty/service contract shall include a 200% performance bond in the owner's favor for the term of the service contract.

END OF SECTION

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SECTION 26 32 00 – ENGINE GENERATORS INSTALLATION

PART 1 - GENERAL

1.1 WORK INCLUDED:

A. The Contractor shall linstall an existing new standby diesel engine/generator system provided by the owner. The generator has never been installed or used and is new provided by Cummins Rocky Mountain through a previous contract.

B. The Contractor shall provide a reinforced concrete pad as detailed on the structural drawings, and provide all conduit and wiring for a complete operation.

C. The contractor shall provide a NEMA 3R ATS and MTS as specified in 263623. The NEMA 1 transfer switch that originally came with the generator will be retained by the owner as spare stock.

D. Cummins will relocate the generator from one location on the airport to the permanent position. The contractor shall assist in receiving the delivery to the new concrete pad.

E. The owner will provide testing services through their contract with Cummins Rocky Mountain. The contractor shall witness and participate to ensure the wiring connections and monitoring provisions are working as required.

1.2 QUALITY ASSURANCES:

A. Coordinate with owner and Cummins Rocky Mountain for proper installation.

B. Coordinate with Division 25 Building Automation for proper wiring, programming, and reporting to the building Automation system.

1.3 WARRANTY:

A. Warranty is limited to wiring provided by the contractor. Generator warranty is covered under separate contract by Cummins Rocky Mountain.

1.4 SUBMITTALS:

A. Submittals shall be provided by the owner to the installing contractor. The contractor shall submit the new ATS and MTS switch, load bank tap box, and any retrofit accessories such as the EPO button and control wiring monitoring, and submittals that show connection to building automation for the generator.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. The generator set shall be owner furnished, contractor installed (OFCI). The existing unit is a 450 kW Cummins with base fuel tank..

2.2 FUEL:

A. Cummins Rocky Mountain will provide a full fuel tank after testing as part of the owner's original purchase agreement.

2.3 GENERATOR MONITORING:

A. The following items shall be annunciated through the building automation. Provide required wiring from the generator, transfer switch, and to the existing building automation system.

1. General fault or Trouble
2. Generator running.
3. Main fuel tank low.
4. Low battery
5. High temperature
6. Low oil pressure
7. Low temperature
8. Overcrank alarm
9. Overspeed
10. Not in auto position
11. Fuel tank leak
12. External test of ATS operation
13. Start and Stop of the Emergency Power Source
14. Availability of normal power source
15. Switch position of the ATS
16. Line frequency of source 1
17. Line to neutral voltage of source 1
18. Line current of the electrical load
19. Power factor of the electrical load
20. Real power of the electrical load as a floating type (in watts).
21. Open or short in transfer switch control wiring

B. The electrical contractor will work with the building automation technician to ensure that all monitoring points are fully tested.

2.4 MAIN LINE CIRCUIT BREAKER:

A. A main line electronic trip adjustable LI circuit breaker , Square D, Micrologic 3.0 comes with the generator. The contractor shall hire a skilled technician to test and set the breaker according to the recommended settings in the Coordination Study.

2.5 PROTECTIVE DEVICE TIME-CURRENT SELECTIVE COORDINATION ANALYSIS

A. The electrical equipment manufacturer shall perform protective device time-current coordination analysis of the life safety electrical power distribution system. This analysis shall include:

1. A determination of settings, ratings, or types for the overcurrent protective devices supplied. Where necessary, an appropriate compromise shall be made between system protection and service continuity with system protection and service continuity considered to be of equal importance. The time-current coordination analysis shall be performed with the aid of computer.
2. Computer generated log-log plots containing the time-current characteristics of series connected overcurrent devices. A sufficient number of log-log plots shall be provided to indicate the degree of system protection and coordination. The log-lot plots shall include transformer ANSI withstand points and inrush currents of transformers where appropriate.
3. Computer printouts to accompany the log-log plots containing descriptions for each of the devices shown on the plot, setting of the adjustable devices, device numbers to simplify location of the devices on the system one-line diagram, and short-circuit currents where known.
4. A tabular computer printout of the suggested settings of the adjustable overcurrent protective devices, the equipment where the device is located, the device number corresponding to the device on the system one-line, diagram, and the number of the time-current log-log graphs where they are illustrated.
5. A computer generated system one-line diagram clearly identifying individual equipment basics, the bus numbers, the device numbers, and the maximum available short-circuit current at each bus which shall include short-circuit current motor contribution.
6. A discussion section evaluating the degree of system protection and service continuity with overcurrent devices, with recommendations as required for increased protection or coordination.
7. Any inadequacies shall be called to the attention of the Architect, and recommendations made for improvements.
8. Provide Six (6) bound copies of the completed protective device time-current coordination analysis for the Architect.
9. Electrical distribution equipment SHALL NOT BE RELEASED FOR MANUFACTURING until AFTER the Analysis has been reviewed by the Engineer. If the Contractor fails to abide by this requirement, the Contractor will be responsible for the cost of any and all required changes to the distribution equipment resulting from findings within the Analysis.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Provide branch circuits and power and control connections for all accessories including the battery charger and any heating elements inside the generator housing.

B. Install signaling and control circuits as required for remote BAS monitoring, battery charger alarm, automatic start-stop of generator set by automatic transfer switch, etc.

C. Do not bond the generator neutral to ground at the generator set unless specifically indicated on the drawings. Confirm that there is a neutral and ground path back to the main service ground. The ground path must be through wire in conduit. Using raceways for the ground path is not acceptable.

D. Prior to running circuits and ordering branch circuit breakers, confirm that the block heater electrical characteristics match the branch circuits shown.

3.2 LABELING:

A. Provide a permanent engraved label with a center white ply and outer red (red label with white lettering) for all generators on the outside of the generator enclosure including the following information:

1. Generator Name and Installation date (month/year)
2. The load supplied equipment
3. Size (KW), Voltage, number of phases, number of wires.
4. Gallons of fuel for tank (if applicable)

3.3 TESTING:

A. Owner will provide generator and transfer switch testing through their contract with Cummins Rocky Mountain. Contractor shall witness and participate in the testing provided by the owner to provide trouble shooting of the contractor provided wiring and transfer switches.

Testing to show the OFCI generator will start automatically from the contractor provided transfer switch, and be subjected to full-load tests.

B. BAS MONITORING ALARM TEST

1. Test all trouble monitoring and ensure it is reporting to the building automation system. Involve Airport BAS system operators to witness and review the screen graphics to ensure proper reporting of each monitoring point from the generator and transfer switch.

END OF SECTION

SECTION 26 36 23 AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 WORK INCLUDED:

A. Provide a new 800 amp, 3 pole, NEMA 3R automatic transfer switch (ATS) as herein specified and shown on the drawings. The intent is to fully install the transfer switch and use it to control the OFCI generator.

B. Provide a new 800 amp, 3 pole, NEMA 3R Manual Transfer Switch (MTS). The transfer switch may be of any manufacturer listed that can switch in an Owner Furnished trailer set load bank for testing.

C. The owner is under contract with Cummins Rocky Mountain to test the generator and ATS (Owner Furnished Testing). The testing of the generator was included in the original purchase of the 450 kW generator, Any cost differences needed by Cummins will be directly paid by the owner. The Contractor shall participate in the owner furnished testing as necessary to ensure that the components and wiring provided by the contractor function properly..

1.2 SUBMITTALS:

A. Submit complete and descriptive shop drawings indicating dimensions and compliance with the specifications herein. Submit in accordance with Section 26 05 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Cummins, Onan.

B. Requests for substitution of other products will be considered if submitted in accordance with the General Conditions and Section 26 05 00.

2.2 GENERAL REQUIREMENTS:

A. ATS and MTS Switches shall be housed in a NEMA 3R enclosure with powder coated paint. Enclosure shall contain power warming strip with temperature sensor and contactor to provide warming to eliminate condensation damage when temperature is below 40 degrees Farenheit.

B. Switches shall conform to U.L. Standard 1008 for automatic transfer switches.

C. Automatic transfer switch to have a means for overriding automatic controls and forcing a manual transfer to either source. The switch for forcing manual operation shall be equipped with a derangement alarm.

D. Voltage, poles, and current rating as indicated on the Drawings.

E. Transfer mechanism shall be quick-make, quick-break spring over-center design.

F. The automatic switch shall be capable of being locked and left in the utility position.

G. Provide all control and monitoring wiring as required for full control and monitoring of the generator and transfer switch through the Building Automation System. The monitoring points shall be programmed by the Division 25 controls contractor. Participate in the programming and testing to ensure that the Contractor provided ATS and wiring equipment is properly reporting to the BAS.

H. The control wiring between the ATS and the generator shall be monitored for shorts and opens as per the current code.

2.3 ACCESSORIES:

A. Automatic Transfer switches shall be equipped with the following accessories.

1. Time Delay - Adjustable 1 to 3 seconds on signal to start. Set at two seconds.
2. Time Delay - Adjustable 1 to 30 seconds on transfer to emergency.
3. Time Delay - Adjustable 2 to 25 minutes on re-transfer with 5 minutes unloading running time. Set at ten minutes.
4. Voltage and frequency lockout relay.
5. Differential protection, 3-phase, dropout at 70% and pickup at 90% voltage.
6. Test switch.
7. Engine starting contact.
8. Two auxiliary contacts each to close on emergency, close on normal.
9. Pilot LED's to indicate switch position.

B. Time delay on transfer to emergency and retransfer to normal shall be set as follows:

1. 5 seconds

C. Provide an exercise clock which will permit the generator system to be automatically exercised on a weekly or monthly basis. The "Run Time" interval shall be adjustable and no less than 5 minutes.

PART 3 - EXECUTION

3.1 ACCEPTANCE AND INSPECTION:

A. Record the following for each automatic transfer switch:

1. Time delay on retransfer to normal.
2. Transfer switch time in neutral position during retransfer to normal for each switch with a neutral delay.
3. Time delay to engine shut down for the entire system.
4. Transfer switches with in-phase monitors shall be tested as follows. Record the phase A voltage and frequency with a power line analyzer between the normal and the emergency source during the re-transfer. The waveshape printout must demonstrate the phase relation ship between the two sources at the moment of transfer.

B. Prior to acceptance of the installation, equipment shall be tested to show it is free of any defects, is communicating properly to the Building Automation System, and is monitoring the start signal for opens and shorts.

3.2 LABELING:

A. Provide engraved nameplate for all ATS's and MTS's permanently mounted on the outside face of the ATS; include the following minimum information:

1. ATS or MTS name
2. Source feeding ATS or MTS and panel or equipment name fed by ATS or MTS
3. Voltage, Size (amps) and number of poles

B. Engraved nameplates shall be have a black back ply, an inner white ply with outer colored ply as follows: Red for Emergency (Optional Standby) power.

END OF SECTION

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SECTION 26 43 00 – SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 WORK INCLUDED:

A. Furnish all labor, materials, equipment and services necessary for and incidental to the installation of the new and existing relocated surge protective device (referred to as SPD herein and/or TVSS on the drawings) components at locations shown on the plans.

1.2 QUALITY ASSURANCE:

A. The SPD shall be UL Listed as a surge protective device, category C, UL 1449 latest Edition. All UL 1449 test data shall be provided with submittal.

B. The SPD shall bear suppressed voltage rating issued by UL, and the units shall be tested in accordance with ANSI/IEEE C62.41 latest edition, Category C, 20kV/10kA, 8x20 uS and 1.2x50 uS Combination Waveform and .5uS - 100kHz Ring Wave with a minimum of 10 sequential impulses delivered directly into the SPD at a maximum of sixty second intervals for each waveform.

C. Manufacturers Qualifications: Only firms regularly engaged in the manufacture of SPD products for category C (ANSI/IEEE C62.41), and whose products have been providing satisfactory service for not less than five years, shall be considered. Manufacturer qualifications shall be provided as part of the submittal.

D. The SPD must be capable of surviving 1000 sequential surges without failure, using IEEE test procedures established in C62.45.

E. The SPD device must have MOV surge devices, installed with full rating indicated between Phase to Neutral, Phase to Ground, and Neutral to Ground, and be capable of handling a minimum surge current as follows:

Panel/Switchboard Size Equal to or greater than (A):	100
Mode:	kA/Mode
Line to Neutral	50
Line to Ground	50
Neutral to Ground	50

1.3 SUBMITTALS:

A. Submit complete and descriptive shop drawings in accordance with the General Conditions, Division 1, and Section 26 05 00.

B. Submit all related SPD Specifications and drawing information requested in this document and U.L. 1449 latest edition surge suppression ratings for the SPD. In order

for a SPD system to be considered, all responses to information requested in this specification must be provided in writing. If a manufacturer cannot comply with any portion of this specification, this must be stated in the reply and the reason for non-compliance shall be provided.

C. Submit operation and maintenance data in accordance with the General Conditions, Division 1, and Section 26 05 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Provide products of one of the following manufacturers:

1. Liebert
2. Mersen
3. Current Technologies
4. United Power
5. EFI

B. Requests for substitution of other products meeting all specification requirements herein will be considered if submitted in accordance with the General Conditions, Division 1 and section 26 05 00.

2.2 SPD EQUIPMENT:

A. The SPD shall be suitable for application in category C environments as described in ANSI/IEEE C62.41. The SPD shall be of parallel design and provide protection from Line to Ground, Line to Line, Line to Neutral, and Neutral to Ground.

B. The SPD shall be compatible with the electrical system voltage, current, configuration and intended application.

C. The SPD maximum continuous operation voltage (MCOV) shall be capable of sustaining 100% of the nominal RMS voltage continuously without degradation.

D. The SPD shall only use solid state clamping components connected in parallel with the supply to limit the surge voltages. Clamping components shall be installed in 7 modes. Four mode SPD devices are not acceptable.

E. For Monitoring of SPD’s Provide:

1. Visual and audible indication with disable switch for properly performing protection.
2. Provide NO/NC dry contacts for remote monitoring.
3. Provide a surge counter.

F. House in the appropriate NEMA rated enclosure, SPD shall not be integrated into panelboards or switchboards.

G. SPD shall be repetitive in nature such that failure of a single component within the SPD (i.e. MOV, fuse, etc) does not leave the electrical system unprotected.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Ship with complete installation instructions, which are to be followed in detail. The manufacturer's representative is to be contacted and is to supervise the installation.

B. Supplemental installation information is as follows:

1. Use the breaker space closest to the neutral bus. Nipple the suppressor to the panel where the suppressor can be installed so as to keep both the hot leads and the neutral lead as short and straight as possible from the suppressor to the breakers and the neutral bus.
2. The best performance is achieved with the shortest leads and neutral. All efforts within the code should be used to minimize the lead lengths. Ideally the leads should be less than eight inches long. Each inch of lead above six inches will add approximately 20 volts to the quoted let-through voltage. Cut the leads down to the shortest size that will allow installation.
3. If the neutral bus is out of reach of the leads, then a #4 AWG conductor is to be run from the remote neutral bus to a lug near the suppressor, and the lead from the suppressor should be cut as short as possible.
4. The ground is to be connected to the case of the panel (equipment ground only). Do not connect the suppressor ground wire to an isolated ground (IG) bus.

C. Installation shall comply with all applicable State and National Electrical Codes, including NEC Articles 240, 250, 310 and 285. Utilize the panelboard/switchboard circuit breaker to provide overcurrent protection and a means to disconnect power from unit. Fuses shall not be utilized for the SPD overcurrent protection unless specifically indicated on the drawings and if utilized shall be of the Time Delay type rated for the available fault current at the location of installation.

D. Phase, neutral and ground leads of installed SPD must be grouped and twisted together up to the point of connection at the bus or overcurrent device. Lead lengths must be as short as possible, avoiding bends where possible. Lead lengths greater than sixteen inches or sharp bends in leads shall not be permitted, where lead lengths greater than sixteen inches cannot be avoided high performance low impedance cable equivalent to Current Technology “High Performance Interconnect (HPI) SPD connection system” shall be used while maintaining the shortest lead lengths possible, wire size shall be as indicated on the drawings. Lead length is measured from switchboard bus or breaker to point of connection to SPD device.

E. Mount so that suppressor indicator lights will be clearly visible after installation.

F. Circuit breaker shall be exclusively utilized for the SPD device.

G. Raceway from SPD to switchboard shall consist of rigid steel conduit with double locknuts and grounding bushings connected to switchboard ground.

H. Overcurrent protection sizing shall be as per manufacturer’s instructions. Conductor sizing shall be based on NEC requirements.

3.2 LABELING:

A. Where changes are made in existing SPD's (TVSS's) provide new labeling to accurately reflect the changes; hand written revisions will not be acceptable.

B. Provide engraved nameplate for all SPD's permanently mounted on the outside face of the SPD; include the following minimum information:

1. TVSS name
2. KA/mode ratings for line to neutral, line to ground, and ground to neutral

3.3 WARRANTY:

A. Warranty shall be for full replacement without pro-rating value, for a minimum period of 10 years.

END OF SECTION

SECTION 26 51 00 - LIGHTING

PART 1 - GENERAL

1.1 WORK INCLUDED:

A. Provide light fixtures with lamps and accessories as herein specified and shown on the drawings.

1.2 QUALITY ASSURANCE:

A. If the catalog number of a specified fixture should conflict with the fixture description or the general lighting specifications, such conflicts shall be brought to the attention of the Engineer prior to bidding.

B. The dimensions shown on the luminaire schedule are for general reference only. Refer to the manufacturer's shop drawings for exact dimensions prior to rough in.

1.3 SUBMITTALS:

H. Submit product data and shop drawings for fixtures, ballasts, and lamps in accordance with the General Conditions, Division 1, and Section 26 05 00.

I. Verify that fixture description matches that which is indicated by the specified catalog number.

J. All features mentioned in the fixture list shall be marked on the submitted items.

K. Submit written confirmation that dimming ballasts and dimming controls are compatible.

L. Submit Operation and Maintenance data in accordance with the General Conditions, Division 1, and Section 26 05 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

H. See Luminaire Schedule for acceptable manufacturers.

I. Requests for substitution of other products will be considered if submitted in accordance with the General Conditions, Division 1, and Section 26 05 00.

J. Substitution requests for fixtures equal to those specified shall include complete construction and photometric data including, if applicable, candlepower distribution curve, spacing to mounting height ratio, table of coefficients of utilization, isofootcandle curve, ANSI beam spread classification, efficiency, etc.

K. Submittals and substitution requests for fluorescent fixtures shall include the sheet metal gauge of the housing and the lens thickness, material, and pattern.

2.2 MATERIALS:

A. Polystyrene lenses and lenses less than 0.125 inches nominal thickness shall not be permitted unless otherwise noted.

B. Provide luminaires with Area Coverage, damp, or wet label if required for the application indicated.

C. All recessed luminaires shall be free of light leaks.

2.3 DRIVERS:

A. All drivers shall be capable of providing reliable operation of the lamps at the lowest temperature normally encountered. The contractor shall confirm that the drivers are appropriate for the ambient conditions.

B. The contractor shall verify the driver voltage prior to submittal.

C. Drivers deemed excessively noisy shall be replaced without cost to the Owner.

D. DIMMING DRIVER LED: Provide integral 0-10 volt dimming driver capable of continuous dimming that works with any standard 0-10V dimmer, unless noted otherwise on Luminaire Schedule:

1. UL listed and CSA certified.
2. Comply with IESNA LM-79 and LM-80 standards.
3. Recognized Testing Laboratory listed, thermally protected, resetting, Class P, For use in insulated ceilings.
4. Power factor equal to or greater than 90%.
5. Meet all current Federal, State and Power Co. efficiency and efficacy standards, and rebate program requirements.
6. Meet all current ANSI, IEEE, and FCC regulations for EMI/RFI, harmonic distortion, and transient protection.
7. Compatible with occupancy sensor switching.

Coordinate dimming with dimming controls specified in separate section.

Provide low voltage cable for 0-10 volt dimming per manufacturer instructions.

2.4 LAMPS:

A. Provide high quality LED lamps that are testing in accordance with IES LM-79 and IES LM-80.

B. Provide LEDs with estimated useful life of 50,000 hours at 70 percent lumen maintenance calculated based on IES LM-80 test data.

C. All lamps and fixtures shall be in proper operation at the time of acceptance.

PART 3 - EXECUTION

3.1 INSTALLATION:

H. Luminaires installed under this work shall be properly and adequately supported from the building structure except where ceiling construction or other provisions are specifically designed to support the fixture units. Fixture support systems shall provide a safety factor of four. This shall apply to chains, hangers, anchors, clamps, screws, and all other hardware and appurtenances associated with the support system.

I. Fixture supports shall provide proper alignment and leveling of fixtures, and shall be arranged to maintain the alignment at all times. The final decision as to adequacy of alignment shall be given by the Architect.

J. All light outlets shall be supplied with a fixture. Outlet symbols on the drawings without a type designation shall have a fixture the same as those used in similar or like locations.

K. Fixture stem or chain lengths for industrial reflector or bare lamp strip fixtures shall be appropriate for the space and for coordination with other work such as ducts and piping. Provide swivel hangers for stem-hung fixtures.

L. Fixtures shall be left clean at the time of acceptance of the work and every lamp shall be in operation. The responsibility for cleaning or protecting fixtures from dirt, dust, paint, debris, etc. shall rest with the Contractor performing this division of work.

M. Prior to the purchase of any luminaire, the finish shall be verified with the Engineer and the voltage shall be verified based on the panelboard voltage.

3.3 WARRANTY:

H. Provide a 5 year complete parts and replacement labor by manufacturer for all LED drivers.

END OF SECTION