TECHNICAL SPECIFICATIONS

VOLUME 2
DIVISION 13 - SPECIAL CONSTRUCTION
13916  Fire Suppression Sprinklers

DIVISION 15 - MECHANICAL
15010  Mechanical Requirements
15030  Electrical Provisions of Mechanical Work
15040  Variable Frequency Drives
15060  Pipe and Pipe Fittings
15110  Pipe & Piping System
15170  Motors
15190  Mechanical Identification
15230  Waterline Valves & Hydrants
15232  Water System Control Valves
15234  Water Service Connections
15236  Water Main Flow Meters
15261  Culinary Water Pipe Insulation
15262  Underground Piping Insulation
15263  Refrigerant Piping Insulation
15290  Ductwork Insulation
15411  Culinary Water Piping Systems
15412  Soil, Waste, and Vent Piping Systems
15414  Heat Trace System
15430  Plumbing Specialties
15440  Plumbing Fixtures
15450  Vibration and Seismic Control For HVAC Piping and Equipment
15452  Standard Drinking Water Cooling System
15453  Handicap Drinking Water Cooling System
15459  Gas Fired Storage Type Water Heaters
15470  Instantaneous Electric Domestic Water Heater (Tankless)
15489  Natural Gas Systems
15530  Refrigerant Piping Systems
15535  Refrigerant Specialties
15611  Gas Fired furnaces (90%)
15622  Combustion and Exhaust Air Piping
15625  Make-Up Air Units (By Kitchen Contractor)
15631  Radiant Heating System
15647  Electric Radiant Wall and Ceiling Heaters
15670  Air-Cooled Condensing Units
15681  Condensing Unit
15752  Cooling Coils
15855  Air Handling Units
15869  Exhaust Fans
15887  Disposable Filters
15890  Low-Pressure Steel Ductwork
15892  Non Metal Ductwork
15896  Duct Lining

DIVISION 16 - ELECTRICAL
16001  Electrical General Provisions
       Substitutions and Substitute Equipment (16001-12)
16050  Basic Electrical Materials and Methods
16052  Existing Facilities and Equipment
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>16055</td>
<td>Electric Service Connection</td>
</tr>
<tr>
<td>16060</td>
<td>Grounding and Bonding</td>
</tr>
<tr>
<td>16072</td>
<td>Electrical Supports and Seismic Restraints</td>
</tr>
<tr>
<td>16075</td>
<td>Electrical Identification</td>
</tr>
<tr>
<td>16110</td>
<td>Conduit Raceways</td>
</tr>
<tr>
<td>16120</td>
<td>Conductors and Cables</td>
</tr>
<tr>
<td>16130</td>
<td>Boxes, Pull Boxes, and Conduit Bodies</td>
</tr>
<tr>
<td>16140</td>
<td>Wiring Devices</td>
</tr>
<tr>
<td>16145</td>
<td>Lighting Control Devices</td>
</tr>
<tr>
<td>16150</td>
<td>Electrical Wiring Connections</td>
</tr>
<tr>
<td>16215</td>
<td>Electrical Power Monitoring and Control</td>
</tr>
<tr>
<td>16289</td>
<td>Surge Protection Device</td>
</tr>
<tr>
<td>16410</td>
<td>Enclosed Switches and Circuit Breakers</td>
</tr>
<tr>
<td>16420</td>
<td>Enclosed Controllers and Starters</td>
</tr>
<tr>
<td>16430</td>
<td>Overcurrent Protective Devices</td>
</tr>
<tr>
<td>16441</td>
<td>Electrical Service and Distribution Switchboards</td>
</tr>
<tr>
<td>16442</td>
<td>Panelboards</td>
</tr>
<tr>
<td>16511</td>
<td>Interior Lighting</td>
</tr>
<tr>
<td>16521</td>
<td>Exterior Lighting</td>
</tr>
<tr>
<td>16700</td>
<td>Auxiliary Introduction (16700-800)</td>
</tr>
<tr>
<td>16714</td>
<td>Data System Conduit</td>
</tr>
<tr>
<td>16715</td>
<td>Data Equipment and Cabling System Expansion</td>
</tr>
<tr>
<td>16716</td>
<td>Telephone System (Conduit Only)</td>
</tr>
<tr>
<td>16717</td>
<td>Telephone Equipment and Cabling System</td>
</tr>
<tr>
<td>16721</td>
<td>Fire Alarm System</td>
</tr>
<tr>
<td>16722</td>
<td>Sound Re-Enforcing and Recording systems</td>
</tr>
<tr>
<td>16786</td>
<td>Television Surveillance System</td>
</tr>
</tbody>
</table>

END OF TABLE OF CONTENTS
DIVISION 13 - SPECIAL CONSTRUCTION
13916  Fire Suppression Sprinklers
SECTION 13916 - FIRE SUPPRESSION SPRINKLERS

PART 1 - GENERAL

1.1 SUMMARY

A. The extent of the fire sprinkler system design and installation shall meet the requirements of NFPA 13 and meet the requirements as shown on Contract drawings and specifications. The completed system shall include all those items necessary to make the fire sprinkler system complete and operational.

1.2 RELATED DOCUMENTS

A. The General provisions of the Contract, including General and Supplementary Conditions and General Requirements apply to the work specified in this Section.

B. Requirements of Mechanical General Provisions Sections govern the work specified in this section except that NFPA 13 shall take precedence.

C. Division 16 Section "Fire Alarm Systems" for connection of valves and alarms.

1.3 APPLICABLE CODES

A. NFPA 13

B. Underwriters Laboratories "Fire Protection Equipment Directory".

C. Factory Mutual Systems "Loss Prevention Data Sheets" where applicable and "Approval Guide".

D. Applicable local building and fire prevention codes and ordinances.

1.4 SYSTEM DESCRIPTION

A. Fire sprinkler protection for the building shall be complete as defined by NFPA 13 and local jurisdiction. The extent of fire sprinkler system installation shall be defined to include all those items necessary to make the system complete and operational and is to include but is not necessarily limited to: Approved design and layout drawings, underground supply, supply mains, backflow preventer, sprinkler riser including fire department connection, alarm devices and valves, gauges, control and test valves, pipe hangers, sprinkler heads, seismic bracing, and identification signs. The sprinkler contractor is required to provide complete fire sprinkler protection of the building as defined by NFPA 13 unless otherwise specifically required by these specifications.

1.5 QUALITY ASSURANCE

A. The standards of NFPA 13 shall take precedence.

B. Sprinkler Contractor shall be licensed as a fire sprinkler contractor in the State of Utah.

C. All materials, devices, and equipment shall be new and shall be Underwriter's Laboratory listed and/or FM approved for use in fire protection systems.
D. Drawings for sprinkler system design included in the Contract Documents are for reference only. Fire Sprinkler Contractor is responsible for making his own job check and provide complete design shop drawings with hydraulic calculations prior to fabrication. Make final coordination with other trades and off-set piping and heads as necessary. Major conflicts shall be brought to the attention of the General Contractor for resolution by the Architect.

E. Data files for drawings may be requested from the Project Architect. A hold-harmless agreement signed by the General Contractor and Sub-contractor will be required before files are released.

F. Do not connect to underground water supply mains provided by others without receiving a copy of the “Contractor's Material and Test Certificate” with certification that all flushing and pressure testing of the mains has been completed.

1.6 SYSTEM DESIGN

A. Sprinkler protection for the building shall be complete as defined by NFPA 13 and local jurisdiction. All design densities, system protection area limitations, and the hydraulically most demanding remote area square footage shall be per NFPA 13, including any combustible ceiling spaces or around any building features which obstruct sprinkler discharge. Any areas subject to freezing shall be protected with a dry system per NFPA 13 and local jurisdiction.

B. The Contractor/CET shall perform a current waterflow test. This test shall be witnessed by or provided by the local authority having jurisdiction. This waterflow test information and date of test shall be provided with hydraulic calculations.

C. Design density shall be as follows:

1. Shall meet a minimum design density of 0.10 over 1500 square feet for Light Hazard occupancy.
2. Shall meet a minimum design density of 0.15 over 1500 square feet for an Ordinary Hazard, Group 1 occupancy.
3. Shall meet a minimum design density of 0.20 over 1500 square feet for an Ordinary Hazard, Group 2 occupancy.

D. Contractor is responsible for coordination of piping and sprinkler head locations with other trades, including any minor offsets as may be required. Where conflicts occur, they shall be resolved prior to installation. Major conflicts shall be brought to the attention of the General Contractor for resolution by the Architect. Coordinate system layout so as not to interfere with light fixture arrangement and air outlets.

E. Wiring of waterflow and valve supervisory switches for local alarms and off-premises monitoring is provided for under Division 16 Section "Fire Alarm Systems".

F. Seismic bracing shall be provided as required by NFPA 13.

G. Sprinkler piping shall be concealed above the ceiling where ceilings are present.

H. Provide identification signs for all control, drain, test, and alarm valves. Attach hydraulic criteria placard permanently to the main riser. Where control valves are located in closets or above ceiling, provide appropriate identification sign on closet door or on ceiling.
1.7 SUBMITTALS

A. Shop drawings shall be prepared by a registered Engineer or an Engineering Technician or Senior Engineering Technician (Level III or Level IV). NICET certification shall be provided for the fire sprinkler design. Include NICET certification number on drawings. Drawings will be signed by the Engineer or Technician and submitted for approval under his or her name.

B. No equipment submittals are required. All equipment used in the fire sprinkler system design and installation shall be clearly indicated on the plans, including manufacturer's name and model numbers.

C. Prior to fabrication, prepare shop drawings for submittal to the State Fire Marshal. After review and acceptance by the State Fire Marshal, submit four (4) sets of approved drawings and hydraulic calculations to the Architect for review and acceptance.

D. Do not proceed with fabrication or installation until all required approvals have been obtained.

E. Upon completion of the system, the CET shall document a 2-inch drain test, inspect the general system installation, and verify that the installation is complete and installed according to the approved drawings and specifications. Minor corrections and/or additions to the drawings shall be red-lined on the record drawings. The Contractor shall submit required record drawings, CET form and test certificates to the Contractor for submittal to Owner. In addition, Contractor shall also submit the following directly to the Architect:

1. One set of blue line drawings marked “As-Builts with appropriate corrections or additions.
2. Copy of Contractor's Material and Test Certificates for overhead and underground piping.
3. Copy of CET Final Inspection Form

F. Final payments will not be released until all submittals have been provided.

PART 2 - PRODUCTS

2.1 PIPING

A. No piping shall be used with a Corrosion Resistance Ratio of less than 1.00.

B. All piping used on dry pipe system shall be Schedule 40 or hot-dipped galvanized.

C. Special pipe such as XL pipe or Lightwall Threadable pipe shall not be used.

D. All piping shall be in conformance with NFPA 13 requirements.

2.2 FITTINGS

A. All fittings shall meet requirements of NFPA 13

B. No plain-end fittings shall be allowed.

2.3 SPRINKLERS

A. Nominal 1/2” orifice for ordinary temperature classification rating unless other indicated or required by application.
COUNTY FAIRGROUNDS BUILDING  
CACHE COUNTY

B. Use sprinklers according to the following applications:

1. Recessed, chrome, pendent sprinklers in public areas.
2. Upright, brass sprinklers in mechanical and electrical rooms.
3. Dry pendent in entry vestibules and any other spaces subject to freezing.

C. O-Ring sprinklers are not allowed.

D. All sprinklers shall be installed in a workmanlike manner in respect to ceiling layout with pendent sprinkler heads to be located no less than 6 inches from edge of ceiling grid.

2.4 DEVICES AND MATERIALS

A. Provide chrome-plated escutcheon plates where sprinkler piping passes through walls, floors, or ceilings.

B. Hangers, clamps, and seismic braces shall conform to requirements of NFPA 13.

C. Fire Sprinkler Contractor shall provide and install an approved double-check backflow preventer.

2.5 SUBSTITUTIONS

A. Where bid documents do not specify a manufacturer, the contractor may use any material or device that is Underwriters Laboratories listed and/or Factory Mutual approved for its intended use. Where plans specify a material or device, that specific item shall be used. Substitution of piping is acceptable subject to the following conditions:

B. If piping is substituted, the Contractor shall provide new hydraulic calculations, show information on shop drawings which specifically identifies the type of pipe and fittings used, and change the information contained in the hydraulic placards on the shop drawings. Adjusted flow test information shown on bid documents shall be used in re-calculating.

C. Substitution of sprinkler heads and other equipment is acceptable if material substituted is equal to that shown on bid documents, does not adversely affect the design, and is clearly identified on the shop drawings.

PART 3 - EXECUTION

3.1 APPROVALS

A. Obtain all required approvals prior to fabrications or installation of any equipment. Install system in accordance with approved shop drawings.

3.2 INSPECTION

A. Examine areas and conditions under which fire sprinkler system is to be installed and notify General Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in an acceptable manner.
3.3 FIRE CAULKING

A. Fire sprinkler contractor shall fire caulk all wall penetrations for fire sprinkler piping and equipment per manufacturer's recommendations to meet or exceed fire rating of wall.

3.4 SERVICE ENTRANCE PIPING

A. Connect sprinkler piping to water-service piping of size and in location indicated for service entrance to building. Fire Sprinkler Contractor to begin approximately 5'-0 from building exterior.

B. Install underground service entrance piping according to NFPA 13 and with restrained joints.

3.5 TESTS

A. Disinfect piping when and as required by local jurisdiction.

B. Perform and pay for all tests required by applicable codes during and after completion of the work and correct any defects in the systems indicated by the tests.

C. Pressure test overhead and underground piping and flush underground piping and document an appropriate test certificate forms. All tests shall be witnessed by a representative of the Owner, General Contractor or local jurisdiction and shall be in accordance with NFPA 13.

3.6 CLEANING

A. Remove oil, scale, debris, and foreign substances from inside and exterior of devices, piping, equipment and materials prior to installation.

B. Upon job completion, remove tools, surplus materials, and equipment, leaving all areas broom clean.

3.7 DEMONSTRATION

A. Sprinkler Contractor shall provide the Owner's representative with general instructions on the operation of the sprinkler system.

B. Sprinkler Contractor shall provide a copy of NFPA 25 to the Owner.

END OF SECTION 13916
I have personally inspected the building sprinkler system and found it to be complete per the approved drawings and/or the approval comments on the drawings. The enclosed red-lined drawings have been corrected to reflect the approval comments and the following field changes:

During my inspection, a drain test was run with the following results:

State Pressure:  
Residual Pressure:  (with drain wide open)

All areas of the building that were sprinkled and/or modified have been done per NFPA 13 and/or the specific Contract requirements.

The spare head cabinet is complete, all required signs have been posted for the system, and all riser equipment is in the proper working order.
DIVISION 15 - MECHANICAL
15010 Mechanical Requirements
15030 Electrical Provisions of Mechanical Work
15040 Variable Frequency Drives
15060 Pipe and Pipe Fittings
15110 Pipe & Piping System
15170 Motors
15190 Mechanical Identification
15230 Waterline Valves & Hydrants
15232 Water System Control Valves
15234 Water Service Connections
15236 Water Main Flow Meters
15261 Culinary Water Pipe Insulation
15262 Underground Piping Insulation
15263 Refrigerant Piping Insulation
15290 Ductwork Insulation
15411 Culinary Water Piping Systems
15412 Soil, Waste, and Vent Piping Systems
15414 Heat Trace System
15430 Plumbing Specialties
15440 Plumbing Fixtures
15450 Vibration and Seismic Control For HVAC Piping and Equipment
15452 Standard Drinking Water Cooling System
15453 Handicap Drinking Water Cooling System
15459 Gas Fired Storage Type Water Heaters
15470 Instantaneous Electric Domestic Water Heater (Tankless)
15489 Natural Gas Systems
15530 Refrigerant Piping Systems
15535 Refrigerant Specialties
15611 Gas Fired furnaces (90%)
15622 Combustion and Exhaust Air Piping
15625 Make-Up Air Units (By Kitchen Contractor)
15631 Radiant Heating System
15647 Electric Radiant Wall and Ceiling Heaters
15670 Air-Cooled Condensing Units
15681 Condensing Unit
15752 Cooling Coils
15855 Air Handling Units
15869 Exhaust Fans
15887 Disposable Filters
15890 Low-Pressure Steel Ductwork
15892 Non Metal Ductwork
15896 Duct Lining
15911 Fire and Fire/Smoke Dampers
15940 Air Outlets and Inlets
15970 Direct Digital Control System for HVAC
15985 Sequence of Operation
SECTION 15010 - GENERAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Related Sections: Refer to "Electrical Requirements for Mechanical Equipment" Section 15030 in Division 15 for basic electrical requirements for all mechanical equipment. Special and specific electrical requirements are specified within each respective equipment specification section.

1.2 SCOPE OF WORK - GENERAL

A. This section specifies the basic requirements for mechanical installations and includes requirements common to more than one section of Division 15. It expands and supplements the requirements specified in sections of Division 1.

B. The work covered by the Mechanical Sections of the Specifications shall include the furnishing of all materials, labor, transportation, tools, permits, fees, inspections, utilities and incidentals necessary for the complete installation of all mechanical work required in the Contract Drawings.

C. It is the intent of the Contract Documents to provide an installation complete in every respect. In the event that additional details or special construction is required for work indicated or specified under this section of work or work specified in other sections, it shall be the responsibility of the Contractor to provide all material and equipment which is usually furnished with such systems in order to complete the installation, whether mentioned or not.

D. The Contractor shall review all Contract Drawings and Specifications and include in his bid any work specifically as being performed in the mechanical section. The Contractor shall be responsible for all work performed by his subcontractors.

1.3 DEFINITIONS

A. "Provide" shall mean "furnish and install complete and ready for intended use."

B. "Indicated" shall mean "indicated on drawings".

C. "Concealed" shall mean "hidden from sight as in trenches, chases, furred spaces or hung ceilings.

D. "Exposed" shall mean "not concealed", as defined above.

E. "Noted" shall mean "noted on drawings or in specifications".

F. "Contractor" also referred to as "this Contractor" or "the Contractor", shall mean "the Mechanical Contractor".
1.4 CODES AND STANDARDS

A. All mechanical work shall be in strict accordance with the most current edition of the International Building Code (IBC), International Mechanical Code (IMC), Uniform Plumbing Code (UPC), National Fire Protection Association (NFPA), International Fire Code (IFC), National Electrical Code (NEC), Energy Code IECC and ASHRAE-90.1, and all applicable state and local codes, laws and ordinances.

1.5 PERMITS AND FEES

A. The Contractor shall obtain and pay for all required permits and fees necessary to fully complete all work included in the Contract Drawings and Specifications.

1.6 CONSTRUCTION OBSERVATIONS:

A. During the course of construction of this project, the engineer shall visit the project site periodically on an as-needed basis. The construction observation intervals may vary depending on the progress and/or stage of construction and whether piping and/or ductwork, etc., is being placed below grade and/or concealed, surface mounted items, setting of equipment, equipment connections, etc. However, written field questions are encouraged and welcomed throughout the course of construction and shall be answered promptly in writing, to keep the project construction on schedule. The project foreman should have the building plans, construction schedules, etc., affixed in mind, so the mechanical systems being assembled, the setting of equipment, of parts and pieces, related to the project are anticipated, to prevent delays or emergencies.

B. The engineer shall make one (1) final inspection. The contractor shall notify the engineer that the installation is complete, i.e., the systems are operating and have been tested and balanced, and everything is complete and operational, all equipment connections have been made and the owner’s representatives have been trained. At this time the engineer, the contractor, and the owner’s representative shall schedule a time to walk the project for evaluation, and record in writing the items found to be incomplete. The contractor shall make the corrections within one (1) week after this inspection.

C. On extra visits, the contractor shall report to the engineer that all systems are complete, and the project is ready for the owner’s acceptance.

1.7 INTENT AND INTERPRETATION

A. The Drawings and Specifications are intended to supplement each other and any details contained in one and not the other shall be included as if contained in both. Items not specifically mentioned in the specifications or noted on the drawings, but which are obviously necessary to make a complete working installation shall be included.

B. The drawings are partly diagrammatic and do not necessarily show the exact location of all new piping and existing utilities, unless specifically dimensioned.

C. Riser and other diagrams are schematic only and do not necessarily show the physical arrangement of the equipment. They shall not be used for obtaining quantities or lineal runs of piping.
D. All grilles, fixtures or other pieces of equipment shall be centered on windows, wall spaces, or other items, unless specifically dimensioned otherwise.

E. The location of the piping and ductwork shall be checked to determine that it clears all openings and structural members; that it may be properly concealed; and that it clears cabinets, lights and equipment having fixed locations.

F. Mechanical drawings shall serve as the working drawings for this portion of the work but the Contractor shall refer to the Architectural, Structural and Electrical drawings for additional detail affecting the installation of his work. Architectural drawings shall take precedence over the Mechanical drawings if any dimensional discrepancies exist.

G. The approximate location of each item is indicated on the drawings. These drawings are not intended to give complete and exact details in regard to location. Exact locations are to be determined by actual measurements at the building, and will in all cases be subject to the approval of the Architect and he reserves the right to make any reasonable changes in the locations indicated without additional cost.

H. The contractor shall not make a change in a system, system layout, and/or equipment, except he receive written approval or drawing over the signature of the engineer.

1.8 SUBMITTAL OF EQUIPMENT FOR APPROVAL

A. Refer to the Conditions of the Contract (General and Supplementary) and Division 1 General Requirements for submittal definitions, requirements and procedures.

B. SHOP DRAWINGS AND PRODUCT DATA OF EQUIPMENT BEING INSTALLED IN THE PROJECT: After the contract is awarded, but prior to manufacture of installation of any equipment, assemble Shop Drawings, parts lists, Brochures, etc., for the materials and equipment requiring approval for each section of this specification. A brief description of submittal conditions is given below. Refer to identified sections for detailed submittal requirements.

C. Confirm equipment approved for the project.

1. Confirm that the equipment is approved for installation. It must be defined as to name, catalog number or both in the bid documents, which includes the published addendums. If not approved, do not submit.

2. Each unit shall state the name of the equipment manufacturer (name, address, phone, email, etc.) catalog number, size, physical dimensions and weight, energy characteristics (electrical and/or fuel), operating characteristics, materials from which constructed, any special conditions that may apply to the construction of the unit, etc.

3. The equipment must explain and define in detail the components that make-up the unit, so the owner and engineer can determine, define the replaceable parts during the life of the unit.

4. Complete operating instruction, normal maintenance recommendations, start-up procedures, etc.

5. In general, the contractor shall acquaint himself with the equipment to confirm that it can be installed as shown on the plans and from his experience perform the indicated function in the system where installed.
6. In the course of reviewing the shop drawings, the Contractor shall confirm the energy usage (gas, power, air, water, drains, etc.) and determine if these services are available at the equipment characteristics. Namely: confirm voltage, phase, etc., with the electrical contractor. Natural gas available with the plumber, also drains, water (hot and cold) pipe sizes, etc., or if there is discrepancies in the services. If the indicated equipment services are not available, inform the engineer by phone and in writing, also note on the shop drawing. This cooperative effort will correct a problem before the equipment arrives at the job site.

The shop drawings shall also indicate the scheduled delivery dates the equipment will be at the site.

If the contractor foresees any problems with equipment size, weight, delivery, etc., it shall be noted in writing, attached to the shop drawings.

1.9 RECORD DOCUMENTS

A. Contractor shall record differences between mechanical work as installed and as shown in Contract Documents on a set of prints of mechanical drawings to be furnished by Architect. Return these prints to Architect at completion of project. Notations made on drawings shall be neat and legible. Comply with Division 1 General Requirements.

1.10 OPERATION AND MAINTENANCE MANUALS

A. Contractor shall prepare and submit Operation and Maintenance Manuals for mechanical systems provided under this Contract. Comply with Division 1 requirements for procedures and requirements for preparation and submittal of manuals.

B. Manual binder shall have permanent lettering of a contrasting color. Information to be included on the binder is as follows:

C. The front cover shall be lettered as follows:

```
MECHANICAL
OPERATION AND MAINTENANCE
MANUAL
(PROJECT NAME)
(CITY AND STATE)
(YEAR)
```

OWNER: (NAME)
ARCHITECT: (NAME)
MECHANICAL ENGINEER: Nielson Engineering Inc.
GENERAL CONTRACTOR: (NAME)
MECHANICAL CONTRACTOR: (NAME)

The spine shall be lettered as follows:

```
MECHANICAL O & M MANUAL (Year)
(Project Name)
```
D. Provide a master index at beginning of Manual showing items included. Use plastic tab indexes for sections of Manual.

E. Cover section shall consist of name, address, and phone number of Project Architect, General Contractor, Mechanical Engineer, Mechanical Contractor and all Mechanical Sub-Contractors.

F. Provide a separate section for each section of the specifications. Provide index for each section listing equipment included. Include all items specified in Sections 15050 through 15900. Provide a list of each type of equipment supplied with the local supplier’s name, address and phone number.

G. Include descriptive literature (manufacturer's catalog data) of each manufactured item. Literature shall show capacities and size of equipment used and be marked indicating each specific item with applicable data underlined. Data sheets shall be original. Copies are not acceptable.

H. One (1) copy of the manual shall be submitted for review and approval by the Engineer. After approval, submit three (3) copies of manual to the Owner for approval unless otherwise directed by Division 1 requirements. Information to be included in manual:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
2. Manufacturer’s printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping shut-down, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.
5. Schematic control diagrams (as built-status) for each automatic control system. Mark correct operating setting for each control instrument on these diagrams. A second complete set of control diagrams encased in clear plastic laminate shall be furnished.
6. Valve schedule indicating the valve symbol (tag number), valve location by room number and description, valve purpose and system served, and valve size. Provide one corresponding set of full size mechanical prints (as-builts status) showing these valve locations for cross-reference. A second complete set of valve schedules (8-1/2 in. x 11 in.) encased in clear plastic laminate and fitted in an aluminum holding frame shall be furnished to the Owner.
8. Test records and certifications.
9. Instruction period checklist.
10. Warranty information.

1.11 OPERATION AND MAINTENANCE INSTRUCTION AND TRAINING

A. The Contractor shall instruct the Owner's Representative(s) in the Operation and Maintenance procedures described in the Operation and Maintenance Manual. Comply with Division 1 requirements.

B. Individuals present shall include Contractors, Subcontractors, and equipment factory representatives. These individuals shall assist in instruction and start-up.
C. Minimum instruction time shall be eight (8) hours unless otherwise specifically noted.

D. All mechanical systems shall be properly functioning prior to instruction period.

E. Contractor shall prepare a checklist of all equipment and systems requiring instruction and maintenance for verification by the Owner's Representative of satisfactory start-up and instruction. A copy of this checklist shall be included in the Operation and Maintenance Manual.

1.12 GUARANTEE

A. Contractor shall guarantee the satisfactory operation of all material and equipment installed under Division 15 and shall repair or replace to the satisfaction of the Owner or Architect, any defective materials, equipment, or workmanship which may show itself within one year from the date of acceptance.

1.13 CLEANING

A. The Contractor shall, at all times, keep the premises free from accumulations of waste material or rubbish.

B. At completion of the job, the Contractor shall remove all tools, scaffolding, and surplus materials.

PART 2 - PRODUCTS

2.1 GENERAL MATERIALS AND EQUIPMENT REQUIREMENTS

A. All materials, in general, shall conform to the requirements of all agencies or publications specified and described in Division 1 of the Contract Specifications.

B. Materials and equipment to be provided shall be the standard catalog products of manufacturers regularly engaged in the manufacture of products conforming to these specifications, and shall essentially duplicate materials and equipment that have been in satisfactory use at least two years.

C. All pipe, fittings, and valves shall be domestic (USA) manufactured.

2.2 LISTED EQUIPMENT

A. The Idaho State Electrical Code requires that all materials, devices, appliances, and equipment, shall be of a type that conforms to applicable standards or be indicated as acceptable by the established standards of the Underwriter's Laboratories, Inc. or other electrical product testing laboratories which are accredited by the department.
B. This statement is being interpreted by the State Electrical Inspector as follows: It is understood that many specialty items such as cast iron boilers, certain items of air handling equipment and other building components are not available with a UL label covering the entire piece of equipment. The State will impose no requirement that an item of equipment be UL labeled unless it is available as a UL labeled items from at least two manufacturers. Electrical components of unlabeled equipment, such as motors, shall be labeled if they are available from at least two manufacturers.

C. If any building component is available with a UL label from at least two manufacturers, an identical or similar unlabeled component shall not be acceptable for installation in the State of Idaho. Should any such component be installed in the State of Idaho, it shall either be inspected and labeled by a UL representative or other authority approved by the State or it shall be replaced with a UL labeled component, before the building will be accepted by the State Electrical Inspector.

D. Consequently, it shall be the sole responsibility of the Contractor (through project suppliers and equipment manufacturers) to purchase and install only equipment bearing the UL label whenever that equipment so labeled is available. The Contractor, (should any equipment be installed without the proper UL label) shall bear the entire cost of correction to the satisfaction of the Idaho State Electrical Inspector.

2.3 SUBSTITUTIONS AND PRODUCT OPTIONS

A. Substitute equipment is encouraged if it is truly an equal to the specified items.

1. The items and/or equipment specified in the contract documents are standard manufacturers items found in suppliers catalogs, except it be indicated as special. The designer has taken time and effort to analyze, evaluate and prove to himself that the specified units will perform the function needed, wherein it is placed. This means the responsibility for the function of the specified equipment rests with the designer, who knows and understands what is to be accomplished.

2. If a supplier and/or the contractor desire to substitute equipment in place of a specified item, he may do so, but he takes upon himself or herself the full responsibility that the substituted equipment will equal all of the performing characteristics, functions, etc., and/or exceed the performance of the specified item. The substitute equipment shall be of such a physical size and weight that it will mount in the designated location without alterations to the building and the structure will carry the load. If for any reason the substitute equipment requires alterations or modification, in any form to the building and/or the structure, the costs shall be paid by the contractor and/or those requesting the substitutions.

3. Those interested in requesting a substitution shall submit a substitution request. The substitution request will be considered if it is at the office of the Engineer eight (8) working days prior to the day of bidding. The request shall include the following:
   a. A statement certifying that the equipment proposed is equal to that specified; that it has the same mechanical operating characteristics, compatible dimensions, weight, electrical characteristics and meets the function and intent of the equipment named in the contract documents
   b. The specification and catalog numbers of the substituted equipment
   c. A pictorial and specification brochure.
4. Because of the short bidding period, (from issuance of drawing to bid date), between the substitution request and the bid date, the designer does not have adequate time to make a full evaluation of substitute equipment. Therefore, those requesting the substitution must accept full responsibility for the items being submitted for substitution (operating characteristics, physical size, weight, output, not increase the load, etc.). If at any time during the course of construction, even up into the final completion, if the designer finds the equipment does not meet the design criteria, comply with the performance, etc., those requesting the substitution and the contractor have the responsibility to remove the substituted equipment and install the specified item at their expense. There shall be no cost assessed to the owner and/or the designer and the replacement will not delay the completion of the project.

D. Discrepancies between equipment specified and the intended function of equipment shall be brought to the attention of the Architect/Engineer in writing prior to bidding. Failure to report any conflict, including catalog numbers, discontinued products, etc., does not relieve the Contractor from meeting the intent of the contract documents, nor shall it change the contract cost. If the Contractor is unable to interpret any part of the plans and/or specifications, or should he find discrepancies therein, he shall bring this to the attention of the Architect/Engineer, who will issue interpretation and/or additional instructions to Bidders before the project is bid.

E. Any conflict arising from the use of substituted equipment shall be the responsibility of the contractor, who shall bear all costs required to make the equipment comply with the intent of the contract documents.

F. Samples may be required for non-standard or substituted items before installation during construction. Provide all samples as required.

G. No materials or apparatus may be substituted after the bid opening except where the equipment specified has been discontinued. This substitution may be made by a change order.

H. Approved equipment shall be so noted, in writing in a formally issued Project Addendum.

PART 3 - EXECUTION

3.1 COORDINATION

A. Each Contractor shall at all times cooperate with other trades on the job to avoid friction and delay to the progress of work. All points in dispute shall be referred to the Architect.

3.2 SUPERVISION

A. This Contractor shall have in charge of the work at all times a thoroughly competent superintendent. Comply with Division 1 requirements.

3.3 WORKMANSHIP

A. The work under the mechanical contract shall be performed by workers skilled in the particular trade and include all work necessary to properly complete the installation in a professional manner so as to present a neat and finished appearance.
3.4 EXAMINATION OF SITE

A. The Contractor shall visit the site of the proposed work and become familiar with the conditions affecting the work. Contractor shall verify all measurements at the building before beginning work.

3.5 SITE UTILITY SERVICES

A. Where applicable, the Contractor shall make connections to existing permanent cold water service immediately so as to provide the use of this service by other trades. Comply with Division 1 requirements.

3.6 LAYING OUT WORK

A. Locations of equipment and devices, as shown on the drawings, are approximate unless dimensioned. Exact locations of such items shall be determined by the Architect's representative and/or secured from special details and drawings. Verify the physical dimensions of each item of mechanical equipment to fit the available space and promptly notify the Architect/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.

B. The contractor shall hand deliver to the general contractor a written statement and/or a manufacturer’s brochure on the equipment being installed at each location. The information shall give the dimensions and weight (loads) of each unit being installed. The general contractor shall forward a copy of this information to the structural engineer and obtain from him confirmation that the building structure will accommodate the loads. If there be any problem the questioning party shall notify the mechanical engineer by phone and in writing.

3.7 CONTRACTOR COORDINATION

A. In the course of installing the systems defined in the contract documents, the contractor shall closely follow the plans, details and specifications (contract documents). The system design has been a careful and laborious undertaking, with the intent purpose of producing a system and/or systems that will serve the owner well with a minimum of maintenance. Thence, the contractor shall adhere as closely as possible to the plans, details and specifications for each system. Questions and suggestions are encouraged as the project is being assembled. If for any reason, the contractor feels to deviate from the defined information, and finds a way, to improve the system, to make the system more easily assembled, make it operate more efficiently, etc., the contractor shall suggest the change to the engineer. Systems are designed to perform a specific function; the most minute change in assembly may change the function. If the engineer agrees with the change he will authorize the contractor to proceed. Contractor cooperation and coordination is appreciated. If the contractor proceeds on construction without the designer’s authorization, it shall be reworked, in accordance to plans and specifications, which work shall be at the contractor’s expense.
3.8 CUTTING AND PATCHING

A. All cutting and patching of new or existing construction required for installation of mechanical systems and equipment specified in Division 15 shall be the responsibility of the Mechanical Contractor unless otherwise noted. Comply with Division 1 for general requirements for cutting and patching.

B. All cutting shall be performed with masonry saws, core drills or similar equipment to provide neat and uniform openings.

C. All patching shall match adjacent surfaces in materials and finish. Do not endanger or damage installed work through procedures and processes of cutting and patching.

D. Arrange for repairs required to restore other work, because of damage caused as a result of mechanical installations.

E. No additional compensation will be authorized for cutting and patching work that is necessitated by ill-timed, defective, or non-conforming installations.

F. Perform cutting, fitting, and patching of mechanical equipment and materials required to:
   1. Uncover work to provide for installation of ill-timed work.
   2. Remove and replace defective work.
   3. Remove and replace work not conforming to requirements of the Contract Documents.
   4. Remove samples of installed work as specified for testing.
   5. Install equipment and materials in existing structures.

G. Upon written instructions from the Architect/Engineer, uncover and restore work to provide for Architect/Engineer observation of concealed work.

H. Cut, remove and legally dispose of selected mechanical equipment, components, and materials as indicated, including, but not limited to removal of mechanical piping, heating units, plumbing fixtures and trim, and other mechanical items made obsolete by the new work.

I. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

J. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

3.9 EXCAVATION AND BACKFILL

A. Contractor shall provide all necessary excavation, shoring, and backfilling required for proper installation of mechanical work inside and outside the building. During excavation, material satisfactory for backfilling shall be stockpiled in an orderly manner at a distance from the banks of the trench equal to ½ the depth of the excavation, but in no instance closer than 2 feet. Excavated material not required or not satisfactory for backfill shall be removed from the site and shall be disposed of in designated areas approved for surplus material storage. Grading shall be done as necessary to prevent surface water from flowing into the excavation, and any water accumulating therein shall be removed so that the stability of the bottom and sides of the excavation is maintained.
COUNTY FAIRGROUNDS BUILDING  
CACHE COUNTY

B. Trenches shall be excavated to depth indicated or required to establish indicated slope and invert elevations and to support bottom of piping or conduit on undisturbed soil. Trenches shall be of uniform width, sufficient to provide ample working room and a minimum of 6 to 9 inches of clearance on both sides of pipe or conduit.

C. The bottoms of trenches shall be accurately graded to provide uniform bearing and support for the bottom quadrant of each section of the pipe. Bell holes shall be excavated to the necessary size at each joint or coupling to eliminate point bearing. Stones of 3 inches or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, shall be removed to avoid point bearing. Where unyielding material is encountered in the bottom of the trench, such material shall be removed 6 inches below the required grade and replaced with materials described below for bedding.

D. Excavation for manholes, catch basins, inlets, or similar structures shall be sufficient to leave at least 12 inches clear between the outer structure surfaces and the face of the excavation or support members. When concrete or masonry is to be placed in an excavated area, special care shall be taken not to disturb the bottom of the excavation. Excavation to the final grade level shall not be made until just before the concrete or masonry is to be placed.

E. Bedding material shall be clean, sand-gravel mixture free from organic matter and conforming to the following gradation when tested in accordance with ASTM D 422.

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<tr>
<th>U.S. Standard</th>
<th>Percent Passing</th>
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<tr>
<td>1-Inch</td>
<td>100</td>
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<tr>
<td>No. 4</td>
<td>25-80</td>
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<tr>
<td>No. 200</td>
<td>0-10</td>
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F. Bedding material shall be placed to a depth of 6 inches (6") over the top of piping. The bedding shall be brought up evenly on both sides of the pipe for the full length of the pipe.

G. Backfill for the remainder of the trench shall be satisfactory soil materials complying with ASTM D2487 soil classification groups GW, GP, GM, SM, SW, and SP.

H. Backfill soil materials shall be free of clay, rock or gravel larger than 2 inches in any dimension, debris, waste, frozen materials, vegetation and other deleterious matter.

I. Backfill to the required grade shall be placed in layers not exceeding 6 inches loose thickness for compaction by hand operated machine compactors, and 8 inches loose thickness for other than hand operated machines otherwise specified. Each layer shall be compacted to density as specified in Section 02200.

J. No underground lines shall be covered until the installation has been approved by the inspector having jurisdiction and the Owner's Representative.

K. Provide 4 inch thick concrete base slab support for piping less than 2'-6" below surface of roadways. After installation and testing of piping, provide minimum 4 inch thick encasements (sides and top) of concrete prior to backfilling or placement of roadway subbase.
L. Bracing and shoring shall be provided where depth of excavation or character of ground render it necessary for personnel protection. Shoring shall be constructed of heavy timber planking with timber supports and shall conform with local and state safety laws and regulations.

M. Removal of bracing and shoring materials shall be done before backfilling except where necessary to insure against caving; in which case, it shall be withdrawn while backfilling is being done.

N. Provide barricades around all excavation. Barricades to be securely constructed.

O. The Contractor shall exercise extreme care while excavating in the area of utilities, carefully check for location of all possible utilities, whether shown on the drawings or not, and establish the location of all cutoff valves for ready shut-off of service in case of emergency. The Contractor shall be completely responsible for all damage to any utilities caused in excavating as well as damage to personnel and property caused by said damaged utilities whether shown on the drawings or not.

3.10 REPLACEMENT OF PAVING AND CONCRETE

A. All existing or new sidewalks, concrete paving, curbs, or asphalt paving removed or damaged by this Contractor during the period of the installation or as a result thereof, shall be replaced with like material in a manner as directed by and to the satisfaction of the Owner's Representative. Comply with Division 2 General Requirements.

3.11 OPENINGS IN PIPES AND DUCTS

A. All temporary openings in pipes and ducts shall be capped or sealed during construction. Caps shall be removed for final connections.

3.12 PROTECTION OF MATERIALS AND EQUIPMENT

A. Contractor shall be held responsible for any and all materials and equipment to be installed under this contract and will be required to make good at his own cost any injury or damage which materials or equipment may sustain from any source or cause whatsoever before final acceptance. Comply with Division 1 requirements.

3.13 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.

B. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.

C. Coordinate deliveries of mechanical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.
3.14 ACCESSIBILITY

A. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing.

B. Access doors or hatches required for servicing of mechanical equipment shall be furnished and installed as specified in the other Divisions of the Specifications.

3.15 PAINTING

A. Contractor shall touch-up scratched or damaged factory finishes of mechanical equipment. Comply with Division 1 requirements.

B. Unless otherwise noted, all other painting of mechanically related items shall be according to Division 9, Section 09900 "PAINTING".

3.16 LUBRICATION

A. Contractor shall properly lubricate all pieces of equipment before turning the building over to the Owner. Comply with Division 1 requirements.

3.17 FINAL CLEANING

A. Refer to Division 1 for general requirements for final cleaning.

B. At time of final cleanup, all fixtures and equipment shall be thoroughly cleaned and left in condition for use.

3.18 FIRE PENETRATION SEALS

A. All penetrations through fire rated floors and walls shall be sealed to prevent the spread of smoke, fire, toxic gas or water through the penetration before, during or after a fire. The fire rating of the penetration seal shall be at least that of the floor to wall into which it is installed so that the original fire rating of the floor or wall is maintained.

B. The sealant shall remain soft and pliable to allow for the removal and/or addition of piping without the necessity of drilling holes. It shall adhere to itself to allow any and all repairs to be made with the same material. It shall permit the vibration, expansion and/or contraction of piping and ducts going through the penetration without the seal cracking or crumbling.

C. When damming materials are to be left in place after the seal is complete, all such materials shall be non-flammable.

D. When sealant is injected into a penetration, the foam shall expand to surround all items within the penetration and maintain pressure against the walls of the penetration. The foam shall cure within five minutes and be fire resistant at that time. No heat shall be required to further expand the foam to block the passage of fire and smoke or water.
E. All wall or floor penetration openings shall be as small as possible.

F. The foam sealant shall meet all of the fire test and hose stream test requirements of ASTM E119-73 and shall be UL classified as a Wall Opening Protective Device. The sealant shall be CHASE-FOAM, CTC PR-855 Fire Resistant Foam Sealant from Chase Technology Corporation, Huntington Station, New York 11746 or 3M Brand Fire Barrier caulk CP25, putty 303, wrap/strip FS 195 or sheet CS 195 from 3M Products Divisions, 224-4N 3M Center, St. Paul, MN 55144-1000.

3.19 TESTING, ADJUSTING, AND BALANCING

A. The air distribution systems shall be balanced by a Balancing or Engineering Firm with five years experience in HVAC design and balancing. The report shall be stamped by a licensed engineer and certified by NEBB. The Balancing firm shall furnish the necessary instruments for making tests and performing work. The Mechanical Contractor shall include in his contract all costs including the Balancing Firm's charges.

B. Balancing work shall not be started until such time as the following conditions are completely fulfilled:

1. All systems shall be completely installed and shall have been successfully test run, and fully operational.
2. All outlets, dampers, balancing devices, and accessories shall be completely installed.
3. Filters and strainers shall be clean.
4. All wiring shall be completed, including all interlocks and heaters.
5. Control system shall be completely installed, tested, and all instruments shall be calibrated.
6. Proper fan rotation shall be verified.

C. The Contractor shall furnish the project foreman to aid the Balancing Firm in balancing the system. The foreman shall be in constant attendance and shall make all equipment adjustments as required.

D. The Contractor shall furnish all ladders, scaffolding, and tools required for access and adjustment. High scaffolding will be required in areas with ceiling over 12 ft.

E. The Contractor shall furnish and install all required exchanges of adjustable sheaves and V-belt drives necessary for proper balance of the system to obtain the desired air balancing of systems.

F. The Automatic Controls Subcontractor shall furnish a man, available upon request, to make necessary adjustments in the control system during the balancing.

G. The balancing agency shall submit in quadruplicate on neat and legible forms the full report of systems operation, initial and final readings.

H. All instruments used for measurements shall be accurate and calibration histories for each instrument shall be available for examination. The Mechanical Engineer has the right to request instrument recalibration, or the use of other instruments, where accuracy of readings is questionable.
COUNTY FAIRGROUNDS BUILDING
CACHE COUNTY

I. Furnish in the report a written guarantee to be effective for one year from the date of acceptance, to make any and all adjustments required to maintain comfort in all rooms and areas.

J. Air balancing shall include the following:

1. Set supply and exhaust fans at design speeds and record average amperage readings on all motor phases, static pressures and CFM of air flow in each system.
2. Read air flows at registers, grilles, and diffusers with a velometer or equal air measuring device. Adjust dampers as required. Outlets shall be adjusted to design CFM plus or minus 10%.
3. Adjust minimum outside air dampers to design CFM or 10% of supply air total CFM.
4. Adjust fans as required to meet design. Check for drafts, noise and vibration.
5. After balancing is complete, mark final position of balancing dampers.
6. Report any discrepancies immediately to the Mechanical Design Engineer.

K. Upon completion of testing, adjusting and balancing of the air and/or water systems, prepare a complete and legible draft report. Submit two (2) copies of the draft report to the Mechanical Design Engineer for review.

L. Upon verification and approval of the draft reports, prepare final reports. Four (4) typewritten, organized and formatted copies of the final report are required. Furnish one (1) copy to the Mechanical Design Engineer for his record, and the remaining three (3) copies are to be included in the Owner's Operation and Maintenance Manuals.

END OF SECTION 15010
SECTION 15030 - ELECTRICAL PROVISIONS OF MECHANICAL WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This section specifies the basic requirements for electrical components which are an integral part of packaged mechanical equipment. These components include, but are not limited to factory installed motors, starters, and disconnect switches furnished as an integral part of packaged mechanical equipment.

B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for mechanical equipment are specified within the individual equipment specifications or scheduled on the drawings.

C. All magnetic motor starters and disconnect switches not furnished as an integral part of packaged mechanical equipment shall be provided under Division 15 - Mechanical.

D. Wiring from motors of mechanical equipment to disconnect switches or junction boxes, including pushbuttons, pilot lights, interlocks, speed controllers, and similar devices shall be the responsibility of this Contractor under Division 15 where not specifically indicated under Division 16.

E. Wiring of field-mounted float control switches, flow control switches, and similar mechanical/electrical devices provided for mechanical systems, to equipment control panels shall be the responsibility of this Contractor under Division 15 where not specifically indicated under Division 16.

F. Wiring required for Automatic Controls Section 15900 shall be the responsibility of this Contractor under Division 15.

1.3 REFERENCES

A. NEMA Standard MG1: Motors and Generators.

B. NEMA Standard ICS2: Industrial Control Devices, Controllers and Assemblies.


1.4  SUBMITTALS

A. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves as required by the individual equipment specification sections.

1.5  QUALITY ASSURANCE

A. All electrical components and materials shall be labeled by an approved testing agency (UL, ETL, CSA, etc.).

PART 2 - PRODUCTS

2.1  MOTORS

A. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment specifications.

1. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.
2. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range.
3. Two-speed motors shall have two separate windings on poly-phase motors.
4. Temperature Rating: Rated for 40°C environment with maximum 50°C temperature rise for continuous duty at full load (Class A insulation). Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors.

B. Motor Construction: NEMA Standard MG 1, general purpose, continuous duty, Design "B", except "C" where required for high starting torque.

C. Frames: NEMA Standard No. 48 or 54; use driven equipment manufacturer's standards to suit specific application.

D. Bearings: Ball or roller bearings with inner and outer shaft seals; regreaseable, except permanently sealed where motor is normally inaccessible for regular maintenance; designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor; for fractional horsepower, light duty motors, sleeve type bearings are permitted.

E. Enclosure Type: Open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation; guarded drip-proof motors where exposed to contact by employee or building occupants; weather-protected Type I for outdoor use, Type II where not housed.

F. Overload Protection: Built-in thermal overload protection and, where indicated, internal sensing device suitable for signaling and stopping motor at starter.

G. Noise Rating: "Quiet" rating on motors located in occupied spaces of building.
H. Efficiency: "Energy efficient" motors shall have a minimum efficiency as scheduled in accordance with IEEE Standard 112, test method "B". If efficiency not specified, motors shall have a higher efficiency than "average standard industry motors", in accordance with IEEE Standard 112, test method "B".

I. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, special features, and similar information.

2.2 STARTERS, ELECTRICAL DEVICES, AND WIRING

A. Motor Starter Characteristics: Enclosures NEMA, general purpose enclosures with padlock ears, except in wet location shall be NEMA 3R with conduit hubs. Type and size of starter shall be as recommended by motor manufacturer and the driven equipment manufacturer for applicable protection and startup condition.

B. Manual switches shall have pilot lights and extra positions for multi-speed motors. Overload protection shall be melting alloy type thermal overload relays.

C. Magnetic starters shall have maintained contact pushbuttons and pilot lights, properly arranged for single speed or multi-speed operation as indicated; trip-fee thermal overload relays each phase, interlocks, pneumatic switches and similar devices as required for coordination with control requirements of Division 15 Controls sections, built-in 120 volt control circuit transformer, fused from line side, where service exceeds 240 volts; externally operated manual reset, under-voltage release or protection.

D. Motor connections shall have flexible conduit, except where plug-in electrical cords are specifically indicated.

2.3 CAPACITORS

A. Features shall include individual unit cells, all welded steel housing, each capacitor internally fused, non-flammable synthetic liquid impregnated, craft tissue insulation and aluminum foil electrodes.

B. KVAR size shall be as required to correct motor power factor to 90 percent or better and shall be installed on all motors 1 horsepower or larger, that have an uncorrected power factor of less than 85 percent at rated load.

PART 3 - EXECUTION

(Not Applicable).

END OF SECTION 15030
SECTION 15040 - VARIABLE FREQUENCY DRIVES

PART 1-GENERAL

1.1 DESCRIPTION

A. This specification is to cover a complete Variable Frequency motor Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use with a standard NEMA Design B induction motor.

B. The drive manufacturer shall supply the drive and all necessary options as herein specified. The manufacturer shall have been engaged in the production of this type of equipment for a minimum of twenty years. VFD’s that are manufactured by a third party and “brand labeled” shall not be acceptable. All VFDs installed on this project shall be from the same manufacturer.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. Institute of Electrical and Electronic Engineers (IEEE)

2. Underwriters laboratories
   a) UL508C

3. National Electrical Manufacturer’s Association (NEMA)
   a) ICS 7.0, AC Adjustable Speed Drives

4. IEC 16800 Parts 1 and 2

5. National Electric Code (NEC)
   a) NEC 430.120, Adjustable-Speed Drive Systems

   a) IBC 2006 Seismic – referencing ASC 7-05 and ICC AC-156

B. Qualifications:

1. VFDs and options shall be UL listed as a complete assembly. VFD’s that require the customer to supply external fuses for the VFD to be UL listed are not acceptable. VFDs with red label UL stickers, requiring additional branch circuit protection are not acceptable. The base VFD shall be UL listed for 100 KAIC without the need for input fuses.

2. CE Mark – The VFD shall conform to the European Union ElectroMagnetic Compatibility directive, a requirement for CE marking. The VFD shall meet product standard EN 61800-3 for the First Environment restricted level.

3. The entire VFD enclosure, including the bypass shall be seismically certified and labeled as such in accordance with the 2006 International Building Code (IBC):
   a) VFD manufacturer shall provide Seismic Certification and Installation requirements at time of submittal.
   b) Seismic importance factor of 1.5 rating is required, and shall be based upon actual shake test data as defined by ICC AC-156.
c) Seismic ratings based upon calculations alone are not acceptable. Certification of Seismic rating must be based on testing done in all three axis of motion.

4. Acceptable Manufactures
   a) ABB ACH Series.
   b) Alternate manufacturer’s requests must be submitted in writing to the Engineer for approval at least 20 working days prior to bid. Approval does not relieve the supplier of specification requirements.

5. The VFD manufacturer shall have available a comprehensive, HVAC Drive Computer Based Training (CBT) product. The CBT product shall include detailed, interactive sections covering VFD unpacking, proper mechanical and electrical installation, and programming. The CBT product shall allow the user to provide just-in-time training to new personnel or refresher training for maintenance and repair personnel on the user’s site. The CBT product shall be repeatable, precise and shall include record keeping capability. The CBT product shall record answers to simulations and tests by student ID number. The CBT product must be professionally produced and have interactive sections, student tests, and include video clips of proper wiring and installation.

1.3 SUBMITTALS

A. Submittals shall include the following information:
   1. Outline dimensions, conduit entry locations and weight.
   2. Customer connection and power wiring diagrams.
   3. Complete technical product description including a complete list of options provided. Any portions of this specification not meet must be clearly indicated or the supplier and contractor shall be liable to provide all additional components required to meet this specification.
   4. Compliance to IEEE 519 – harmonic analysis for particular jobsite including total harmonic voltage distortion and total harmonic current distortion (TDD).
      a) The VFD manufacturer shall provide calculations; specific to this installation, showing total harmonic voltage distortion is less than 5%. Input filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with IEEE standard 519. All VFD’s shall include a minimum of 5% impedance reactors, no exceptions.
PART 2 – PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES

A. The VFD package as specified herein shall be enclosed in a UL Listed Type enclosure, exceeding NEMA enclosure design criteria (enclosures with only NEMA ratings are not acceptable), completely assembled and tested by the manufacturer in an ISO9001 facility. The VFD tolerated voltage window shall allow the VFD to operate from a line of +30% nominal, and -35% nominal voltage as a minimum.

1. Environmental operating conditions: VFDs shall be capable of continuous operation at 0 to 50°C (32 to 122°F) ambient temperature as per VFD manufacturers documented/submittal data or VFD must be oversized to meet these temperature requirements. Not acceptable are VFD’s that can only operate at 40°C intermittently (average during a 24 hour period) and therefore must be oversized. Altitude 0 to 3300 feet above sea level, less than 95% humidity, non-condensing. All circuit boards shall have conformal coating.

2. Enclosure shall be rated UL Type 1 and shall be UL listed as a plenum rated VFD. VFD’s without these ratings are not acceptable. NEMA only type 1 enclosures are not acceptable (must be UL Type 1).

B. All VFDs shall have the following standard features:

1. All VFDs shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.

2. The keypad shall include Hand-Off-Auto selections and manual speed control. The drive shall incorporate “bumpless transfer” of speed reference when switching between “Hand” and “Auto” modes. There shall be fault reset and “Help” buttons on the keypad. The Help button shall include “on-line” assistance for programming and troubleshooting.

3. There shall be a built-in time clock in the VFD keypad. The clock shall have a battery back up with 10 years minimum life span. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault. If the battery fails, the VFD shall automatically revert to hours of operation since initial power up. Capacitor back-up is not acceptable. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter sets and output Form-C relays. The VFD shall have a digital input that allows an override to the time clock (when in the off mode) for a programmable time frame. There shall be four (4) separate, independent timer functions that have both weekday and weekend settings.

4. The VFD’s shall utilize pre-programmed application macro’s specifically designed to facilitate start-up. The Application Macros shall provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time. The VFD shall have two user macros to allow the end-user to create and save custom settings.

5. The VFD shall have cooling fans that are designed for easy replacement. The fans shall be designed for replacement without requiring removing the VFD from the wall or removal of circuit boards. The VFD cooling fans shall operate only when required. To extend the fan and bearing operating life, the VFD shall cycle the cooling fans on and off as required.
6. The VFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to set point without tripping or component damage (flying start).

7. The VFD shall have the ability to automatically restart after an over-current, over-voltage, under-voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between attempts shall be programmable.

8. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430.250 for 4-pole motors.

9. The VFD shall have internal 5% impedance reactors to reduce the harmonics to the power line and to add protection from AC line transients. The 5% impedance may be from dual (positive and negative DC bus) reactors, or 5% AC line reactors. VFD’s with only one DC reactor shall add an AC line reactor.

10. The input current rating of the VFD shall be no more than 3% greater than the output current rating. VFD’s with higher input current ratings require the upstream wiring, protection devices, and source transformers to be oversized per NEC 430.120. Input and output current ratings must be shown on the VFD nameplate.

11. The VFD shall have a coordinated AC transient surge protection system consisting of 4-120 joule rated MOV’s (phase to phase and phase to ground), a capacitor clamp, and 5% impedance reactors.

12. The VFD shall provide a programmable loss-of-load (broken belt / broken coupling) Form-C relay output. The drive shall be programmable to signal the loss-of-load condition via a keypad warning, Form-C relay output, and / or over the serial communications bus. The loss-of-load condition sensing algorithm shall include a programmable time delay that will allow for motor acceleration from zero speed without signaling a false loss-of-load condition.

13. The VFD shall have user programmable underload and overload curve functions to allow user defined indications of broken belt or mechanical failure / jam condition causing motor overload.

14. The VFD shall include multiple “two zone” PID algorithms that allow the VFD to maintain PID control from two separate feedback signals (4-20mA, 0-10V, and / or serial communications). The two zone control PID algorithm will control motor speed based on a minimum, maximum, or average of the two feedback signals. All of the VFD PID controllers shall include the ability for “two zone” control.

15. If the input reference (4-20mA or 2-10V) is lost, the VFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The drive shall be programmable to signal this condition via a keypad warning, Form-C relay output and / or over the serial communication bus.

16. The VFD shall have programmable “Sleep” and “Wake up” functions to allow the drive to be started and stopped from the level of a process feedback signal.

C. All VFDs to have the following adjustments:

1. Three (3) programmable critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed. The lockout range must be fully adjustable, from 0 to full speed.
2. Two (2) PID Set point controllers shall be standard in the drive, allowing pressure or flow signals to be connected to the VFD, using the microprocessor in the VFD for the closed-loop control. The VFD shall have 250 ma of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others. The PID set point shall be adjustable from the VFD keypad, analog inputs, or over the communications bus. There shall be two independent parameter sets for the PID controller and the capability to switch between the parameter sets via a digital input, serial communications or from the keypad. The independent parameter sets are typically used for night setback, switching between summer and winter set points, etc.

3. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain the set point of an independent process (ie. valves, dampers, etc.). All set points, process variables, etc. to be accessible from the serial communication network.

4. Two (2) programmable analog inputs shall accept current or voltage signals.

5. Two (2) programmable analog outputs (0-20ma or 4-20 ma). The outputs may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, Active Feedback, and other data.

6. Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices. All digital inputs shall be programmable to initiate upon an application or removal of 24VDC or 24VAC.

7. Three (3) programmable, digital Form-C relay outputs. The relay outputs shall include programmable on and off delay times and adjustable hysteresis. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; Maximum voltage 300 VDC and 250 VAC; continuous current rating of 2 amps RMS. Outputs shall be true Form-C type contacts; open collector outputs are not acceptable.

8. Run permissive circuit - There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad, input contact closure, time-clock control, or serial communications), the VFD shall provide a dry contact closure that will signal the damper to open (VFD motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to a VFD digital input and allows VFD motor operation. Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop and the damper shall be commanded to close. The keypad shall display “start enable 1 (or 2) missing”. The safety input status shall also be transmitted over the serial communications bus.

9. The VFD control shall include a programmable time delay for VFD start and a keypad indication that this time delay is active. A Form C relay output provides a contact closure to signal the VAV boxes open. This will allow VAV boxes to be driven open before the motor operates. The time delay shall be field programmable from 0 – 120 seconds. Start delay shall be active regardless of the start command source (keypad command, input contact closure, time-clock control, or serial communications), and when switching from drive to bypass.

10. Seven (7) programmable preset speeds.

11. Two independently adjustable accel and decel ramps with 1 – 1800 seconds adjustable time ramps.

12. The VFD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and reduce audible motor noise. The VFD shall have selectable software for optimization of motor noise, energy consumption, and motor speed control.
13. The VFD shall include a carrier frequency control circuit that reduces the carrier frequency based on actual VFD temperature that allows higher carrier frequency settings without derating the VFD.

14. The VFD shall include password protection against parameter changes.

D. The Keypad shall include a backlit LCD display. The display shall be in complete English words for programming and fault diagnostics (alpha-numeric codes are not acceptable). All VFD faults shall be displayed in English words. The keypad shall include a minimum of 14 assistants including:

1. Start-up assistant
2. Parameter assistants
   a. PID assistant
   b. Reference assistant
   c. I/O assistant
   d. Serial communications assistant
   e. Option module assistant
   f. Panel display assistant
   g. Low noise set-up assistant

3. Maintenance assistant
4. Troubleshooting assistant
5. Drive optimizer assistants

E. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable):
   - Output Frequency
   - Motor Speed (RPM, %, or Engineering units)
   - Motor Current
   - Motor Torque
   - Motor Power (kW)
   - DC Bus Voltage
   - Output Voltage

F. The VFD shall include a fireman’s override input. Upon receipt of a contact closure from the fire / smoke control station, the VFD shall operate in one of two modes: 1) Operate at a programmed predetermined fixed speed ranging from -500Hz (reverse) to 500Hz (forward). 2) Operate in a specific fireman’s override PID algorithm that automatically adjusts motor speed based on override set point and feedback. The mode shall override all other inputs (analog/digital, serial communication, and all keypad commands), except customer defined safety run interlocks, and force the motor to run in one of the two modes above. “Override Mode” shall be displayed on the keypad. Upon removal of the override signal, the VFD shall resume normal operation, without the need to cycle the normal digital input run command.
G. Serial Communications

1. The VFD shall have an EIA-485 port as standard. The standard protocols shall be Modbus, Johnson Controls N2, Siemens Building Technologies FLN, and BACnet. [Optional protocols for LonWorks, Profibus, EtherNet, BACnet IP, and DeviceNet shall be available.] Each individual drive shall have the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be “certified” by the governing authority (i.e. BTL Listing for BACnet). Use of non-certified protocols is not allowed.

2. The BACnet connection shall be an EIA-485, MS/TP interface operating at 9.6, 19.2, 38.4, or 76.8 Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC including, but not limited to:
   a. Data Sharing – Read Property – B.
   b. Data Sharing – Write Property – B.
   e. Device Management – Communication Control – B.

3. If additional hardware is required to obtain the BACnet interface, the VFD manufacturer shall supply one BACnet gateway per drive. Multiple VFDs sharing one gateway shall not be acceptable.

4. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible.

5. Serial communication in bypass shall include, but not be limited to; bypass run-stop control, the ability to force the unit to bypass, and the ability to lock and unlock the keypad. The bypass shall have the capability of allowing the DDC to monitor feedback such as, current (in amps), kilowatt hours (resettable), operating hours (resettable), and bypass logic board temperature. The DDC shall also be capable of monitoring the bypass relay output status, and all digital input status. All bypass diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote bypass fault reset shall be possible.

6. The VFD / bypass shall allow the DDC to control the drive and bypass digital and analog outputs via the serial interface. This control shall be independent of any VFD function. The analog outputs may be used for modulating chilled water valves or cooling tower bypass valves. The drive and bypass’ digital (Form-C relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the drive and bypass’ digital inputs shall be capable of being monitored by the DDC system. This allows for remote monitoring of which (of up to 4) safeties are open.
7. The VFD shall include an independent PID loop for customer use. The independent PID loop may be used for cooling tower bypass valve control, chilled water valve / hot water valve control, etc. Both the VFD PID control loop and the independent PID control loop shall continue functioning even if the serial communications connection is lost. As default, the VFD shall keep the last good set point command and last good DO & AO commands in memory in the event the serial communications connection is lost and continue controlling the process.

H. EMI / RFI filters. All VFD’s shall include EMI/RFI filters. The onboard filters shall allow the VFD assembly to be CE Marked and the VFD shall meet product standard EN 61800-3 for the First Environment restricted level with up to 100 feet of motor cable. No Exceptions. Certified test reports shall be provided with the submittals confirming compliance to EN 61800-3, First Environment.

I. All VFD’s through 75HP at 480 V shall be protected from input and output power mis-wiring. The VFD shall sense this condition and display an alarm on the keypad. The VFD shall not sustain damage from this power mis-wiring condition.

J. BYPASS CONTROLLER

1. A complete factory wired and tested bypass system consisting of a door interlocked, padlockable circuit breaker, output contactor, bypass contactor, and fast acting VFD input fuses are required. UL Listed motor overload protection shall be provided in both drive and bypass modes.

2. The bypass enclosure door and VFD enclosure must be mechanically interlocked such that the disconnecting device must be in the “Off” position before either enclosure may be accessed.

3. The VFD and bypass package shall have a UL listed short circuit current rating (SCCR) of 100,000 amps and this rating shall be indicated on the UL data label.

4. The drive and bypass package shall be seismic certified and labeled to the IBC:
   a. Seismic importance factor of 1.5 rating is required, and shall be based upon actual shake table test data as defined by ICC AC-156.

5. Drive Isolation Fuses - To ensure maximum possible bypass operation, fast acting fuses, exclusive to the VFD, shall be provided to allow the VFD to disconnect from the line prior to clearing upstream branch circuit protection. This maintains bypass operation capability in the event of a VFD failure. Bypass designs which have no such fuses, or that incorporate fuses common to both the VFD and the bypass, will not be accepted.

6. The system (VFD and Bypass) tolerated voltage window shall allow the system to operate from a line of +30%, -35% nominal voltage range. The system shall incorporate circuitry that will allow the drive or bypass contactor to remain “sealed in” over this voltage tolerance at a minimum.

7. The bypass shall maintain positive contactor control through the voltage tolerance window of nominal voltage +30%, -35%. This feature is designed to avoid contactor coil failure during brown out / low line conditions and allow for input single phase operation when in the VFD mode. Designs that will not allow input single phase operation in the VFD mode are not acceptable.

8. Motor protection from single phase power conditions - the bypass system must be able to detect a single phase input power condition while running in bypass, disengage the motor in a controlled fashion, and give a single phase input power indication. Bypass systems not incorporating single phase protection in bypass mode are not acceptable.
9. The bypass system shall NOT depend on the VFD for bypass operation. The bypass system shall be designed for stand alone operation and shall be completely functional in both Hand and Automatic modes even if the VFD has been removed from the system for repair / replacement. Serial communications shall remain functional even with the VFD removed.

10. Serial communications – the bypass shall be capable of being monitored and / or controlled via serial communications. On-board communications protocols shall include ModBus; Johnson Controls N2; Siemens Building Technologies FLN (P1); and BACnet.

11. Serial communication capabilities shall include, but not be limited to; bypass run-stop control; the ability to force the unit to bypass; and the ability to lock and unlock the keypad. The bypass shall have the capability of allowing the DDC to monitor feedback such as, current (in amps), kilowatt hours (resettable), operating hours (resettable), and bypass logic board temperature. The DDC shall also be capable of monitoring the bypass relay output status, and all digital input status. All bypass diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote bypass fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus and / or via a Form-C relay output – keypad “Hand” or “Auto” selected, bypass selected, and broken belt indication. The DDC system shall also be able to monitor if the motor is running in the VFD mode or bypass mode over serial communications. A minimum of 50 field serial communications points shall be capable of being monitored in the bypass mode.

12. The bypass serial communications shall allow control of the bypass’ digital outputs via the serial interface. This control shall be independent of any bypass function or operating state. The bypass’ digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the bypass’ digital inputs shall be capable of being monitored by the DDC system.

13. There shall be an adjustable motor current sensing circuit for the bypass and VFD modes to provide proof of flow (broken belt) indication. The condition shall be indicated on the keypad display, transmitted over the building automation protocol and / or via a Form-C relay output contact closure. The broken belt indication shall be programmable to be a system (drive and bypass) indication. The broken belt condition sensing algorithm shall be programmable to cause only a warning or a fault and / or system shutdown.

14. The digital inputs for the system shall accept 24VAC or 24VDC. The bypass shall incorporate an internally sourced power supply and not require an external control power source. The bypass power board shall supply 250 ma of 24 VDC for use by others to power external devices.

15. There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad command, time-clock control, digital input, or serial communications) the bypass shall provide a dry contact closure that will signal the damper to open (motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to a bypass system input and allows motor operation. Up to four separate safety interlock inputs shall be provided. When any safety is opened, the motor shall be commanded to coast to stop, and the damper shall be commanded to close. This feature will also operate in Fireman’s override / smoke control mode.

16. The bypass control shall monitor the status of the VFD and bypass contactors and indicate when there is a welded contactor contact or open contactor coil. This failed contactor condition shall be indicated on the bypass LCD display, programmed to fire a Form-C relay output, and / or over the serial communications protocol.
17. The bypass control shall include a programmable time delay for bypass start and keypad indication that this time delay is in process. A Form C relay output provides a contact closure to signal the VAV boxes open. This will allow VAV boxes to be driven open before the motor operates at full speed in the bypass mode. The time delay shall be field programmable from 0 – 120 seconds.

18. There shall be a keypad adjustment to select manual or automatic transfer bypass. The user shall be able to select via keypad programming which drive faults will result in an automatic transfer to the bypass mode and which faults require a manual transfer to bypass. The user may select whether the system shall automatically transfer from drive to bypass mode on the following drive fault conditions:
   a. Over current
   b. Over voltage
   c. Under voltage
   d. Loss of analog input

19. The following operators shall be provided:
   a. Bypass Hand-Off-Auto
   b. Drive mode selector
   c. Bypass mode selector
   d. Bypass fault reset

20. The bypass shall include a two line, 20 character LCD display. The display shall allow the user to access and view:
   a. Energy savings – in US dollars
   b. Bypass motor amps
   c. Bypass input voltage– average and individual phase voltage
   d. Bypass power (kW)
   e. Bypass faults and fault logs
   f. Bypass warnings
   g. Bypass operating time (resettable)
   h. Bypass energy (kilowatt hours – resettable)
   i. I/O status
   j. Parameter settings / programming
   k. Printed circuit board temperature

21. The following indicating lights (LED type) or keypad display indications shall be provided. A test mode or push to test feature shall be provided.
   a. Power-on (Ready)
   b. Run enable
   c. Drive mode selected
   d. Bypass mode selected
   e. Drive running
   f. Bypass running
   g. Drive fault
   h. Bypass fault
   i. Bypass H-O-A mode
   j. Automatic transfer to bypass selected
   k. Safety open
   l. Damper opening
   m. Damper end-switch made
22. The Bypass controller shall have six programmable digital inputs, and five programmable Form-C relay outputs. This I/O allows for a total System (VFD and Bypass) I/O count of 24 points as standard. The bypass I/O shall be available to the BAS / DDC system even with the VFD removed.

23. The on-board Form-C relay outputs in the bypass shall programmable for any of the following indications.
   a. System started
   b. System running
   c. Bypass override enabled
   d. Drive fault
   e. Bypass fault
   f. Bypass H-O-A position
   g. Motor proof-of-flow (broken belt)
   h. Overload
   i. Bypass selected
   j. Bypass run
   k. System started (damper opening)
   l. Bypass alarm
   m. Over temperature

24. The bypass shall provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in VFD or Bypass mode. The remote start/stop contact shall operate in VFD and bypass modes. The terminal strip shall allow for independent connection of up to four (4) unique safety inputs.

25. The bypass shall include a supervisory control mode. In this bypass mode, the bypass shall monitor the value of the VFD’s analog input (feedback). This feedback value is used to control the bypass contactor on and off state. The supervisory mode shall allow the user to maintain hysteresis control over applications such as cooling towers and booster pumps even with the VFD out of service.

26. The user shall be able to select the text to be displayed on the keypad when an external safety opens. Example text display indications include “FireStat”, “FreezStat”, “Over pressure” and “Low suction”. The user shall also be able to determine which of the four (4) safety contacts is open over the serial communications connection.

27. Smoke Control Override Mode (Override 1) – The bypass shall include a dedicated digital input that will transfer the motor from VFD mode to Bypass mode upon receipt of a dry contact closure from the Fire / Smoke Control System. The Smoke Control Override Mode action is not programmable and will always function as described in the bypass User’s Manual documentation. In this mode, the system will ignore low priority safeties and acknowledge high priority safeties as required by UL 864/UUKL. All keypad control, serial communications control, and normal customer start / stop control inputs will be disregarded. This Smoke Control Mode shall be designed to meet the intent of UL 864/UUKL.

28. Fireman’s Override Mode (Override 2) – the bypass shall include a second, programmable override input which will allow the user to configure the unit to acknowledge some digital inputs, all digital inputs, ignore digital inputs or any combination of the above. This programmability allows the user to program the bypass unit to react in whatever manner the local Authority Having Jurisdiction (AHJ) requires. The Override 2 action may be programmed for “Run-to-Destruction”. The user may also force the unit into Override 2 via the serial communications link.

29. Class 10, 20, or 30 (programmable) electronic motor overload protection shall be included.
PART 3 – EXECUTION

3.01 INSTALLATION

A. Installation shall be the responsibility of the mechanical contractor. The contractor shall install the drive in accordance with the recommendations of the VFD manufacturer as outlined in the VFD installation manual.

B. Power wiring shall be completed by the electrical contractor, to NEC code 430.122 wiring requirements based on the VFD input current. Caution: VFDs supplied without internal reactors have substantially higher input current ratings, which may require larger input power wiring and branch circuit protection. The contractor shall complete all wiring in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.

3.02 START-UP

A. Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file at the manufacturer.

3.03 PRODUCT SUPPORT

A. Factory trained application engineering and service personnel that are thoroughly familiar with the VFD products offered shall be locally available at both the specifying and installation locations. A toll free 24/365 technical support line shall be available.

B. A computer based training CD or 8-hour professionally generated video (VCR format) shall be provided to the owner at the time of project closeout. The training shall include installation, programming and operation of the VFD, bypass and serial communication.

3.04 WARRANTY

A. The VFD Product Warranty shall be 24 months from the date of certified start-up, not to exceed 30 months from the date of shipment. The warranty shall include all parts, labor, travel time and expenses. A toll free 24/365 technical support line shall be available.

END OF SECTION 15040
SECTION 15060 - PIPE AND PIPE FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To -
   1. General piping installation procedures for all piping systems.

B. Related Sections -
   1. General Conditions, Division 01, and Section 15010 apply to this Section.
   2. Type of pipe and fittings specified under each piping system.

1.2 QUALITY ASSURANCE

A. Manufacturer -
   1. Use domestic (USA) made pipe and pipe fittings on Project.

PART 2 - PRODUCTS

2.1 VALVES

A. Valves of same type shall be of same manufacturer.

B. Valves shall be domestic (USA) on this project.

2.2 PIPE HANGERS

A. Adjustable, malleable iron clevis type of a diameter adequate to support pipe size.

B. Approved Manufacturers -
   1. B-Line Systems Fig. B3100
   2. Grinnell No. 260
   3. Kin-Line 455
   4. Superstrut CL-710

2.3 INSULATING COUPLINGS

A. Suitable for at least 175 PSIG WP at 250/F.

B. Approved Manufacturers -
   1. Central Plastics Co
   2. Victualic Co
   3. Watts Regulator Co
2.4 SLEEVES

A. Sleeves shall be standard weight galvanized iron pipe, Schedule 40 PVC, or 14 gauge galvanized sheet metal two sizes larger than pipe or insulation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Furnish and install complete system of piping, valved as indicated or as necessary to completely control entire apparatus. Pipe drawings are diagrammatic and indicate general location and connections. Piping may have to be offset, lowered, or raised as required or directed at site. This does not relieve this Division from responsibility for proper erection of systems of piping in every respect.

B. Properly support piping and make adequate provisions for expansion, contraction, slope, and anchorage.

1. Cut piping accurately for fabrication to measurements established at site and work into place without springing or forcing.
2. Do not use pipe hooks, chains, or perforated metal for pipe support.
3. Remove burr and cutting slag from pipes. All pipe and tube shall be reamed to the full inside diameter of the pipe and tube.
4. Make changes in direction with proper fittings.
5. Insulate hangers for copper pipe from piping by means of at least two layers of Scotch 33 plastic tape.
6. Support piping at 8 feet on center maximum for pipe 1-1/4 inches or larger and 6 feet on center maximum for pipe one inch or less. Provide support at each elbow. Install additional support as required.
7. Suspend piping from roof trusses or clamp to vertical walls using Unistrut and clamps (except underground pipe). Laying of piping on any building member is not allowed.

C. Arrange piping to not interfere with removal of other equipment, ducts, or devices, or block access to doors, windows, or access openings. Provide accessible, ground joint unions in piping at connections to equipment.

D. Make connections of dissimilar metals with insulating couplings.

E. Provide sleeves around pipes passing through floors, walls, partitions, or structural members.

1. Seal sleeves with plastic or other acceptable material.
2. Do not place sleeves around soil, waste, vent, or roof drain lines passing through concrete floors on grade.

F. Cap or plug open ends of pipes and equipment to keep dirt and other foreign materials out of system. Do not use plugs of rags, wool, cotton waste, or similar materials.

G. Install piping systems so they may be easily drained.
H. Grade soil and waste lines within building perimeter ¼ inch fall per ft in direction of flow or as noted on the plans.

I. Insulate water piping buried within building perimeter.

J. Do not use reducing bushings, street elbows, or close nipples.

K. Bury water piping 6 inches minimum below bottom of slab and encase all water lines in PVC or ABS sleeves, a minimum of 2 pipe sizes larger than water line being encased and the insulation installed on this piping. Install 2 inches minimum of sand around the encasement pipe.

END OF SECTION 15060
15110.1 DESCRIPTION

This section is a materials specification and is included for guidance in selecting materials for pipe and related fittings and appurtenances used in the construction of water and sewer systems.

15110.1.1 RELATED WORK

Section 02222 - Waterline Pipe Installation
Section 02224 - Sewer Line Pipe and Manhole Installation
Section 15230 - Waterline Valves and Hydrants
Section 15232 - Water System Control Valves

15110.1.2 SUBMITTALS

The Contractor shall submit for review complete information, showing all pipe, materials, fittings, gaskets, couplings, coatings, linings, supports, mechanical restraints, thrust blocks and configuration prior to the delivery of any components to the project. All information shall be provided in accordance with Section 01300 and written evidence of compliance from the manufacturer shall accompany each delivery of material.

15110.1.3 DEFINITIONS

Not used.

15110.2 MATERIALS

15110.2.1 NSF COMPLIANCE

All pipe and materials furnished and installed for culinary use shall comply with NSF International Standard 61. Also, all plastic pipe must be approved by the NSF for potable water use and shall carry the factory ”NSF” stamped label on the pipe indicating such approval.

15110.2.2 POLYVINYL CHLORIDE PIPE (PVC)

15110.2.2.1 PVC PIPE FOR WATER LINE CONSTRUCTION – Shall be as follows:

- For sizes less than 4 inches OD, PVC pipe shall be Schedule Rated pressure pipe meeting the requirements of ASTM D1785 of the schedule and size shown on the Drawings.

- PVC pipe 4 inches and larger, shall be rigid, thermoplastic Class Rated pressure pipe meeting the requirements of ANSI/AWWA Standard C900 or C905 (latest revision). The pressure class or the dimensional ratio and the size shall be as shown on the Drawings.

- While Class Rated and Pressure Rated pipe materials are not interchangeable, when specifically allowed in the Contract Documents, for size 4” and larger, rigid thermoplastic Pressure Rated pressure pipe, meeting the requirements of ASTM D2241, may be furnished and installed. Operating pressure for this pipe shall be as shown on the Drawings.

15110.2.2.2 FITTINGS FOR PVC PIPE – Unless specifically authorized otherwise, fittings for 4 inch and larger size PVC pipe in underground service shall be ductile iron (DI) and shall meet the requirements of NSF 61 and ANSI/AWWA C-153. They shall have a standard coating of cement mortar on the interior surfaces in compliances with AWWA C-104. DI fittings meeting these requirements may be used with smaller PVC piping. PVC fittings meeting the requirements of ANSI/AWWA C-907 may be used with PVC pipe smaller than 4 inches, and, in some instances, where specifically authorized, with PVC pipe sizes 4 inches through 8-inches.
**15110.2.3 DUCTILE IRON PIPE**

**15110.2.3.1 INTERIOR COATING** - The interior surface of all DI pipe shall be coated with a standard coating of cement-mortar in accordance with ANSI/AWWA Standard C-104 unless required otherwise in the Contract Documents. Field coating of DI pipe will not be acceptable.

**15110.2.3.2 BURIED PIPE** – Unless shown otherwise on the Drawings, shall be as follows:

- Buried ductile iron pipe shall be Thickness Class 51.
- Shall meet requirements of ANSI/AWWA C-151.
- Joints shall be bell and spigot or mechanical, which meet the requirements of ANSI/AWWA C-111.

**15110.2.3.3 EXPOSED PIPE** – Shall meet these requirements, unless shown otherwise on the Drawings:

- Exposed ductile iron pipe shall be Thickness Class 53.
- Pipe shall comply with ANSI/AWWA Standard C-151.
- Pipe joints shall be flanged, meeting the requirements of ANSI/AWWA C-115, or mechanical type couplings (MTC), meeting the requirements of ANSI/AWWA C-606. MTC shall be Victaulic grooved couplings, as manufactured by Victaulic Company of America or approved equal), unless shown otherwise on the drawings.
- 3” to 12” compact flanged fittings shall be ductile iron and shall be produced in accordance with laying lengths specified in ANSI/AWWA C110/A21.10. Flange surface shall be faced and drilled in accordance with ANSI Class 125 B16.1. Nominal body thickness shall be Manufacturer’s Standard, but shall not be less than those specified in ANSI/AWWA C153/A21.53 “Standards for Ductile Iron Compact Fittings”. Flange thickness shall be in accordance with the Manufacturer’s Standards. Working pressure rating shall be 250 psi for water. Fittings shall be made in the United States of America and shall not have been refurbished or reworked by anyone other than the manufacturer. When greater than 250 psi is called for on the Plans, then the Supplier shall furnish higher class rated flanges. Standard Class 125 template for drilling shall be used for all flanges. Drilling templates shall be in multiples of four, so that fittings may be made to face in any quarter. Boltholes shall straddle the centerline and shall be equally spaced. Misalignment of boltholes of two opposing flanges shall not exceed 0.12 inches. Blind flanges 12 inches and over shall be provided with lifting eyes. Insulated flanges shall be provided where required.
- Gaskets shall be full faced, 1/16-inch thick compressed sheets of Aramid fiber base, with nitrile binder and non stick coating, suitable for temperatures to 700°, pressures to 1000 psig and a pH range of 1 to 11. Blind flange gaskets shall cover the entire inside face of the flange and shall be cemented in place. Gaskets shall be as manufactured by John Crane, style 2160; Garlock, style 3000; or approved equal.

**15110.2.4 HIGH DENSITY POLYETHYLENE PIPE (HDPE)**

**15110.2.4.1 PIPE** – Shall be as follows:

- PE pipe shall be classified as 445574C, according to ASTM D3350. All PE pipe shall be manufactured according to AWWA C906 and ASTM D3035, F714. For oil and gas piping, PE pipe shall be per API 15LE.
Pipe shall be made of high density, high molecular weight resin. PE plastic shall have a cell classification of 445574C as defined by ASTM D3350/AWWA C906. It shall be rated as PE4710 according to the requirements of the Plastics Pipe Institute. Internal pressure rating shall be as specified elsewhere in the project documents.

15110.2.4.2 FITTINGS FOR HDPE – Molded fittings shall be made of pre-blended virgin resins in accordance with the materials specifications of ASTM D3350. PE plastic fittings shall have a cell classification of 445574C as defined by ASTM D3350/AWWA C906. Socket fusion fittings shall be manufactured in compliance with ASTM D2683 and butt fusion fittings with ASTM D3261. Measurements of fittings shall be as required by ASTM D2122. All fittings shall be compatible for heat fusion with any pipe manufactured for like or similar resins.

Heat welded Flange Adapter Couplings shall be used for transition to other type piping material. The Contractor shall follow the manufacturer’s recommendations, as well as specified procedures herein in fusing fittings to the polyethylene pipe.

15110.2.5 GALVANIZED IRON PIPE AND FITTINGS

Shall be of the schedule rating shown on the Drawings and shall be used only in exposed, non-corrosive atmospheres where piping diameters are less than 4 inches.

15110.2.6 PIPE AND FITTINGS FOR WATER SERVICE LINES

Shall meet the requirements provided in Section 15234 for water service connections.

15110.2.7 PIPE FOR GRAVITY SEWER SYSTEMS

Gravity sewer pipelines may be constructed with PVC or polyethylene (PE) plastic sewer pipe and fittings. Such materials shall be of the type, configuration and size shown on the Drawings and/or on the Bid Schedule.

15110.2.7.1 PVC PIPE - All PVC sewer pipe and fittings shall meet the standards of ASTM D3034 and F679. Such pipe shall be manufactured with a rubber gasketed joining system which meets ASTM D3212 and shall be furnished with a standard dimensional ratio of 35 (SDR 35) for wall thickness, unless shown otherwise on the Drawings.

15110.2.7.2 PE PIPE - All PE sewer pipe shall be smooth, solid wall, high density polyethylene pipe manufactured from PE 4710 material conforming to ASTM D3350 cell classification 445574C rating from the Plastic Pipe Institute. Fittings for this pipe shall be molded from a polyethylene compound equal to or exceeding the properties of the pipe being supplied.

15110.2.8 PIPE FOR PRESSURE SEWER SYSTEMS

Pressure sewer pipelines shall be constructed with DI, PVC, or PE plastic sewer pipe. Fittings and materials shall be of the type, SDR rating, (or pressure class) and size shown on the Drawings and/or on the Bid Schedule.

15110.2.8.1 PVC PIPE - All PVC pipe for pressure sewer lines shall be rigid, pressure rated, thermoplastic pipe which meets the standards of ASTM D2241. Fittings for PVC pipelines shall be Class 50, cement mortar lined, rubber gasketed, DI which meet the requirements of ANSI/AWWA C-153 and C-104.

15110.2.8.2 PE PIPE - PE pipe for pressure sewer lines shall be smooth, solid wall, high density polyethylene pipe manufactured from PE 4710 material conforming to ASTM D3350 cell classification 445574C
rating from the Plastic Pipe Institute. Fittings for this pipe shall be molded from a polyethylene compound equal to or exceeding the properties of the pipe being supplied.

15110.2.9 PIPE AND FITTINGS FOR IRRIGATION SYSTEMS

Pipe and fitting for irrigation systems shall be either DI or Pressure Rated PVC, of the type and class shown on the Drawings, for line diameters 4-inches and greater. Buried lines smaller than 4 inches in diameter shall be Schedule Rated PVC as shown on the Drawings.

15110.2.10 PIPE FOR DRAIN SYSTEMS

Piping for sub-drainage may be constructed with polyvinyl chloride (PVC) or polyethylene (PE) plastic non-pressure drainage or sewer pipe and fittings. Such materials shall be of the type, configuration and size shown on the Drawings and/or on the Bid Schedule.

15110.2.10.1 PVC PIPE - All PVC drainage pipe and fittings shall meet the standards of ASTM F794. Such pipe shall be manufactured with a rubber gasketed joining system which meets ASTM D3212 and may be furnished with ribbed, corrugated or smooth exterior walls with smooth interior wall surfaces, unless shown otherwise on the Drawings. Rubber gasketed joints will not be required for collection pipe applications with perforated or slotted pipe sections.

15110.2.10.2 PE PIPE - All PE drainage pipe shall be solid, corrugated or ribbed wall high-density polyethylene pipe with smooth interior wall surfaces. Material shall be PE 4710 material conforming to ASTM D3350 cell classification 445-574C rating from the Plastic Pipe Institute. Fittings for this pipe shall be molded from a polyethylene compound and with equivalent properties and configurations specifically designed to fit the pipe being supplied.

15110.2.11 MISCELLANEOUS FITTINGS AND MATERIALS

15110.2.11.1 PIPE SUPPORTS - Floor mounted pipe supports for suspended, exposed piping systems shall be adjustable stanchion type supports designed to cradle the pipe diameter by 170 degrees. The support shall fit ductile iron or steel diameters snugly, without excessive gaps between the support and the pipe. Support saddle width shall be a minimum of 2 inches wide. The support must offer a minimum of 3 inches of final adjustment, after installation. Supports shall be supplied with independent base and adjustment collar designed to accept standard sized Schedule 40 galvanized steel pipe for coarse adjustment. Supports shall be fabricated from A36 mild steel, and shall have an electro-galvanized finish. Floor mounted pipe supports shall be the Standon Model S92 or C92 as manufactured by Material Resources, Inc., 22700 N. W. Quatama Street, Hillsboro, Oregon 97124, or approved equal. The standard required model shall be the S92. Non standard materials or model numbers shall be as specified on the Drawings.

15110.2.11.2 "Y" STRainers - shall be constructed of high-tensile ASTM A126 Class B Cast Iron with blow-off connections and self-aligning cylindrical screens and shall be equal to Watts Regulator Series 77F or better quality.

15110.2.11.3 FASTENERS – Fastener requirements are as follows:

- Unless otherwise required in these Specifications or shown on the Drawings, all bolting hardware for buried pipe, fittings, valves, and components shall be of manufacturer’s standard materials.
- Unless otherwise required in these Specifications or shown on the Drawings, all bolting materials for exposed pipe, fittings, valves, and components shall be Type 316 stainless steel. Where space restrictions preclude the use of regular bolts, stainless steel threaded studs may be used on all valve flange connections.
• In all instances where stainless steel threaded fasteners are used, a coating of an approved, permanent anti-seize compound shall be applied to the fastener to prevent galling and to assist in disassembly.

• All bolts and/or studs shall extend through the nuts at least 1/4 inch.

15110.2.11.4 COUPLINGS – Couplings shall meet the following requirements:

• Unless prescribed otherwise on the Drawings or in these Specifications, couplings shall meet the requirements of ANSI/AWWA C-219. All flexible couplings shall meet the minimum requirements of Smith Blair 400 series.

• Sleeves shall have a smooth inside taper and there shall be no surface irregularities on any sealing surface. Gaskets shall be suitable for the project application.

• Flexible couplings for buried DI and PVC pipe sizes 2 through 16 inches in diameter shall be fabricated of steel or ductile iron. For pipe sizes larger than 16 inches, flexible couplings shall be of steel. Coupling components for use in potable water systems shall be factory coated with an FDA approved, bonded epoxy coating, applied to an average 12 mil thickness.

• Flexible couplings for exposed pipe shall be manufactured of steel, unless shown otherwise on the Drawings, or approved by the Engineer. Coupling components for use in potable water systems shall be factory coated with an FDA approved, fusion-bonded epoxy coating, applied to an average 12 mil thickness.

15110.2.11.5 RESTRAINT HARNESS – Where required, restraint harness for bell and spigot pipe joints shall be as manufactured by EBAA Iron Co. or an approved equal. The restraint shall consist of a split bell ring to go behind the bell and a split, serrated ring to grip the pipe on the other side of the joint. The harness shall be held together with clamping bolts and tie bolts. The rings shall be fabricated of 60-42-10 DI conforming to ASTM A-536. Clamping bolts shall be grade 5 zinc coated machine bolts. Tie bolts are of low alloy steel. The harness shall have a minimum working pressure of 150 psi. Harness size shall be as shown in the schedule on the Drawings or as specified in the Special Provisions.

15110.2.11.6 VALVES AND FITTINGS - Shall be as specified in their respective sections in these Specifications.

15110.2.11.7 BOXES AND ENCLOSURES – Shall be of the size, type, and configuration indicated on the Drawings and Contract Documents.

15110.3 CONSTRUCTION REQUIREMENTS

See Sections 02222 and 02224 for construction requirements for applicable piping systems.

15110.4 METHOD OF MEASUREMENT

In general, fittings for pipe and piping systems are, and will be, considered appurtenant to the pipeline being installed unless specifically called out for separate payment on the Bid Schedule.

15110.5 BASIS OF PAYMENT

Not used.
SECTION 15170 - MOTORS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To -

1. Quality of motors three horsepower or larger furnished and installed by Division 15.

B. Related Sections -

1. General Conditions, Division 01, and Section 15010 apply to this Section.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Motor shall be quiet in operation and speed not exceed 1800 rpm.

2.2 APPROVED MANUFACTURERS

A. Allis Chalmers
B. General Electric
C. Gould/Century
D. Lincoln
E. Marathon
F. Reliance
G. Toshiba
H. U S

PART 3 - EXECUTION

(Not Applicable)

END OF SECTION 15170
SECTION 15190 - MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To -
   1. Furnish and install identification of equipment and piping as described in Contract Documents.

B. Related Sections -
   1. General Conditions, Division 01, and Section 15010 apply to this Section.

PART 2 - PRODUCTS

2.1 PAINT

A. Benjamin Moore Impervo or equivalent by Paint Manufacturer approved in Architectural Painting Sections.

B. Use appropriate primer.

2.2 LABELS

A. Black Formica with white reveal on engraving.

PART 3 - EXECUTION

3.1 APPLICATION

A. Engraved Plates -
   1. Identify thermostats and control panels in mechanical rooms, furnaces, boilers and hot water heating specialties, duct furnaces, air handling units, electric duct heaters, and condensing units with following data engraved and fastened to equipment with screws -
      a. Equipment mark noted on Drawings (i.e., CU-1)
      b. Area served (i.e., Gym, Administration)

B. Stenciling -
   1. Locate identifying legends and directional arrows at following points on each piping system -
      a. Adjacent to each item of equipment and special fitting.
      b. At point of entry and exit where piping goes through wall.
      c. On each riser and junction.
      d. Every 50 feet on long continuous lines.
COUNTY FAIRGROUNDS BUILDING
CACHE COUNTY

2. Domestic Hot & Cold Water Piping Identification -
   a. Identify domestic hot and cold water piping above and below ceilings with
      stenciled letters "HW' and "CW" respectively.
   b. Letters shall be one inch high. Provide "Direction of Flow" arrow at each stencil.
   c. Paint color shall be as specified below.

3. Steam Pipe, Hot Water Heating, Chilled Water, Gas, & Valve Identification -
   a. Identify specific pipe contents by stenciling pipe with written legend and placing
      of arrows to indicate direction of flow.

C. Painting: All pipe painting shall be provided for by the installing contractor i.e.: Fire
   sprinkling by the Fire Sprinkler contractor, plumbing by the Plumbing Contractor.

D. Identification shall comply with, but not limited to the following:

PIPE PAINTING AND LABELING LEGEND

<table>
<thead>
<tr>
<th>SERVICE &amp; LABEL</th>
<th>SYMBOL</th>
<th>LABEL COLOR</th>
<th>LETTER</th>
<th>PIPE COLOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOMESTIC COLD WATER</td>
<td>DCW</td>
<td>GREEN</td>
<td>WHITE</td>
<td>DARK ROYAL BLUE</td>
</tr>
<tr>
<td>DOMESTIC HOT WATER</td>
<td>DHW</td>
<td>YELLOW</td>
<td>BLACK</td>
<td>MAGENTA</td>
</tr>
<tr>
<td>DOM. HOT WATER RETURN</td>
<td>DHWR</td>
<td>YELLOW</td>
<td>BLACK</td>
<td>MAGENTA</td>
</tr>
<tr>
<td>SOFT COLD WATER</td>
<td>DSW</td>
<td>GREEN</td>
<td>WHITE</td>
<td>DARK ROYAL BLUE</td>
</tr>
<tr>
<td>RAIN WATER</td>
<td>RW</td>
<td>GREEN</td>
<td>WHITE</td>
<td>BROWN</td>
</tr>
<tr>
<td>SANITARY SEWER</td>
<td>SAN</td>
<td>GREEN</td>
<td>WHITE</td>
<td>BROWN</td>
</tr>
<tr>
<td>NATURAL GAS</td>
<td>G</td>
<td>YELLOW</td>
<td>BLACK</td>
<td>DARK GREEN</td>
</tr>
</tbody>
</table>


** Exposed piping in mechanical rooms, boiler rooms, etc., shall be painted color indicated on chart.

E. SIZE OF LETTERS AND LENGTH OF FIELD

<table>
<thead>
<tr>
<th>OD OF PIE OR COVERING LETTERS</th>
<th>SIZE OF COVERING LETTERS</th>
<th>LENGTH OF COLOR FIELD</th>
</tr>
</thead>
<tbody>
<tr>
<td>¾” TO 1-1/2”</td>
<td>½”</td>
<td>8”</td>
</tr>
<tr>
<td>1-1/2” TO 2”</td>
<td>¾”</td>
<td>8”</td>
</tr>
<tr>
<td>2-1/2” TO 6”</td>
<td>1-1/4”</td>
<td>12”</td>
</tr>
<tr>
<td>8 TO 10”</td>
<td>2-1/2”</td>
<td>24”</td>
</tr>
<tr>
<td>OVER 10”</td>
<td>3-1/2”</td>
<td>32”</td>
</tr>
</tbody>
</table>

F. Paint Specification: All surfaces to be painted shall be prepared in accordance with the
detailed painting specifications in the Painting Section of these specifications. Surfaces that
are not subjected to temperatures higher than 212 deg. F shall be painted as specified for the
area in which they are located. Pipes, valves or other equipment subjected to temperature
above 212 deg. F, shall be painted with heat resisting black enamel or heat resisting aluminum
paint as specified below. The Owner's Representative shall designate surfaces to be painted
aluminum painted at least three coats. Colors shall be selected by Owner's Representative.
G. Heat resisting black enamel shall be Sta-Black as manufactured by Pratt and Lambert Co., or Ebonite Boiler and Stack Paint as manufactured by W.P. Fuller Co. or approved equal suitable for use at temperatures of at least 450°F.

END OF SECTION 15190
15230.1 DESCRIPTION

This section covers furnishing and installing valves and fire hydrants in water transmission and distribution lines, together with fittings, thrust blocking, and boxes and enclosures related to the operating equipment.

15230.1.1 RELATED WORK

Section 02222 - Waterline Pipe Installation
Section 15110 - Pipe and Piping Systems
Section 15232 - Water System Control Valves

15230.1.2 SUBMITTALS

All information shall be provided in accordance with Section 01300. Written evidence of compliance from the manufacturer shall accompany each delivery of material.

15230.1.2.1 VALVES 12 INCHES AND SMALLER, AND HYDRANTS - For valve sizes 12-inches and smaller, and fire hydrants, the Contractor shall furnish the manufacturer's standard data and catalogues for review and approval.

15230.1.2.2 VALVES LARGER THAN 12 INCHES - For all valves sized larger than 12-inches, the Contractor shall furnish shop drawings and technical data prepared by the manufacturer for review and approval.

15230.1.2.3 CONTENT - Submittals shall include complete details, dimensions, weights, diameter of stems, alloy for all valve parts and any information that may be required to assemble, install, operate and maintain the valve.

15230.1.2.4 BUTTERFLY VALVES - Certification of performance together with leakage and hydrostatic tests as described in Section 13 of ASTM/AWWA C-504 shall be furnished to the Engineer upon the Engineer's request.

15230.1.2.5 BALL VALVES - Certification of performance together with leakage and hydrostatic tests as described in Section 5 of ASTM/AWWA C-507, shall be furnished to the Engineer upon the Engineer's request.

15230.1.3 DEFINITIONS

Not used.

15230.2 MATERIALS

15230.2.1 GATE VALVES

15230.2.1.1 COMPLIANCE - All gate valves shall conform to AWWA C-500 or C-509 with the following characteristics:

15230.2.1.2 3-INCH AND SMALLER VALVES - Valves 3-inches and smaller shall be as follows:

- Valves shall be as manufactured by Ford, Hayes, Mueller, Red & White, or an approved equal.
- Valves shall be standard, double-disc, non-rising stem valves with wheel handles.
- Valve bodies shall be all bronze or brass.
• Valves shall be threaded, unless shown otherwise on the Drawings or required in these Specifications.

15230.2.1.3 GATE VALVES 4-INCH THROUGH 14-INCH - Gate valves 4-inches through 14-inches in size shall be as follows:

• Valves shall have a ductile iron body.
• Valves shall have a solid cast iron, rubber coated, wedge gate and a resilient seat.
• Gate shall be designed to work equally well with pressure on either side of it.
• Valves shall be of the non-rising stem type and shall be left hand opening (counter-clockwise) with a 2-inch square operating nut.
• All interior ferrous surfaces exposed to fluid flow shall have an NSF approved, fusion bonded, epoxy coating. Epoxy coatings shall be factory applied by an electrostatic or thermosetting process.

15230.2.1.4 GATE VALVES 16-INCHES AND LARGER - Gate valves 16-inches and larger shall be as follows:

• Valves shall be double-disc gate valves with flanged ends.
• Valves shall be manufactured in accordance with AWWA C-500. Bolts, nuts, studs, etc., used with the gear case also shall conform to the requirements for Bonnet Bolting in AWWA C-500.
• Valves shall have bevel gears and shall be actuated by 2-inch square operating nuts.
• The gears and stuffing box shall be enclosed in a watertight cast or ductile iron case for operation in buried location.
• The case shall be filled with grease at the factory.
• Valves shall be designed to operate in a horizontal orientation.
• Valves shall be equipped with bronze tracks, rollers and scrapers.
• By-pass valves shall be furnished with each valve mounted in position A as indicated in AWWA C-500.

15230.2.1.5 VALVES ON WATER MAINS - Valves on water mains shall have the following features:

• In-line valves shall have push-on or mechanical joints conforming to AWWA C-111.
• Valves attached to side outlets shall be flanged.
• By-pass valves shall be flanged.
• Valves in blow-off lines shall be flanged.
• Valves in fire hydrant lines shall have push-on or mechanical joints.
• Valves in air release and vacuum relief lines shall be flanged or threaded.
● Valves 12-inches and smaller shall be equipped with O-ring packing.

15230.2.2 BUTTERFLY VALVES

15230.2.2.1 MANUFACTURER - Butterfly valves shall be Dresser Industries "450", Allis-Chalmers "Streamseal", Henry Pratt "Groundhog", Mueller Lineseal III, or an approved equal.

15230.2.2.2 COMPLIANCE - Butterfly valves shall conform to AWWA C-504.

15230.2.2.3 CLASS - Valves shall be Class 150 seated, tight closing valves, furnished with mechanical or flanged joints.

15230.2.2.4 SEATS - Rubber valve seats shall be replaceable without disassembling the valve and shall not be interrupted by the shafting. Rubber seats may be retained on the disc edge by stainless steel clamping in lieu of bonding to the valve body.

15230.2.2.5 SHAFT PACKING - Shaft packing shall be of the self-adjusting permanent type.

15230.2.2.6 OPERATION - Underground opening and closing shall be accomplished with permanently lubricated screw-type operators, totally enclosed and of watertight construction. Overload protection shall be incorporated into the operator allowing the application of 450 foot-pounds input torque at full-open and full-closed positions without damage to the operator or valve. A 2-inch square wrench nut and valve box shall be provided for operating the valve. Valves shall open counter clockwise unless indicated otherwise in the Special Provisions.

15230.2.3 BALL VALVES

15230.2.3.1 MANUFACTURER - Valves shall be produced by a manufacturer having at least five years experience in the manufacture of water works and valves.

15230.2.3.2 VALVES 4-INCHES AND LARGER - Ball valves, 4-inches and larger, shall be ductile iron or cast-steel body, double seated valves meeting the requirements of ANSI/AWWA C-507.

15230.2.3.3 SMALLER VALVES - Smaller valves shall be stainless steel, bronze, or iron bodied valves of the size, type and class shown on the Drawings.

15230.2.4 CHECK VALVES

15230.2.4.1 COMPLIANCE - Check valves shall be manufactured in accordance with ANSI/AWWA C-508.

15230.2.4.2 DESIGN - Check valves shall be of a clear waterway, swing-check type. They shall be designed to be mounted horizontally. They shall be fitted with flanged ends for easy servicing. They shall have an iron body and be bronze mounted.

15230.2.4.3 SEATING - Valves shall be provided with a metal to resilient material seating.

15230.2.5 HOSE BIBS

Hose bibs shall be 3/4-inch bronze or brass body, Watts Model SC-1, Red & White Model RW 301 or approved equal. All hose bibs shall have a tee handle.

15230.2.6 SAMPLE FAUCET

Sample faucet shall be a ½-inch chromed or brass body hose bib without hose connection threads.
15230.2.7  FIRE HYDRANTS

15230.2.7.1  COMPLIANCE - Fire hydrants shall conform to standard for dry barrel fire hydrants, AWWA C-502 and modifications herein specified.

15230.2.7.2  DESIGN - Hydrants shall be designed as follows:

- Hydrants shall be of the "compression" or "toggle joint" type with safety flange and safety stem coupling above the ground line so that they can be repaired without shutting off the water.

- Hydrants shall be of the dry top design with two or more "O" rings sealing the water from the operating mechanism.

- Hydrants shall be furnished with 5-inch minimum valve openings, one 4 1/2-inch NST pumper connection and two 2 1/2-inch hose connections.

- Hose nozzle threads, pump nozzle threads, operating nut and opening direction shall match existing hydrants in the system.

- Hydrant lengths shall be designed for the cover depth shown on the drawings plus the diameter of the main line pipe.

15230.2.7.3  PAINTING - The portion of the hydrant above the ground line shall be painted in accordance with the Owner's standards.

15230.2.8  OPERATING WRENCHES

Unless notified otherwise by the Engineer, the Contractor shall furnish two, T-handle, operating wrenches for each project incorporating valves with 2-inch, square-head, operating nuts.

15230.2.9  VALVE BOXES

Valve boxes shall be cast iron, two piece, and adjustable valve boxes. Valve boxes shall be of the slip joint type and be of sufficient length for the pipe burial depth required. The cast iron cover of the valve box shall have the word "water" stamped thereon.

15230.2.10  CONCRETE ENClosures

Concrete enclosures for valves shall be precast and of the type, size and configuration shown on the Drawings and shall be fabricated in accordance with the requirements for precast concrete construction provided in Section 03500.

15230.3  CONSTRUCTION REQUIREMENTS

15230.3.1  SETTING VALVES AND VALVE BOXES

All valves shall be set and jointed to the pipe in the manner described for pipe laying and jointing in Section 02222 of these Specifications. Valves shall be oriented with the operating nut vertical. Valve boxes shall be centered and plumb over the operating nut and shall be set so that no shock or stress will be transmitted to the valve. Tops of the valve boxes shall be set flush with the ground surface, concrete collars, or street surfacing, unless otherwise shown on the Drawings.
15230.3.2 VALVE RESTRAINT

Restraint shall be installed on all valves connected with slip-on, gasketed, or O-ring joints (i.e., bell & spigot, mechanical, etc.) in accordance with these Specifications and as shown on the Drawings.

15230.3.3 CONNECTING TO EXISTING MAINS

15230.3.3.1 CONNECTION TO EXISTING WORK - All connections to existing water mains shall be made by the Contractor, unless otherwise provided in these Specifications. The Contractor shall provide labor and materials, including special fittings and restraint devices, required to make the required connections between existing lines and new lines.

15230.3.3.2 INTERRUPTION OF SERVICES - Where the connection of new work to old requires interruption of service, the Owner, Engineer and Contractor shall mutually agree upon a date for such connection which will allow ample time to assemble labor and materials and to notify all customers in accordance with Section 01510.

15230.3.4 FIRE HYDRANT INSTALLATION

15230.3.4.1 SETTING - All hydrants shall stand plumb use hand level with the pumper nozzle facing the street. The hydrant shall be set with the ground line at the location indicated by the hydrant manufacturer.

15230.3.4.2 DRAINAGE - Drainage shall be provided at the base of the hydrant by placing clean gravel under and around the base of the hydrant as shown on the Drawings.

15230.3.4.3 RESTRAINT - All hydrants shall be restrained by setting thrust blocks or mechanical restraint assemblies in accordance with the Drawings.

15230.3.4.4 AUXILIARY GATE VALVES - All fire hydrant assemblies shall include auxiliary gate valves positioned as shown on the Drawings.

15230.3.5 THRUST BLOCKS

Thrust blocks or joint restraints (Mega Lug) shall be formed to prevent coverage of the pipe joints in accordance with the details shown on the Drawings and as described in Section 03100 and 03050. All thrust blocks shall be set against undisturbed earth.

15230.4 METHOD OF MEASUREMENT

15230.4.1 VALVES

Excavation, foundation preparation, restraint devices, valve boxes, backfill, and other miscellaneous devices, materials, or equipment required for installation shall be considered part of and included in the measurement of all valves and valve assemblies.

15230.4.1.1 NUMERICAL COUNT - When valves are installed as separate items or assemblies, the measurement shall be determined by counting the number of each size and type (including any associated valve box and concrete valve box collar) of valve installed and accepted.

15230.4.1.2 LUMP SUM - When valves are located in an enclosure, measurement shall be made as lump sum for the enclosure assembly and shall include the valve, any supplemental valves and fittings in the enclosure, and the enclosure.
15230.4.2 HYDRANTS

Measurement of hydrants shall be made by counting the number of hydrants set and accepted. For each hydrant, this measurement shall include the tee, shut-off gate valve, excavation and backfill, drain gravel, valve box and concrete collar, restraint, hydrant, and 5-feet of pipeline extending from the tee on the main line to the hydrant.

15230.4.3 NO SEPARATE MEASUREMENT

No separate measurement will be made for thrust blocks or other restraint provided with valves and fittings. Neither will separate measurement be approved for sample faucets and hose bibbs. Measurement for these items will be included with the quantity of the assembly whereon they are installed.

15230.5 BASIS OF PAYMENT

The accepted quantities will be paid for at the contract unit price.

<table>
<thead>
<tr>
<th>PAY ITEM</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Size) Gate Valve</td>
<td>Each</td>
</tr>
<tr>
<td>(Size) Ball Valve</td>
<td>Each</td>
</tr>
<tr>
<td>(Size) Ball Valve</td>
<td>Each</td>
</tr>
<tr>
<td>(Size) Butterfly Valve</td>
<td>Each</td>
</tr>
<tr>
<td>(Size) Check Valve</td>
<td>Each</td>
</tr>
<tr>
<td>Fire Hydrant Assembly</td>
<td>Each</td>
</tr>
</tbody>
</table>
15232.1 DESCRIPTION

This section covers furnishing and installing water system control valves, including: pressure release, pressure sustaining, pressure reducing, water level control, air relief, vacuum relief, deep well pump control, back flow prevention and surge control with their enclosures and miscellaneous support equipment.

15232.1.1 RELATED WORK

Section 02222 - Waterline Pipe Installation
Section 03050 - Portland Cement Concrete
Section 03100 - Concrete Forming, Finishing and Curing
Section 03200 - Concrete Reinforcement
Section 15110 - Pipe and Piping Systems
Section 15230 - Waterline Valves and Hydrants

15232.1.2 SUBMITTALS

15232.1.2.1 CERTIFICATION OF COMPLIANCE - Certification of compliance to the standards and Specifications contained herein shall be obtained from the manufacturer and provided by the Contractor at the time of delivery of these materials to the project site.

15232.1.2.2 DESCRIPTIVE LITERATURE - Descriptive literature which identifies the manufacturer, model numbers, materials of which the control valves are fabricated, and their capacities shall be provided by the Contractor in accordance with Section 01300 of these Contract Documents.

15232.1.2.3 OPERATION AND MAINTENANCE INSTRUCTIONS - Manufacturer's installation, operation and maintenance literature for each control valve shall be furnished to the Owner prior to the time of final acceptance for payment.

15232.1.3 DEFINITIONS

Not used.

15232.2 MATERIALS

15232.2.1 GENERAL

All control valves furnished and installed under this contract shall be of the model, size, and type shown on the Drawings or required in these Specifications. They shall have been produced by the same manufacturer and shall be provided by a supplier located in the state in which the installation is to be made. They shall be furnished with a manufacturer applied, NSF approved, fusion bonded, epoxy coating. Seats shall be designed so that they are easily maintained and without edges that induce cutting or wear at low flows. Unless otherwise required to meet specific service conditions, all cast iron or steel valves shall be 150 lb. Class.

15232.2.2 ALTITUDE CONTROL VALVES

Altitude control valves shall be as manufactured by CLA-VAL Company, or approved equal. Valves shall be of ductile iron flanged, spring loaded, 3-way, diaphragm actuated, globe pattern valves. Valve control shall be provided by a pressure difference sensor (and when called for on the Drawings or in these Specifications, fitted with a direct acting solenoid control) with appropriately sized piping and supports. Valves shall have a valve position indicator, cocks to isolate the pilot system and closing speed control. Four-inch and smaller valves shall be fitted with flow clean strainer while larger valves shall be provided with a "Y"-pattern strainer in the pilot control system.
15232.2.3 PRESSURE RELIEF/PRESSURE SUSTAINING VALVES

Shall be ductile iron, modulating, hydraulic operated, pilot controlled, flanged valves with globe pattern. All pressure sustaining valves shall be designed to maintain constant upstream pressure at the set point indicated on the Drawings or in the Special Provisions. Pressure sustaining valves shall be provided with a position indicator operated by a pressure difference sensor and shall have appropriately sized piping and supports. The pilot system shall be capable of being isolated with shut-off cocks, be fitted with a strainer, and shall be able to control closure to prevent surges.

15232.2.4 COMBINATION BACK PRESSURE/SOLENOID SHUTOFF VALVE

Shall be ductile iron, flanged, globe pattern, modulating hydraulic operated, pilot controlled, with solenoid activated shut-off. The valve shall open sufficiently to maintain a pre-set inlet (back) pressure. When the inlet pressure is less than the control setting, the pilot system shall close the valve tight. The pilot system shall be capable of being isolated with shut-off cocks, be fitted with a strainer and shall be able to control closure to prevent surges.

15232.2.5 PRESSURE REDUCING VALVES

Shall be modulating pressure reducing with globe pattern. Valves shall be provided with pilot control which operates such that positive and gradual closure can occur to prevent any surge or line shock. Pressure reducing valves shall be equipped with a valve position indicator, cocks to isolate the pilot system, speed for control of closure and a strainer on the pilot system inlet.

15232.2.6 BACK-FLOW PREVENTION VALVES

Shall be an assembly of double independently acting, spring-loaded toggle lever check valves with two shut-off valves which meet the requirements of ANSI/AWWA C-506. Valve body and cover shall be of bronze. Valves shall be fitted with stainless steel springs and with molded synthetic rubber clapper, poppet and facing rings.

15232.2.7 AIR/VACUUM RELIEF VALVES

Shall be simple lever type, kinetic combination air valves, with cast iron body and stainless steel floats. Vents for air/vacuum relief valves shall be threaded GI pipe and shall be protected with fittings covered with No. 14 stainless steel, bronze or aluminum screen.

15232.2.8 DEEP WELL SOLENOID PUMP CONTROL VALVE

Shall be globe pattern, hydraulically operated diaphragm valve controlled by a solenoid pilot valve. The pilot system shall have separate adjustable flow control valves, a "Y" strainer, and shall be fitted with cocks to enable isolation during servicing. The valve stem shall have a limit switch to serve as an electrical interlock between the valve and pump motor.

15232.2.9 ENCLOSURES

Enclosures for control valves shall be concrete, furnished and installed in accordance with the Drawings and the requirements of Sections 03100, 03200, and 03050 of these Specifications.

15232.2.10 MISCELLANEOUS PIPE, FITTINGS, VALVES AND EQUIPMENT

Miscellaneous pipe, fittings, valves and equipment needed to assemble and support operation of the control valves shall be as shown on the Drawings and in conformance with Sections 02222, 15110, and 15230 of these Specifications.
15232.3 CONSTRUCTION REQUIREMENTS

Prior to installing control valves, the Contractor shall flush, blowout, or otherwise clean all dirt and debris from connecting lines. Control valves shall be installed with appropriate supporting piping and equipment in accordance with manufacturer's recommendations. Control valves shall be fitted with flanged connections or installed in a manner which will allow easy removal in the enclosure or area wherein the valves are installed. As soon as control valves are pressurized (placed in service), the Contractor shall check and adjust, if necessary, all valve assemblies to assure they are adjusted correctly and functioning as designed.

15232.4 METHOD OF MEASUREMENT

15232.4.1 NO MEASUREMENT

Measurement will not be made for control valves that are installed as part of a structure or assembly identified as a separate line item in the Bid Schedule. In such cases, valves and their installation will be included in the lump sum quantity represented for that structure.

15232.4.2 SEPARATE MEASUREMENT

When valves are identified as individual line items on the Bid Schedule, quantities shall be measured by counting the numbers of each type of valve in place and accepted. In such cases, measurement will include all valves, couplings, enclosures, manhole covers, excavating and footings required and other necessary equipment and materials required to complete the assembly as shown on the Drawings.

15232.5 BASIS OF PAYMENT

The accepted quantity will be paid for at the contract unit price:

<table>
<thead>
<tr>
<th>PAY ITEM</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Altitude Valve (size, type)</td>
<td>Each</td>
</tr>
<tr>
<td>Float Valve (size, type)</td>
<td>Each</td>
</tr>
<tr>
<td>Pressure Relief Valve (size, type)</td>
<td>Each</td>
</tr>
<tr>
<td>Pressure Sustaining Valve (size, type)</td>
<td>Each</td>
</tr>
<tr>
<td>Pressure Reducing Valve (size, type)</td>
<td>Each</td>
</tr>
<tr>
<td>Pressure Reducing Valve (size, type)</td>
<td>Each</td>
</tr>
<tr>
<td>Back Pressure Valve (size, type)</td>
<td>Each</td>
</tr>
<tr>
<td>Backflow Prevention Valve (size, type)</td>
<td>Each</td>
</tr>
<tr>
<td>Air Release Valve (size, type)</td>
<td>Each</td>
</tr>
<tr>
<td>Vacuum Relief Valve (size, type)</td>
<td>Each</td>
</tr>
<tr>
<td>Air/Vacuum Relief Valve (size, type)</td>
<td>Each</td>
</tr>
<tr>
<td>Combination Air/Vacuum Valve (size, type)</td>
<td>Each</td>
</tr>
<tr>
<td>Sewage Air Relief Valve (size, type)</td>
<td>Each</td>
</tr>
<tr>
<td>(Type) Valve Assembly</td>
<td>Each</td>
</tr>
</tbody>
</table>
15234.1 DESCRIPTION

Includes furnishing and installing materials which include excavation, water main tapping, stops, valves, service lines, meters, settings, boxes and other accessories required for installing water services to system users.

15234.1.1 RELATED WORK

Section 02200 - Trench Excavation and Backfill
Section 02222 - Waterline Pipe Installation
Section 15110 - Pipe and Piping Systems

15234.1.2 SUBMITTALS

15234.1.2.1 DESCRIPTIVE LITERATURE - Descriptive literature which identifies the manufacturer, model, size, material and parts lists from which the piping, fittings, valves and meters are manufactured, including installation instructions, shall be provided to the Engineer in accordance with Section 01300.

15234.1.2.2 CERTIFICATION OF COMPLIANCE - Written certification of compliance from the respective manufacturer shall be provided with each delivery of metal fittings, valves and meters.

15234.1.3 DEFINITIONS

Mains - Water distribution pipes, located in streets or rights-of-ways, to which water service connections are made for users of the system.

Tap - The actual connection made to water mains which includes drilling an opening into the main, threading, installing a tapping saddle when appropriate, and inserting (screwing) a valve into the opening.

Saddle - A fitting placed on a pipe to reinforce the pipe wall through which the tapping hole is drilled.

Key - Can mean either: the center piece of a corporation or curb valve which is turned to control flow through the valve; or, the "T-shaped" tool used by operators to reach and turn the key or closing piece of a valve.

Setter (also referred to as "yoke") - Is the prefabricated assembly of pipes and valves installed in a meter box and connected into the service line in which the water meter is mounted (or "set").

15234.2 MATERIALS

15234.2.1 SADDLES

Saddles shall be copper alloy body with copper alloy or stainless steel straps designed and sized specifically for tapping PVC water mains. Threading shall be tapered and the saddle shall conform to ANSI/AWWA C-800. Straps shall provide full support around the circumference of the pipe and have a bearing area of sufficient width along the pipe axis so that the pipe will not be distorted when tightened.
15234.2.2 CORPORATION STOPS

Corporation stops shall be copper alloy body ball-type or balanced pressure, o-ring sealed plug type valves with tapered threads and in conformance with the requirements of ANSI/AWWA C-800.

15234.2.3 CURB VALVES

Curb valves shall be copper alloy body ball-type valves; or balanced pressure, o-ring sealed, plug type valves. Curb valves shall be furnished with cast iron curb boxes and one-piece lids fitted with copper alloy pentagon plug. The curb box shall be sized to properly fit the valve and adjust to the depth to which the valve is set.

15234.2.4 SERVICE LATERAL PIPE

Service lateral pipe shall be as called for on the Drawings and in accordance with the following:

15234.2.4.1 COPPER SERVICE PIPE - Copper service pipe shall be Type K soft, conforming to Federal specification WW-T-799 or ASTM B88-62.

15234.2.4.2 POLYETHYLENE PIPE - Polyethylene service pipe shall conform to the requirements of AWWA C-901, "Polyethylene (PE) Pressure Pipe, Tubing and Fittings, 2-inch through 3-inch for water." PE Pipe shall be pressure tubing conforming to Table 6 of said Specification. Tubing shall be Class 160 with a DR of 9.0 or Class 200 with a DR of 7.3. If not specified, DR 7.3 shall be used.

15234.2.4.3 Ends of polyethylene tubing inserted in compression connections should be fitted with insert reinforcement.

15234.2.5 METER SETTER (YOKE)

Meter setter shall be fit with copper tubing (when required), copper alloy, and copper alloy fittings. Setters shall be furnished with copper alloy body, angle, or straight, ball-type inlet valves with fittings appropriately sized to fit the meter. When required, a cast iron yoke ban shall be furnished to provide the setting.

15234.2.6 CHECK VALVE

Unless indicated otherwise on the Drawings, a check valve shall be provided with each meter setting. Check valves shall be copper alloy bodied, dual valves which meet the requirements of the State and local health authorities and conform to ASTM/AWWA C-510.

15234.2.7 WATER METERS

Water meters shall be cold-water displacement type meters, which complies with ANSI/AWWA C-700. The main case and bottom plate shall be of bronze and the meter shall be sized and equipped as shown on the Drawings. The meters shall be Model SR II by SENSUS Technologies, PMM Multi-Jet Series by Precision Meters, or an approved equal.

15234.2.8 METER BOX

Meter boxes shall be fabricated from rigid PVC or ABS plastic pipe. They shall be white in color. They shall have a minimum diameter of 18-inches, be sized to fit over the meter assembly while allowing reasonable interior access, and shall make an appropriate fit with the meter box ring and cover.
15234.2.9 METER BOX RING AND COVER

The meter box ring and cover shall be cast iron with a minimum diameter of 18-inches but shall be appropriately sized to fit larger meter boxes where required. The words "WATER METER" shall be cast into the cover. The cover shall be a locking type with a pentagonal head, corrosion resistant, screw down, locking device.

15234.2.10 METER BOX DRAINAGE

Meter box drainage shall be provided by placing 3-cubic yards of drain gravel at the base of new meter box drain.

15234.3 CONSTRUCTION REQUIREMENTS

15234.3.1 TRENCHING AND BACKFILL

Trenching and backfill for installation of service connections shall be completed in accordance with Section 02200. Service lines shall have a minimum of 3.5-feet of cover.

15234.3.2 INSTALLATION OF CONNECTIONS

Installation of water service connection components shall be as shown on the Drawings. All connections to PVC pipe shall be made by using a saddle rather than a direct tap. Service lines shall be slightly snaked in the trench near the connection to the water main to allow for some movement to avoid a rigid connection.

15234.3.3 REPLACEMENT OF EXISTING FACILITIES

When replacement of specified components of service connections is required, the Contractor shall: protect existing equipment, provide appropriate connecting fittings to accommodate the new component, use care in removal and salvaging of the existing component, and deliver the existing components to the Owner's maintenance shop or headquarters.

15234.4 METHOD OF MEASUREMENT

15234.4.1 CONNECTIONS

Measurement for service connections shall be made by counting the number of "each" size of connection (consisting of furnishing and installing: (1) service saddle on the water main; (2) drilling and tapping; (3) corporation stop; and (4) the necessary excavation and backfilling) installed and accepted.

15234.4.2 SERVICE LATERALS

Service laterals shall be measured using an accurate measuring device to determine the number of linear feet of each size of service lateral pipe installed between the corporation stop and the meter setter. This measurement shall include furnishing and installing the pipe and appropriate connecting fittings and any necessary trench excavation and backfilling.

15234.4.3 SERVICE METER SETTER ASSEMBLY

Measurement of service meter setter assemblies shall be made by counting the number of each size of assembly furnished, installed, and accepted. This measurement shall include the curb stop meter
setter, connecting fittings, meter box, lid, drain gravel, and the necessary excavation and backfilling.

15234.4.4 WATER METERS

Measurement of water meters shall be made by counting the number of meters of each size furnished, installed, and accepted.

15234.4.5 STOCK WATERING TAPS

Measurement for stock watering taps shall be made by counting the number of each size of connection installed and accepted. This measurement shall include furnishing and installing: (1) service saddle on the water main; (2) drilling and tapping; (3) corporation stop; (4) 20-feet of service lateral; (5) curb stop and box; and (6) the necessary excavation and backfilling required to complete the connection.

15234.4.6 REPLACEMENT OF EXISTING FACILITIES

Where certain components of a total existing water service connection are to be replaced, measurement will be made by counting the number of each size and/or kind of the specifically identified component or components as shown in the Bid Schedule as installed and accepted. Such measurement shall include furnishing and installing the identified component, necessary excavation, and backfill, and salvaging and delivery of any replaced component when designated.

15234.5 BASIS OF PAYMENT

The accepted quantities shall be paid for at the contract unit price for:

<table>
<thead>
<tr>
<th>PAY ITEM</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Size) Service Connection</td>
<td>Each</td>
</tr>
<tr>
<td>(Size) Service Lateral</td>
<td>Linear Foot</td>
</tr>
<tr>
<td>(Size) Service Meter Assembly</td>
<td>Each</td>
</tr>
<tr>
<td>(Size) Meter</td>
<td>Each</td>
</tr>
<tr>
<td>Replace (Size) (Component Name)</td>
<td>Each</td>
</tr>
<tr>
<td>Install (Size) (Component Name)</td>
<td>Each</td>
</tr>
<tr>
<td>(Size) Stock Watering Tap</td>
<td>Each</td>
</tr>
<tr>
<td>(Size) Stock Watering Tap</td>
<td>Each</td>
</tr>
</tbody>
</table>
15236.1 DESCRIPTION

Includes furnishing and installing tubular flanged water flow meter(s) of the size and type and location shown on the Drawings and as described in these Specifications.

15236.1.1 RELATED WORK

Section 02222 - Pipe Installation

15236.1.2 SUBMITTALS

The Contractor shall provide complete information which includes cutaway drawings, parts lists, and manufacturer's installation instructions in accordance with the requirements of Section 01300.

15236.1.3 DEFINITIONS

Not used.

15236.2 MATERIALS

15236.2.1 PERFORMANCE CAPABILITY

Flow meters shall be able to accurately operate in working pressures up to 150 PSI, at temperatures up to 140 degrees F. and for flows 40 GPM and greater. Meter sizes and measuring capacity shall be as shown on the Drawings. The meter’s flow indicator shall be mechanically driven with a 3.5-inch (minimum) dial that provides a flow reading and totalizer reading up to six digits in GPM and total gallons. Meters installed in systems or at locations which are controlled by an electronic telemetry system shall be furnished with flow transmitters which can be connected into that system to indicate flow conditions.

15236.2.2 FABRICATION

Flow meters shall be manufactured to meet the requirements of ANSI/AWWA C-704 with a steel meter tube fitted with straightening vanes, all of which is coated with a fusion epoxy resin. Interior components of the meter shall be fabricated from stainless steel, plastic or other corrosion resistant materials which will provide long service. The propeller shall be magnetically connected to the drive mechanism and mounted with bearings which provide smooth operation for flows in both directions. The gearbox shall be cast bronze and the meter head shall be fabricated from cast iron or epoxy coated steel.

15236.3 CONSTRUCTION REQUIREMENTS

Flow meters shall be installed in accordance with the manufacturer’s recommendations and consistent with the Drawings. The Contractor shall provide all materials and installation labor to assure proper installation and calibration of the meter(s) required.

15236.4 METHOD OF MEASUREMENT

15236.4.1 NO MEASUREMENT

Separate measurement will not be made for flow meters when installed as a component of a building, enclosure or assembly for which measurement is indicated in the Bid Schedule.
15236.4.2 SEPARATE MEASUREMENT

Separate measurement may be made for meters furnished and installed when so identified in the Bid Schedule. Measurement shall be made by counting the number of each size and type of valve installed and accepted.

15236.5 BASIS OF PAYMENT

The accepted quantities will be paid for at the contract unit price for:

<table>
<thead>
<tr>
<th>PAY ITEM</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Size) Flow Meter</td>
<td>Each</td>
</tr>
</tbody>
</table>
SECTION 15261 - CULINARY WATER PIPE INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To -

1. Furnish and install insulation on above ground hot and cold water lines, fittings, valves, and accessories as described in Contract Documents.

B. Related Sections -

1. General Conditions, Division 01, and Section 15010 apply to this Section.

PART 2 - PRODUCTS

2.1 INSULATION

A. Heavy density pipe insulation with factory vapor jacket equal to Fiberglas ASJ with Butt Joints.

B. Approved Manufacturers -

1. Manville
2. Owens-Corning
3. Knauf

2.2 PVC FITTING, VALVE, & ACCESSORY COVERS

A. Approved Manufacturers -

1. Knauf
2. Zeston

PART 3 - EXECUTION

3.1 APPLICATION

A. Piping -

1. Apply insulation to clean, dry piping with joints tightly butted.
2. Adhere "factory applied vapor barrier jacket lap" smoothly and securely at longitudinal laps with a white vapor barrier adhesive.
3. Adhere 3 inch wide self-sealing butt joint strips over end joints.
COUNTY FAIRGROUNDS BUILDING
CACHE COUNTY

B. Fittings, Valves, & Accessories -

1. Insulate with same type and thickness of insulation as pipe, with ends of insulation tucked snugly into throat of fitting and edges adjacent to pipe insulation tufted and tucked in.
2. Cover insulation with one piece fitting cover secured by stapling or taping ends to adjacent pipe covering.
3. Alternate Method -
   a. Insulate fittings, valves, and accessories with one inch of insulating cement and vapor seal with two 1/8 inch wet coats of vapor barrier mastic reinforced with glass fabric extending 2 inches onto adjacent insulation.

C. Pipe Hangers -

1. Do not allow pipes to come in contact with hangers.
2. Provide 16 ga x 6 inch long galvanized shields at each pipe hanger to protect pipe insulation from crushing by clevis hanger.

D. No insulation shall be applied until piping has been pressure tested and approved.

E. In all cold attic situations where the building insulation is located at the ceiling, all piping installed in the ceiling to roof space shall be insulated as specified herein. In addition, install at 6" thick by 30" wide fiberglass blanket with vapor barrier (vapor barrier towards warm side of cavity) over the pipe to tent and allow heat loss through the ceiling to prevent the pipe from freezing. The insulation blanket shall be held in place by rolling it to a wood lathe and nailed to the joist. The building insulation shall then be applied over this pipe protection layer.

F. In room installations where excess moisture or humidity will be present, only the polyolefin or elastomeric insulation shall be used.

END OF SECTION 15261
SECTION 15262 - UNDERGROUND PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To -

1. Furnish and install insulation on underground hot and cold water pipes within confines of building as described in Contract Documents.

B. Related Sections -

1. General Conditions, Division 01, and Section 15010 apply to this Section.

PART 2 - PRODUCTS

2.1 MATERIAL

A. Insulation -

1. ½ inch thick Armaflex Standard Pipe Insulation.
2. Equal by Rubatex or IMCOA "ImcoLock".

B. Joint Sealant -

1. Armstrong 520

PART 3 - EXECUTION

3.1 INSTALLATION

A. Slip underground pipe insulation onto pipe and seal butt joints.

B. Where slip-on technique is not possible, slit insulation, apply to pipe, and seal seams and joints.

END OF SECTION 15262
SECTION 15263 - REFRIGERANT PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To -
   1. Furnish and install insulation on above ground refrigerant suction piping and fittings, including thermal bulb, from thermal expansion valve as described in Contract Documents.

B. Related Sections -
   1. General Conditions, Division 01, and Section 15010 apply to this Section.

PART 2 - PRODUCTS

2.1 FLEXIBLE FOAMED PIPE INSULATION

A. Thickness -
   1. ½ inch for one inch outside diameter and smaller pipe.
   2. 3/4 inch for 1-1/8 through 2 inch outside diameter pipe.
   3. One inch for 2-1/8 inches outside diameter and larger pipe (two layers of ½ inch).
   4. One inch sheet for fittings as recommended by Manufacturer.

B. Approved Manufacturers -
   1. Armaflex
   2. Rubatex
   3. CSG "Ultrafoam"
   4. IMCOA "ImcoLock"

2.2 JOINT SEALER

A. Approved Manufacturers -
   1. Armaflex 520
   2. BFG Construction Adhesive #105
   3. Therma-Cel 950

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install insulation in snug contact with pipe and in accordance with Manufacturer's recommendations.

B. Stagger joints on layered insulation.
C. Slip insulation on tubing before tubing sections and fittings are assembled keeping slitting of insulation to a minimum.

D. Seal joints in insulation. Use black nylon 1" tie straps every two feet.

E. Insulate flexible pipe connectors.

F. Insulate thermal expansion valves with insulating tape.

G. Insulation exposed outside building shall have "slit" joint seams placed on bottom of pipe.

H. Insulate fittings with sheet insulation and as recommended by Manufacturer.

I. Paint exterior exposed insulation with two coats of white or gray finish recommended by Insulation Manufacturer, except on Therma-Cel insulation.

END OF SECTION 15263
SECTION 15290 - DUCTWORK INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To -

1. Furnish and install insulation on air ducts outside building insulation envelope as described in Contract Documents.
2. Furnish and install insulation on supply, exhaust, return, and fresh air ducts and combustion air ducts within building insulation envelope.
3. Furnish and install insulation on other air ducts where indicated on Drawings.

B. Related Sections -

1. General Conditions, Division 01, and Section 15010 apply to this Section.
2. Section 15896 - Acoustical insulation inside air ducts.

PART 2 - PRODUCTS

2.1 INSULATION

A. 2 inch thick fiberglass with aluminum foil scrim kraft facing and have a density of .75 lb/cu ft. (R-Value = 5.6) (inside building envelope). The duct insulation shall meet the current International Energy Conservation Code (IECC).

B. 3 inch thick fiberglass with aluminum foil scrim kraft facing and have a density of .75 lb/cu ft. (R-Value = 8.4) (outside building envelope). The duct insulation shall meet the current International Energy Conservation Code (IECC).

C. Approved Manufacturers -

1. Manville Microlite FSK
2. CSG Type IV standard duct insulation
3. Owens-Corning FRK
4. Knauf (Duct Wrap FSK)

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct wrap in accordance with Manufacturer's recommendations (overlap insulation 4-inches).

B. Do not compress insulation except in areas of structural interference.

C. Completely seal joints.
SECTION 15411 - CULINARY WATER PIPING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To -
   1. Furnish and install culinary water piping complete with necessary valves, connections, and accessories inside building and connect with outside utility lines 5 feet from building perimeter.
   2. Perform excavating and backfilling required by work of this Section.

B. Related Sections -
   1. General Conditions, Division 01, and Sections 15010, 15060 and 15190 apply to this Section.
   2. Division 02 - Culinary water piping from 5 feet from building to main.
   3. Division 02 - Criteria for performance of excavation and backfill.

1.2 SUBMITTALS

A. Quality Control -
   1. Submit written report of sterilization test to Architect.

PART 2 - PRODUCTS

2.1 MANUFACTURING

A. All pipe & fittings shall be domestic (USA) manufacturer.
B. All valves shall be domestic (USA) manufacturer.

2.2 PIPE

A. Type K copper for piping underground or beneath concrete slab. 3/4 inch minimum under slabs. Trap primer supplies shall be ½ inch.
B. Type L hard drawn copper for above ground applications.
C. Wirsbo “Aquapex” Tubing & Manifold or Rehau “Raupex” plumbing pipe. (Engel Method Extrusion Process or PEX a.).
D. Aquatherm Greenpipe or 7.4 Faser - composite pipe

2.3 FITTINGS

A. Wrought copper.
B. ProPEX fittings.

C. Uponor engineered polymer (EP) fitting for PEX pipe.

D. Aquatherm fusion fittings.

2.4 CONNECTIONS

A. Sweat copper type with 95/5 or 96/4 Tin-Antimony solder.

B. Joints under slabs, if allowed by local codes, shall be brazed.

C. ProPex Rings

D. Aquatherm (fusion)

2.5 BALL VALVES

A. Use ball valves exclusively unless otherwise specified. Ball valves shall be by single manufacturer from approved list below. Valves shall be for 150 PSI SWP.

B. Approved Manufacturers -

1. Nibco-Scott T595 or S595 or equal by
2. ConBraCo (Apollo)
3. Crane
4. Hammond
5. Stockham
6. Watts

2.6 STOP & WASTE VALVES

A. Approved Manufacturers -

2. Buffalo screw type curb box H-10350 complete with lid and H-10349 enlarged base by Mueller.

2.7 BACKFLOW PROTECTIONS

A. Approved Manufacturers-

1. Watts No. 909 or No. 009AQ - R.P. Backflow Preventer.
2. FEBCO Model No. 825 or Model No. 880 - R.P. Backflow Preventer.
4. ConBraCo.
2.8 COMBINATION PRESSURE REDUCING VALVE/STRAINER

A. Integral stainless steel strainer, or separate 'Y' strainer installed upstream of pressure reducing valve.
B. Built-in thermal expansion bypass check valve.
C. Approved Manufacturers -
   1. Watts U5B or equal by
   2. Cash Valve
   3. Spencer
   4. Wilkins

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install piping under slabs without joints where possible.
B. Locate cold water lines a minimum of 6 inches from hot water line.

3.2 FIELD QUALITY CONTROL

A. Before pipes are covered, test systems in presence of Architect at 100 psi hydrostatic pressure for two hours and show no leaks.
B. Sterilize domestic water system with solution containing 250 parts per million minimum of available chlorine. Introduce chlorinating materials into system in manner approved by Architect. Allow sterilization solution to remain for 24 hours and open and close valves and faucets several times during that time.
C. After sterilization, flush solution from system with clean water until residual chlorine content is less than 0.2 parts per million.
D. Water system will not be accepted until negative bacteriological test is made on water taken from system. Repeat dosing as necessary until such negative test is accomplished.

END OF SECTION 15411
SECTION 15412 - SOIL, WASTE, AND VENT PIPING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To -

1. Furnish and install soil, waste, and vent piping systems within building and connect with outside utility lines 5 feet out from building where applicable.
2. Perform excavation and backfill required by work of this Section.

B. Products Furnished But Not Installed Under This Section -

1. Galvanized steel roof jacks.

C. Related Sections -

1. General Conditions, Division 01, and Sections 15010, 15060 and 15190 apply to this Section.
2. Division 02 - Criteria for performance of excavation and backfill.
3. Division 02 - Sewage piping from 5 feet out from building to main.
4. Division 02 - Storm sewer piping.
5. Division 07 - Installing of galvanized steel roof jacks.
6. Division 07 - Furnishing and installing of lead roof jacks.

PART 2 - PRODUCTS

2.1 MANUFACTURING

A. All pipe and fittings shall be domestic (USA) manfacturer.

2.1 BURIED LINES

A. Service weight, single-hub type cast iron soil pipe and fittings meeting the requirements of ASTM A 74, "Specification for Cast Iron Soil Pipe & Fittings". Service weight, no-hub cast iron pipe and fittings meeting the requirements of ASTM A 888, “Specifications for Cast Iron Soil Pipe and Fittings”.

B. Plastic pipe conforming to IAPMO and ASTM specifications will be acceptable where permitted by local code.

C. Joint Material -

1. 50% oakum and 50% lead, well calked.
2.2 ABOVE GRADE PIPING & VENT LINES

A. Same as specified for buried lines except no-hub pipe may be used.

B. Vent lines 2-1/2 inches or smaller may be Schedule 40 galvanized steel.

C. Plastic pipe conforming to IAPMO and ASTM specifications will be acceptable where permitted by local codes.

D. Joint Material -
   1. Bell & Spigot Pipe - 50% oakum and 50% lead, well caulked, or rubber gaskets meeting requirements of ASTM C 564, " Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings".

2.3 BURIED AND ABOVE GRADE ACID WASTE AND VENT LINES

A. Schedule 40 polypropylene acid waste pipe, manufactured to dimensions and tolerances of ASTM F 1412. The pipe shall be fire retardant polypropylene material conforming to ASTM D4101.

B. Fitting shall be schedule 40 polypropylene, manufactured to dimensions as per ASTM F1412. The polypropylene material shall be fire retardant and conform to ASTM D4101.

C. Joining methods between the pipe and fittings shall be mechanical joint, meeting ASTM F1412 or electrofusion to produce a hermetically sealed joint, conforming to ASTM 1290.

D. All acid waste lines and fittings above floor shall be insulated for noise abatement.

E. Approved products
   1. Zurn
   2. Orion

2.4 ABOVE GRADE ACID WASTE AND VENT LINES LOCATED IN PLENUM OR FIRE RATED ROOM OR STRUCTURE.

A. Schedule 40 polyvinylidene Fluoride (PVDF) acid waste pipe, manufactured to dimensions and tolerances of ASTM F1672. The pipe shall be fire resistant Polyvinylidene Fluoride material conforming to ASTM D3222.

B. Fitting shall be schedule 40 polyvinylidene Fluoride, manufactured to dimension per ASTM F1673. The polyvinylidene Fluoride (PVDF) material shall be fire resistant and conform to ASTM D3311 and F1673.

C. Joining method between the pipe and fittings shall be mechanical joint, meeting ASTM F1673.
D. Approved products

1. Zurn
2. Orion

E. All acid waste lines and fittings shall be insulated with an approved insulation that meets the flame smoke rating for plenum or fire rated rooms or structure. If necessary the insulation shall be wrapped with a plenum rated tape.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Do not caulk threaded work.

B. Slope horizontal pipe at ¼ in/ft.

C. Place cleanouts as follows -

1. Where shown on Drawings and near bottom of each stack and riser.
2. At every 90 degree change of direction for horizontal lines.
3. Every 100 feet of horizontal run.
4. Extend cleanout to accessible surface. Do not place cleanouts in carpeted floors. In such locations, use wall type cleanouts.

D. Each fixture and appliance discharging water into sanitary sewer or building sewer lines shall have seal trap in connection with complete venting system so gasses pass freely to atmosphere with no pressure or syphon condition on water seal.

E. Vent entire waste system to atmosphere. Discharge 10 inches above roof. Join lines together in fewest practicable number before projecting above roof. Set back vent lines so they will not pierce roof near edge or valley.

F. Use torque wrench to obtain proper tension in cinch bands when using hubless cast iron pipe. Butt ends of pipe against centering flange of coupling.

*** Roof systems other than concrete roof tile ***

G. Flash pipes passing through roof with galvanized base “no-caulk”, roof flashing with flexible rubber waterproof collar. Flashing base shall be at least 18" x 18".

1. Flashing may be 4 lb per sq ft lead flashing fitted around pipes and turned down into pipe ½ inch with turned edge hammered against pipe wall.
2. Consult roofing contractor for exact method of flashing, coordinate with engineer.
3.2 FIELD QUALITY CONTROL

A. Before piping is covered, conduct tests for leaks and defective work. Notify Architect prior to testing. Correct leaks and defective work. Fill waste and vent system to roof level with water, 10 feet minimum, and show no leaks for two hours.

END OF SECTION 15412
SECTION 15414 - HEAT TRACE SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To -

   1. Furnish, install and test domestic hot water temperature maintenance system on domestic hot water system.

B. General Conditions, Division 01 and Section 15010 apply to this section.

PART 2 - PRODUCTS

2.1 MATERIAL

A. Electric self-regulating heating cables and components for maintaining the water temperature of the domestic hot water system as indicated on the drawings. Raychem Hwat-Plus System.

B. System cables and components shall be U.L. Listed for domestic hot water temperature maintenance.

C. System shall maintain a nominal temperature of 105°F at 208-volt.

D. Submittals: Manufacturers catalog cuts showing materials and performance data.

E. Acceptable Manufacturers: Nelson

F. All heat trace shall be domestic (USA) manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The system shall be installed according to the drawings and meets all code requirements and the manufacturer’s instructions. The installer shall be responsible for providing a functional system, installed in accordance with applicable national and local code requirements. Each circuit shall be protected with a 30-mA ground-fault protection device.

3.2 TESTING

A. Procedure: Measure the heater circuit continuity and the installation resistance between the braid and bus wires with a 2500-Vdc megohm meter (megger).

B. Timing: The tests should be performed after the pipe insulation has been installed and prior to installation of wall or ceiling panels, and shall be witnessed by the Construction Manager and the manufacturer’s representative.
C. Acceptable Results: The heater circuit shall be continuous and megger readings shall be at least 20 megohms regardless of heater length. Circuits yielding unacceptable readings must be repaired or replaced.

D. Submittal of Results: Submit records of the test data to the Construction Manager.

END OF SECTION 15414
SECTION 15430 - PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To -

1. Furnish and install items specified in this Section and/or described in Contract Documents.

B. Related Sections -

1. General Conditions, Division 01, and Sections 15010, 15060 and 15190 apply to this Section.

PART 2 - PRODUCTS

2.1 FLOW CONTROL FITTINGS:

A. Vandal proof type and fit faucet spout of fixture used. Flow shall be controlled as required by local codes.

2.2 CONDENSATE DRAINS

A. Provide Type M copper for condensate drains from air handling units, fan coil units, furnace coils, and cooler/freezers. Support piping and protect from damage.

B. Provide schedule 40 PVC for condensate from high tech furnaces, boiler, and water heater.

C. Install 3 inch deep seal, vented water trap adjacent to coil connection.

D. If condensing equipment is installed without a clarifier, the condensate lines shall be PVC pipe and fitting. Secure all piping.

2.3 CONDENSATE PUMP

A. Rated at 225 gph at 15 feet total head. Complete with one gallon polystyrene tank with pump and automatic float control. 1/5 hp, 120 volt, one phase, 60 Hertz.

B. Condensate piping shall be Type M copper.

C. Approved Manufacturers -

1. Little Giant #VCL45S

2.4 PRESSURE GAUGES

A. Cast aluminum case
B. Chrome plated ring

C. Clear glass window

D. Phosphor bronze alloy steel bourdon tube

E. ½ percent scale range accuracy

F. 4-1/2 inch diameter dial face

G. Range 0 to 100 psig.

H. Liquid Filled.

I. Approved Manufacturers -
   1. Trerice 700 or equal
   2. Crosby-Ashton
   3. Marsh

2.5 BRASS GAUGE COCKS

A. Approved Manufacturers -
   1. Ashcroft
   2. Ernst
   3. Trerice
   4. Walworth

2.6 WATER HAMMER ARRESTERS

A. Provide and install a water hammer arrester at each hot and cold water connection and battery of fixtures.

B. Water hammer arresters shall be sized in accordance with PDI WH-201, precharged, suitable for operation in temperature range 100 to 300 degrees F, and maximum 250 psig working pressure.

C. Approved Manufacturers:
   1. Josam
   2. J.R. Smith
   3. Wade
   4. Zurn

2.7 THERMOMETERS

A. 9 inch adjustable, angle, red reading, mercury type with cast aluminum case and 3-1/2 inch chrome-plated brass separable socket.

B. Range -30 to 240/ F.
C. Approved Manufacturers

1. Trerice BX9 or equal by
   a. H-B
   b. Palmer
   c. Taylor
   d. Weiss
   e. Weksler

PART 3 - EXECUTION

3.1 INSTALLATION

A. Connect gauges to pipe with ¼ inch connections utilizing cocks.

END OF SECTION 15430
SECTION 15440 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To -

1. Furnish and install plumbing fixtures as described in Contract Documents.

B. Related Sections -

1. General Conditions, Division 01, and Section 15010 and 15 060 apply to this Section.

PART 2 - PRODUCTS

2.1 GENERAL

A. Interior exposed pipe, valves, and fixture trim shall be chrome plated.

2.2 WATER CLOSETS

A. Standard Fixture -

1. Approved Manufacturers -
   a. American Standard
   b. Kohler

B. Handicap Fixture -

1. 18 inch rim height.
2. Approved Manufacturers
   a. American Standard
   b. Kohler

C. Seat -

1. Provide split front type with check hinge.
2. Approved Manufacturers for Standard, Handicapped and Nursery Fixtures -
   a. Bemis
   b. Kohler

D. Supply Pipe & Stop -

1. Provide stuffing box and chrome plated escutcheons
2. Approved Manufacturers
   a. Brass Craft
E. Flush Valves -

1. Approved Manufacturers
   a. Sloan

2. Flush Valve Filters
   a. SFOBI “Dirt Grabber” South Fork Manufacturing

F. Water Closet Supports

1. J.R. Smith
2. Zurn
3. Josam
4. Wade
5. Watts Drainage Products

2.3 URINALS

A. Fixture -

1. Approved Manufacturers
   a. American Standard
   b. Kohler

B. Flush Valve -

1. Approved Manufacturers
   a. Sloan

2. Flush Valve Filters
   a. SFOBI “Dirt Grabber” South Fork Manufacturing

2.4 LAVATORIES

A. Self-Supporting Fixture –

1. Size 20” x 18”
2. Approved Manufacturers
   a. American Standard
   b. Kohler

B. Counter Top Fixture -

1. Size 20” x 17” (maximum)
2. Approved Manufacturers
   a. American Standard
   b. Kohler
C. Fittings -

1. Faucet and Drain -
   a. Approved Manufacturers-
      1) Moen Commercial
      2) Symmons
      3) Kohler

2. Supply pipes with stops -
   a. Provide stuffing box and chrome plated escutcheons.
   b. Approved Manufacturers -
      1) Brass Craft

3. Trap -
   a. 17 ga tube "P" trap, chrome plated
   b. Approved Manufacturers -
      1) Brass-Craft
      2) Dearborn
      3) McGuire
      4) Keeney Manufacturing
      5) Watts

D. All handicap accessible lavatories shall have traps and hot and cold water supplies insulated with flexible vinyl insulation manufactured by Truebro, Inc. Handi Lav-Gaurd Model No. 102W or No. 105W (no equals accepted).

2.5 HANDICAPPED LAVATORIES

A. Self-Supporting Fixture –

1. Size - 20" x 27"

2. Approved Manufacturers –
   a. American-Standard
   b. Kohler

B. Fittings -

1. Faucet & Drain -
   a. Approved Manufacturers -
      1) Symmons
      2) Kohler
      3) Moen Commercial

2. Supplies with stops
   a. Provide stuffing box, brass stems and chrome plating.
   b. Approved Manufacturers
      1) Brass Craft

3. Traps
   a. 17 ga tube “P” trap, chrome plated
b. Approved manufacturers
   1) Watts
   2) Dearborn
   3) McGuire
   4) Keeney Manufacturing

C. All handicap accessible lavatories shall have traps and hot and cold water supplies insulated with flexible vinyl insulation manufactured by Truebro, Inc. Handi Lav-Gaurd Model No. 102W or No. 105W (no equals accepted).

2.6 SERVICE SINK

A. Fixture -

1. Floor Type.
2. Approved Manufacturers -
   a. American Standard
   b. Kohler

B. Fittings -

1. Faucet -
   a. Mounting height of 42 inches
   b. Provide 48 inch hose and clamp.
   c. Approved Manufacturers -
      1) T & S Brass
      2) Kohler
      3) Chicago Faucet

2. Drain and Strainer -
   a. Approved Manufacturers -
      1) American Standard
      2) Zurn
      3) Kohler

3. Trap -
   a. Cast iron - “Deep Seal”.

2.7 FLOOR DRAINS -

A. Approved Manufacturers -

1. Josam
2. J. R. Smith
3. Wade
4. Zurn
5. Watts Drainage Products

2.8 HYDRANTS

A. Provide with integral anti-siphon device.
COUNTY FAIRGROUNDS BUILDING
CACHE COUNTY

B. Approved Manufacturers (Exterior Frost Free)

1. Wade
2. J. R. Smith
3. Woodford

C. Approved Manufactures (Interior)

1. Acorn
2. Woodford

2.9 CLEANOUTS:

A. Furnish wall cleanouts with chrome wall cover and screw.

1. Finish Floors - Wade W-6000
2. Resilient Flooring - Wade W-6000-T
3. Finished Wall - Wade W8460R
4. Exposed Drain Lines - Wade W-8650A
5. General Purpose - Wade W-8550A
6. Approved Alternate Manufacturers for Cleanouts
   a. Josam
   b. Smith
   c. Zurn
   d. Watts Drainage Products

2.10 FLOOR SINK

A. 8 inch square top, medium receptor cast iron body with flanged receptor, acid resistant coated interior, and acid resistant coated half grate. Aluminum sediment bucket and 2 inch calked regular outlet connection.

B. Approved Manufacturers -

1. Commercial Enameling
2. JR Smith
3. Josam
4. Wade
5. Zurn
6. Watts Drainage Products

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install fixtures including traps and accessories with accessible stop or control valve in each hot and cold water branch supply line.

B. Mount fixtures per architectural elevations unless noted otherwise.
C. Make fixture floor connections with approved brand of cast iron floor flange, soldered or caulked securely to waste pipe.

D. Make joints between fixtures and floor flanges tight with approved fixture setting compound or gaskets.

E. Calk between fixtures and wall and floor with white butyl rubber non-absorbent caulking compound. Point edges.

F. All wall hung fixtures shall be securely attached to carriers, fixture hanger or arm shall be supported free of finished wall.

3.2 ADJUSTING, CLEANING

A. Polish chrome finish at completion of Project.

B. Clean sediment from aerators.

END OF SECTION 15440
SECTION 15450 - VIBRATION AND SEISMIC CONTROL FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
   1. Quality of and requirements for anchorage and seismic restraint systems and vibration isolation systems for HVAC piping and equipment.

B. Related Sections:
   1. Section 03 3111: Cast-In-Place Concrete.
   2. Furnishing and installing of seismic restraint and vibration isolation systems is by installer of equipment requiring such systems. Manufacturers of equipment specified for seismic restraint shall provide product data needed for calculation of seismic restraint needs. This information shall include, but not be limited to, equipment dimensions, dimensioned anchor points, operating weight, and center of gravity dimension.

1.2 REFERENCES

A. American Society For Testing And Materials:
   1. ASTM A 615-04b, 'Standard Specification for Deformed & Plain Billet-Steel Bars for Concrete Reinforcement.'

B. Sheet Metal & Air Conditioning Contractors National Association / American National Standards Institute:

1.3 SUBMITTALS

A. Product Data:
   1. Restraint system and anchorage method to be used for each piece of equipment.
   2. Seismic restraints and calculations for all flexible mounted equipment.
   3. Vibration isolators and flexible couplings.
   4. Clearly outlined procedures for installing and adjusting isolators, seismic bracing anchors, and snubbers.

B. Shop Drawings:
   1. Show size, hanger length, and location of seismic restraints for piping and ductwork.
   2. Show details for each isolator and seismic brace with snubbers proposed for specified equipment.
   3. Show details for proposed structural steel frames and rails and for anchors to be used in conjunction with isolation of equipment.
4. Show locations of piping and ductwork restraints on installation and fabrication floor plans (not bid set of documents of floor plans), noting size and type of restraint to be used.

5. Show details of supports, hangers, anchorage, and bracing for isolated equipment as designed or proposed by professional engineer employed by Restraint Manufacturer and qualified with seismic experience in bracing for mechanical equipment. Shop drawings submitted for seismic bracing and anchors shall bear engineer's signed professional seal.

6. Include anchor bolt calculations, signed and stamped by registered engineer, showing adequacy of bolt sizing and type.
   a. Calculations shall include anchor embedment, minimum edge distance and minimum center distance.
   b. Design lateral forces shall be distributed in proportion to mass distribution of equipment.
   c. Furnish calculations for anchors on restraint devices, cable, isolators, and on rigidly mounted equipment.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: System design and installation shall meet seismic requirements as defined in 2000 Edition of International Building Code, Section 1621 and applicable state and local codes in accordance with Seismic Zone 3 with minimum restraint capability of .4 g. Explicit requirements and details can be found in referenced SMACNA Manual.

B. Seismic Requirements: Mechanical equipment, piping, and ductwork shall be braced, snubbed, or supported to withstand seismic disturbances and remain operational.

C. Vibration Isolation Requirements: Isolate equipment from structure by means of resilient vibration and noise isolators.

PART 2 - PRODUCTS

PROJECT SPECIFIC: Edit materials list below to include only those materials or elements that are actually part of the Mechanical design.

2.1 MATERIALS

A. Isolation And Seismic Equipment:


2. Equipment with Fixed Anchor or Support:
   a. Restraint designed according to Sections 1621 and 1622 of International Building Code.
   b. Horizontal force factor for elements of structures:
      1) In addition, vertical force restraint requirement shall be computed at 1/2 value of horizontal forces.
      2) Restrain equipment not anchored directly to floors by cable system designed and furnished by Restraint Manufacturer.

3. Ductwork: Restrain ductwork in accordance with Figures 4.2 to 4.10 in SMACNA Manual as appropriate.
B. Vibration Isolation Requirements:

1. Unless otherwise noted, isolate HVAC equipment one horsepower and over from structure by means of resilient vibration and noise isolators in accordance with ASHRAE HANDBOOK 2003 - HVAC Applications, Table 42, Chapter 47.

2. Design and install isolation equipment, hangers, connections, and other isolating devices to prevent transmission of vibration to structure from equipment and associated piping and ductwork.

3. For floor-mounted equipment, use recommendations of Table 45.

4. For roofs and floors constructed with open web joints, thin long span slabs, wooden construction and unusual light weight construction, evaluate equipment weighing more than 300 pounds to determine additional deflection of structure caused by equipment weight. Isolator deflection shall be 15 times additional deflection or deflection shown in Table 45, whichever is greater.

5. Under-Equipment Spring Isolators:
   a. Equal to Mason SSLFH earthquake motion restrained spring mounts with freestanding stable steel springs, leveling bolts, corrosion resistant finish, motion limiting design, uplift restraining bolts, and 1/4 inch ribbed neoprene noise stop pad.
   b. Isolators shall accept force in any direction up to 1.0 g without failure, and shall limit movement to 3/4 inch 19 mm in any direction.
   c. Springs shall have 50 percent overload capacity.
   d. Size as required to achieve specified static deflection.
   e. Outer diameter of spring proper shall not be less than 0.8 of spring height when in loaded position.

6. Overhead Support Spring And Rubber Hangers:
   a. Combination spring and neoprene hangers.
   b. Hanger bracket shall have 500 percent overload capability and shall allow up to 15 degree hanger rod misalignment without short-circuiting.
   c. Springs shall have 50 percent overload capacity.
   d. Provide seismic bracing as required.

7. Isolate piping and ductwork in mechanical equipment room and piping and ductwork three supports away or 50 feet from other mechanical equipment, whichever is greater, from structure by means of vibration and noise isolators.
   a. Isolate suspended piping with combination spring and fiberglass hangers in supporting rods.
   b. Support floor-mounted piping directly on spring mounts.

8. Isolate vertical pipe risers from structure using vibration and noise isolating expansion hangers having minimum rated deflection of four times anticipated pipe movement. Enclose in housing for fail-safe equipment.

9. Incorporate flexible connectors in piping adjacent to reciprocating equipment.

10. Incorporate flexible connections in ductwork adjacent to air-moving units.

11. Elastomeric Isolator: Neoprene or high quality synthetic rubber with anti-ozone and anti-oxidant additives.


13. Isolators Exposed To Weather: Cadmium plated and neoprene coated springs.
C. Seismic restraint equipment and resilient isolation devices shall be designed and furnished by single Manufacturer:

D. Type One Acceptable Manufacturers:

4. Equal as approved by Architect before bidding. See Section 01 6000.

2.2 FINISHES

A. Clean and paint steel components. Thoroughly clean structural steel bases of welding slag and prime with zinc-chromate or metal etching primer. Etch and paint hot dipped galvanized steel components.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Isolation Equipment:

1. Mount vibration isolated equipment on rigid steel frames or concrete bases unless Equipment Manufacturer certifies direct attachment capability.
2. Install snubbers with factory set clearances.
3. Piping:
   a. Protect isolated and non-isolated piping 2-1/2 inches inside diameter and larger in all planes by restraints to accommodate thermal movement as well as restrain seismic motions.
   b. Locations shall be as scheduled and include, but not be limited to:
      1) At drops to equipment and at flexible connections.
      2) At 45 degree or greater changes in direction of pipe.
      3) At horizontal runs of pipe 30 feet maximum on center spacing.
      4) Gas piping shall have additional restraints as scheduled.

4. Ductwork
   a. Protect isolated and non-isolated rectangular ductwork 4 sq ft in cross-sectional area and larger in all planes by restraints to accommodate thermal movement as well as restrain seismic motion.
   b. Locations shall be determined by Seismic Restraint Manufacturer and include, but not be limited to:
      1) Horizontal runs of ductwork 30 feet maximum on center spacing.
      2) 45 degree or greater changes in direction of ductwork.
      3) Each end of duct runs and drops of equipment.
      4) Each flexible connection.

B. Vibration Isolation: Install piping and ductwork to prevent transmission of noise and vibration into structure.

END OF SECTION 15450
SECTION 15452 - STANDARD DRINKING WATER COOLING SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To -
   1. Furnish and install drinking water cooling system as described in Contract Documents.

B. Related Sections -
   1. General Conditions, Division 01, and Sections 15010 and 15 060 apply to this Section.

PART 2 - PRODUCTS

2.1 STANDARD FOUNTAIN

A. Include accessory fountain. 14 GPH of 50/F water with 90/F room temperature, 1/5 horsepower motor, 115 V, 60 Hz, single phase. Bubbler shall be chrome plated brass.

B. Approved Manufacturers -
   1. Elkay
   2. Oasis

PART 3 - EXECUTION

3.1 INSTALLATION

A. Anchor bottom of fountain to wall.

B. Top surface to be 40 inches above floor.

END OF SECTION 15452
SECTION 15453 - HANDICAP DRINKING WATER COOLING SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To -
   1. Furnish and install handicap drinking water cooling system as described in Contract Documents.

B. Related Sections -
   1. General Conditions, Division 01, and Sections 15010 and 15060 apply to this Section.

PART 2 - PRODUCTS

2.1 HANDICAPPED FOUNTAIN

A. Vandal proof operating bar on front and both sides. 7-1/2 GPH of 50 deg F water with 90° F room temperature, 1/5 horsepower compressor motor, 120 V, 60 Hz, single phase. One piece stainless steel back splash and basin. Flexi-guard or chrome plated brass bubbler.

B. Approved Manufacturers -
   1. Elkay
   2. Oasis

PART 3 - EXECUTION

3.1 INSTALLATION

A. Anchor bottom of fountain to wall.

B. Top surface to be 32 inches above floor unless required otherwise by local code.

C. Install 3/8 inch IPS union connection and Chicago No. 376 stop to building supply line.

D. Install 1-1/4 inch IPS slip cast brass "P" trap. Install trap so it is concealed.

END OF SECTION 15453
SECTION 15459 - GAS FIRED STORAGE TYPE WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To -

1. Furnish and install water heater as described in Contract Documents.

B. Related Sections -

1. General Conditions, Division 01, and Section 15010, 15060 and 15190 apply to this Section.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Glass lined storage tank, pressure tested and rated for 150 psi wp complete with thermostat, high limit control, gas valve, gas pressure regulator, 100% safety shut-off, and draft diverter. AGA approved.

1. With hand hole cleanout and non-prorated three year tank warranty.

2. Approved Manufacturers -
   a. A O Smith
   b. Bradford-White
   c. Lochinvar
   d. Rheem
   f. State

2.2 ACCESSORIES

A. In seismic zones 3 and/or 4 (UBC Figure 23-2) provide and install anchoring components:

1. 1" x 18 ga. galvanized steel straps.
2. #10 x 2-1/2 inch screws.

B. Anchor to wall to resist horizontal displacement due to earthquake motion.

C. Water heaters shall have a Vacuum Breaker and a Thermal Expansion Tank installed on the cold water supply line. Tank shall be of drawn steel construction with a Butyl rubber diagram, plastic lined, and pre-charged with 40 psi air. Maximum working pressure - 150 psi maximum temperature - 200°F. Tank shall be sized as noted on the drawings or as recommended by the manufacturer. Acceptable Manufacturers:

1. State Industries
2. Amtrol, Inc.

D. Check valves shall be spring loaded non-slam type, brass construction.
E. Water heater pan shall be aluminum construction and pipe the drain to the nearest floor drain or floor sink.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Water heaters shall each have temperature-pressure relief valve sized to match heat input and set to relieve at 120 psi.

B. Install temperature-pressure relief valve on hot water heater and pipe discharge to directly above funnel of floor drain.

C. Water heaters with heat input above 200,000 btu/hr shall be ASME certified.

D. Factory installed heat trap nipples.

END OF SECTION 15459
SECTION 15470 - INSTANTANEOUS ELECTRIC DOMESTIC WATER HEATER (TANKLESS)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General Conditions, Division 01, and Sections 220501 shall apply to this Section.

B. Sections 221116 and 220553

1.1 SUMMARY

A. Includes But Not Limited To

1. Provide and install water heaters as described in Contract Documents.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS:

A. Instantaneous, AGA rated.

B. Rated at 2.4 gpm water flow with rise of 80° F. Minimum water flow rate shall be 0.5 gpm.

C. Water flow shall activate heater be modulated by the electric controls to proportionally increase in water flow maintaining a constant temperature rise.

D. Water carrying components shall be either copper or brass.

E. Unit shall be designed for wall mounting.

F. Approved Manufacturers & Models

1. Power Star
2. Eemax
3. Chronomite

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as per manufacture recommendations.

3.2 adjusting, cleaning

A. Installation

1. Open water heater water flow control valves on each unit wide open to allow maximum water flow.
COUNTY FAIRGROUNDS BUILDING
CACHE COUNTY

2. Set leaving water temperature at faucet nearest water heater to 105° F or as directed by the owner, by throttling flow of water through the heater.

END OF SECTION 15470
SECTION 15489 - NATURAL GAS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To -
   1. Furnish and install gas piping and fittings within building including connection to meter.

B. Related Sections -
   1. General Conditions, Division 01, and Sections 15010, 15060 and 15190 apply to this Section.

1.2 QUALITY ASSURANCE

A. Qualifications -
   1. Welders shall be certified and bear evidence of certification 30 days prior to commencing work on project. If there is doubt as to proficiency of welder, Owner's Representative may require welder to take another test. This shall be done at no cost to Owner. Certification shall be by Pittsburgh Testing Laboratories or other approved authority.

PART 2 - PRODUCTS

2.1 MANUFACTURING

A. All pipe & fittings shall be domestic (USA) manufacturer.

B. All valves shall be domestic (USA) manufacturer.

2.2 PIPE

A. Meet requirements of ASTM A 53-89a, "Specification for Pipe, Steel, Black & Hot-Dipped Zinc-Coated Welded & Seamless".

B. Carbon steel, butt welded, Schedule 40 black steel pipe.

2.3 FITTINGS

A. Black Pipe -
   1. Welded forged steel fittings meeting requirements of ASTM A 234-89a, "Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures", or standard weight malleable iron screwed.
2.4 VALVES

A. 125 psi bronze body ball valve, UL listed

B. Approved Manufacturers & Models -

1. ConBraCo - "Apollo" series 80-100
2. Jenkins - FIG-30-A
3. Jomar - Model T-204
4. McDonald - 3410
5. PGL Corp - "Red Cap" gas ball valve
6. Watts - Model B-6000-UL

2.5 EARTHQUAKE ACTUATED GAS SHUT-OFF VALVES

A. Aluminum Body Valve.

B. Stainless Steel Ball Shut-off.

C. Manual reset.


E. Approved Manufacturers:

1. Safe-T-Quake.
2. Koso
3. Quakemaster.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Pipe installed underground, through air plenums, in walls, and pipes 2-1/2 inches and larger shall have welded fittings and joints. Other pipe may have screwed or welded fittings.

B. Wrap and lay underground pipe in accordance with local gas utility company regulations and specifications.

C. Install gas cocks on lines serving boilers, furnaces, duct heaters, and water heaters adjacent to boiler, furnace, or heater on outside of boiler, furnace, or heater cabinet and easily accessible.

D. Do not use flexible pipe connections to boilers, furnaces, duct heaters, or hot water heaters.

E. Install dirt leg with pipe cap, 6 inches long minimum, on each vertical gas drop to heating equipment.

F. Use fittings for changes of direction in pipe and for branch runouts.
G. Protection Coatings: All underground steel pipes shall be wrapped with "Scotchrap" NP. 50 tape to give not less than two complete layers on the entire underground piping system. Factory wrapped pipe in accordance with American Water Works Standard, or X-tru-Coast Plastic coated pipe will be acceptable.

H. Paint main gas valve red and label "Main Gas Shut-off" with a permanent label.

I. Install earthquake activated gas shut-off valve downstream of meter before entering building with gas line (required only in seismic zones 3 and 4).

END OF SECTION 15489
SECTION 15530 - REFRIGERANT PIPING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To -
   1. Furnish and install piping for refrigeration systems as described in Contract Documents.

B. Related Sections -
   1. General Conditions, Division 01, and Section 15010 - check all sections, 15060 and 15190 apply to this Section.
   2. Section 15263 - Refrigerant piping Insulation

1.2 QUALITY ASSURANCE

A. Qualifications -
   1. Refrigerant piping shall be installed by a refrigeration contractor licensed by State.

PART 2 - PRODUCTS

2.1 REFRIGERANT PIPING


B. Do not use pre-charged refrigerant lines.

2.2 REFRIGERANT FITTINGS

A. Wrought copper with long radius elbows.

B. Approved Manufacturers -

   1. Mueller Streamline
   2. Nibco Inc
   3. Grinnell
   4. Elkhart Products Corp

2.3 SUCTION LINE TRAPS

A. Manufactured standard one-piece traps.
COUNTY FAIRGROUNDS BUILDING
CACHE COUNTY

2.4 CONNECTION MATERIAL

A. Brazing Rods -

1. Copper to Copper Connections -
   a. AWS Classification BCuP-4 Copper Phosphorus (6% silver).
   b. AWS Classification BCuP-5 Copper Phosphorus (15% silver).

2. Copper to Brass or Copper to Steel Connections -
   a. AWS Classification bAg-5 Silver (45% silver).

3. Do not use rods containing Cadmium.

2.5 FLUX

A. Approved Manufacturers -

1. "Stay-Silv white brazing flux" by J W Harris Co
2. High quality silver solder flux by Handy & Harmon

PART 3 - EXECUTION

3.1 INSTALLATION

A. Do not install refrigerant piping underground or in tunnels.

B. Slope suction lines down toward compressor one inch/10 feet. Locate traps at vertical rises against flow in suction lines.

C. Refrigeration system connections shall be copper-to-copper, copper-to-brass, or copper-to-steel type properly cleaned and brazed with specified rods. Use flux only where necessary.

   1. No soft solder (tin, lead, antimony) connections will be allowed in system.

D. Braze valve, sight glass, and flexible connections.

E. Circulate dry nitrogen through tubes being brazed to eliminate formation of copper oxide during brazing operation.

3.2 FIELD QUALITY CONTROL

A. Make evacuation and leak tests in presence of Architect's Engineer after completing refrigeration piping systems. Positive pressure test will not suffice for procedure outlined below.

   1. Draw vacuum on each entire system with vacuum pump to 300 microns using vacuum gauge calibrated in microns. Do not use cooling compressor to evacuate system nor operate it while system is under high vacuum. Isolate compressor from system piping using shut-off valves prior to pulling vacuum.
2. Break vacuum with Freon to be used and re-establish vacuum test. Vacuum shall hold for 30 minutes at 200 microns without compressor running.

3. Conduct tests at 70° F ambient temperature minimum.

4. Do not run systems until above tests have been made and systems started up as specified. Inform Owner's Representative of status of systems at time of final inspection and schedule start-up and testing if prevented by outdoor conditions before this time.

5. After testing, fully charge system with refrigerant and conduct test with Halide Leak Detector.

END OF SECTION 15530
SECTION 15535 - REFRIGERANT SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

B. Section 15010 Basic Mechanical Materials and Methods sections apply to work of this section.

C. Section 15530 - Refrigeration piping

D. Section 15671 - Expansion valves for 2 through 5 ton condensing units

1.2 SUMMARY

A. Includes But Not Limited To

1. Furnish and install refrigeration specialties as described in Contract Documents except for expansion valves on 2 through 5 ton condensing units.

PART 2 - PRODUCTS

2.1 EXPANSION VALVES:

A. For pressure type distributors, externally equalized with stainless steel diaphragm, and same refrigerant in thermostatic elements as in system.

B. Size valves to provide full rated capacity of cooling coil served. Coordinate selection with evaporator coil and condensing unit.

C. Approved Manufacturers

1. Alco
2. Henry
3. Mueller
4. Singer
5. Sporlan

2.2 FILTER-DRIER

A. On lines 3/4 inch outside diameter and larger, filter-drier shall be replaceable core type with non-ferrous casing and Schraeder type valve.

B. On lines smaller than 3/4 inch outside diameter, filter-drier shall be sealed type using flared copper fittings.

C. Size shall be full line size.
D. Approved Manufacturers

1. Alco
2. Mueller
3. Sporlan
4. Virginia

2.3 SIGHT GLASS

A. Combination moisture and liquid indicator with protection cap.
B. Sight glass shall be full line size.
C. Sight glass connections shall be solid copper or brass, no copper-coated steel sight glasses allowed.
D. Approved Manufacturers

1. Alco
2. Asco
3. Mueller
4. Sporlan

2.4 MANUAL REFRIGERANT SHUT-OFF VALVE

A. Ball valves designed for refrigeration service and full line size.
B. Valve shall have cap seals.
C. Valves with hand wheels are not acceptable.
D. Provide service valve on each liquid and suction line at compressor.
E. If service valves come as integral part of condensing unit, additional service valves shall not be required.
F. Approved Manufacturers

1. ConBraCo (Apollo)
2. Henry
3. Mueller
4. Superior
5. Virginia

2.5 FLEXIBLE CONNECTORS

A. Provide in each liquid line and suction line at both condensing unit and evaporator on systems larger than five tons.
B. Anchor pipe near each flexible connector.
C. Connectors shall be for refrigerant service with bronze seamless corrugated hose and bronze braiding.

D. Approved Manufacturers

1. Packless Vibration Absorbers Model VAF
2. Style "BF" Spring-flex Freon connectors by Vibration Mountings.
3. Anaconda "Vibration Eliminators" by Anamet.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install valves and specialties in accessible locations. Install refrigeration distributors and suction outlet at same end of coil.

END OF SECTION 15535
SECTION 15611 - GAS FIRED FURNACES (90%)

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To -

1. Furnish and install vertical gas-fired condensing furnaces as described in Contract Documents.

B. Related Sections -

1. Section 15010: General Mechanical Requirements
2. Section 15530: Refrigerant Piping System.

1.2 SYSTEM DESCRIPTION

A. Performance Requirements: Rated at 90 percent minimum AFUE (Annual Fuel Utilization Efficiency) calculated in accordance with DOE test procedures.

1.3 SUBMITTALS


1.4 WARRANTY

A. Provide 15-year minimum limited warranty on heat exchanger.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Furnaces:

1. Factory assembled units certified by AGA complete with blower section, steel casing, piped, and wired.
2. Blower section shall consist of cabinet, blower, and motor.
   a. Cabinet shall be of 22 ga minimum cold rolled steel and have finish coat of baked-on enamel.
   b. Blower shall be Class 1, full DIDW, statically and dynamically balanced.

3. Automatic controls shall consist of:
   a. 100 percent cut-off safety pilot.
   c. Operating automatic gas valve.
   d. Solid-state type fan and thermal limit controls.
   e. 24-volt transformer.
   f. Electronic ignition system.
4. Blower shall be driven by motor with adjustable pitch V-belt drive or by multi-speed direct driven motor.
5. Furnace section shall be enclosed in 22 ga minimum enameled steel casing lined with foil covered insulation.
6. Heat exchanger; Aluminized Steel.
8. PVC intake of outside air and PVC combustion product exhaust, with sealed combustion, direct vent system.
9. Concentric roof termination kit for roof mounting.
10. Approved Products:
   a. Standard furnaces:
      1) Carrier
      2) Lennox
      3) Trane
   b. Two-Stage Furnaces
      1) Carrier
      2) Lennox
      3) Trane

B. Cooling Coil

1. Cooling coil shall consist of heavy gauge steel cabinet with baked-on enamel finish to match furnace.
   a. Coil shall have aluminum fins bonded to seamless copper tubing.
   b. Coil shall be ARI rated. Provide drain pans with connections at one end.
   c. Use thermal expansion valve with brazed joints in place of capillary tube metering device. Compression fittings not acceptable.
   d. Do not include cooling coil and coil cabinet on furnaces serving zones where cooling is not required.

2. Approved Products:
   a. Vertical:
      1) Carrier/Bryant
      2) Lennox
      3) Trane

2.2 ACCESSORIES

A. Build 2" thick filter frame external to furnace as detailed on drawings. Provide standard 2" thick size filter.

B. Vibration Isolators:

1. Horizontal Installation.
   a. Neoprene hanger type with load of 75 lbs maximum.
   b. Approved Products:
      1) RH by Kinetics Noise Control.
      2) HD by Mason Industries.
      3) RH by Vibration Mounting & Controls.
COUNTY FAIRGROUNDS BUILDING
CACHE COUNTY

2. Vertical Installation: 4 inches square by ½ inch thick minimum neoprene type vibration isolation pads.

2.3 MANUFACTURERS

A. Contact Information

1. Carrier Corp, Syracuse, NY (800) 227-7437 or Carrier Canada Ltd/Ltee, Mississuaga ON (905) 826-9508.
2. Kinetics Noise Control, Dublin, OH (800) 959-0191 or (514) 889-0480 www.kineticsnoise.com
3. Lennox Industries, Dallas, TX (972) 497-5000 or Lennox Industries (Canada) Ltd. Etobicoke, ON (416) 621-9302.
5. Trane, La Crosse, WI (800) 288-7263.
6. Vibration Mounting & Controls, Bloomingdale, NJ (800) 569-8423 or (973) 838-1780 www.vmc-kdc.com

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install vibration isolator on each hanger rod supporting horizontal furnace and under each corner of vertical furnace.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service -

1. Furnace distributor's technical service representative shall:
   a. Verify proper gas orifice size.
   b. Clock gas meter for rated input.
   c. Verify and set gas pressure at furnace.
   d. Check and measure temperature rise.
   e. Check safety controls for proper operation.
   f. Check combustion vent sizes and combustion air sizes.

B. In addition, furnace distributor’s technical service representative shall start up, check out, and adjust furnaces using equipment check-out sheet provided by Manufacturer. Complete and sign all items on sheet.

END OF SECTION 15611
SECTION 15622 - COMBUSTION AND EXHAUST AIR PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To -
   1. Furnish and install heating equipment exhaust piping and combustion air intake piping as described in Contract Documents.

B. Related Sections -
   1. Section 15060: Pipe and pipe fittings
   2. Section 15190: Mechanical Identification

1.2 REFERENCES

A. American Society for Testing and Materials

PART 2 - PRODUCTS

2.1 MATERIALS

A. Air Piping: Schedule 40 pipe and fittings meeting requirements of ASTM D 1785, ASTM D 2661, or ASTM D 2665.

B. Piping Primer and Cement: Meet requirements of ASTM D 2654.

C. Flexible Foamed Pipe Insulation:
   1. Thickness:
      a. ½ inch for 2 through 3 inch outside diameter pipe.
      b. ½ inch sheet for fittings as recommended by Manufacturer.
   2. Approved Products:
      a. Tubalok by Armaflex.
      b. ImcoLock or ImcoShield by IMCOA.
      c. Therma-Cel by Rubatex.
D. Insulation Joint Sealer:

   1. Approved products:
      a. 520 by Armaflex.
      b. Construction Adhesive No. 105 by BFG.
      c. 950 Therma-Cel by Rubatex.

2.2 MANUFACTURERS

   A. Contact Information:

   1. Armaflex by Armacell, Mebane, NC (800) 232-3341. www.armaflex.com
   2. BFG industries, West Columbia, SC (800) 845-2220 or (802) 796-1380.
   3. IMCOA, Haltom City, TX (800) 535-5078 or (817) 485-5290. www.imcoa.com
   4. Rubatex, Roanoke, VA (800) 782-2839 or (540) 561-6000. www.rbxcorp.com

PART 3 - EXECUTION

3.1 INSTALLATION

   A. Installation For condensing Furnaces:

   1. Run individual vent and individual combustion intake piping from each furnace to
      concentric roof termination kit provided by Furnace manufacturer. Slope lines downward
      toward furnace.
   2. Slope combustion chamber drain downward to funnel drain. Anchor to wall with wall
      clamps, allowing free movement through clamp for expansion.
   3. Use concentric roof termination kit provided by Furnace Manufacturer. Install vent and
      combustion air intake piping at clearance and distances required by Furnace
      Manufacturer.
   4. Attach factory-supplied neoprene coupling to combustion-air inlet connection and secure
      with clamp.
   5. Ensure that factory-supplied perforated metal disc is installed in flexible coupling, unless
      its removal is required.

   B. Installation For Condensing Water heaters:

   1. Run individual vent and individual combustion intake piping from each water heater to
      roof termination as recommended by Water Heater Manufacturer. Concentric roof
      termination kit may be used if approved by and provided by Water heater Manufacturer.
      Slope lines downward toward water heater.
   2. Slope combustion chamber exhaust drain downward to floor drain.

   C. Support:

   1. Support concentric roof termination kit at ceiling or roof line with 20 ga sheet metal
      straps as detailed on Drawings.
   2. Support horizontal sections of pipe in accordance with requirements of Section 15060.
      Anchor securely to structure, not allowing pipe to sway.
D. Insulation:

1. General:
   a. Install insulation in snug contact with pipe and in accordance with Manufacturer’s recommendations.
   b. Slip insulation on piping before piping sections and fittings are assembled keeping slitting of insulation to a minimum.
   c. Joints:
      1) Place ‘slit’ joint seams of insulation exposed outside building on bottom of pipe.
      2) Stagger joints on layered insulation.
      3) Seal joints in insulation.
   d. Paint exterior exposed insulation with two coats of finish recommended by Insulation Manufacturer, color selected by Architect.

2. Install specified insulation on PVC air piping serving mechanical equipment as follows:
   a. Combustion air PVC piping in truss space and in attic.
   b. Combustion vent PVC piping in attic, in truss space, and above roof.
   c. Insulate fittings with sheet insulation and as recommended by Manufacturer.

END OF SECTION 15622
SECTION 15625 - MAKE-UP AIR UNITS (By Kitchen Contractor)

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To -
   1. Furnish and install make-up units as described in Contract Documents.

B. Related Sections -
   1. General Conditions, Division 01, and Section 15010 apply to this Section.
   2. Section 15887 - Filters

PART 2 - PRODUCTS

2.1 SUMMARY

A. Make-up Air Units
   1. Cabinets -
      a. Constructed by galvanized steel with protective enamel on zinc coated finish, adequately braced and reinforced, and of sectionalized construction.
      b. Panels shall be removable for easy access to interior of unit.
      c. With interior mounted motors, hinged access doors with cam locks.
      d. Cabinet panels shall be internally insulated with one inch thick, 3/4 lb density, vinyl coated glass fiber insulation.
      e. Seal joints with permanent type flexible mastic.
   2. Provide insulated drain pan with condensate connections at each end. Extend drain pan under coil headers and refrigerant distributors plus unused ends.
   3. Fans -
      a. Double inlet, double width, forwardly curved centrifugal type designed for Class I operation.
      b. Base fan ratings on tests conducted in accordance with AMCA Code #210.
      c. Construct fan housings with streamline inlet and side sheets.
      d. Fans shall be statically and dynamically balanced and tested. Maximum rated fan RPMs shall be well below first critical fan shaft speed.
   5. Bearing -
      a. Self-aligning, grade lubricated, ball type, and sized minimum service factor of 4.
      b. Provide lubrication fittings. Permanently lubricated bearings are not acceptable.
      c. Provide extended lubrication lines to accessible side of unit.
   6. Rate V-belt drives at 150% of motor rating.
      a. Motor sheaves shall be of adjustable pitch type giving 30% speed variation.
      b. Fabricate belt guards from 16 gauge galvanized steel rigidly supported.
c. Provide 1-1/2 inch diameter tachometer holes for both fan and motor shafts.

7. Motors -
   a. As described in Contract Documents and mounted on rubber isolated base incorporating a device for belt tightening, or internal to unit with fan, motor, and drive assembly internally isolated.

8. Burner & Heat Exchanger -
   b. Gas Burner: Atmospheric type with adjustable combustion air supply, combination gas valve and pressure regulator incorporate manual shut-off, automatic 100 percent shut-off and thermo-couple pilot safety device, and electronic pilot ignition.
   c. Gas Burner Safety Controls: Thermo-couple sensor prevents opening of solenoid gas valve until pilot flame is proven and stops gas flow on ignition failure.
   d. Duct Thermostat: Cycles burner to maintain discharge air temperature setting.
   e. High Limit Control: Fixed stop at maximum permissible setting, de-energized burner on high bonnet temperature and re-energizes when temperature drops to lower value.
   f. Duct Thermostat: Shall be low voltage, to control burner operation, heater modulates to maintain temperature setting.

9. Filter -
   a. Provide with hinged access doors and quick release locking handles.
   b. Provide end fillers as necessary to prevent by-passing of air.
   c. Provide one inch wide 16 gauge galvanized steel filter removal strap with one end bent up on inch to form hook.

10. Approved Manufacturers -
    a. Trane
    b. Modine
    c. Reznor
    d. Hastings
    e. Sterling

2.2 ACCESSORIES

A. Roof
   1. Curb shall be fully welded. PART 3 - EXECUTION

3.1 INSTALLATION

A. Set units on manufacture fully welded curbs.
3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service -

1. Equipment Contractor to provide start-up service.

END OF SECTION 15625
SECTION 15631 - RADIANT HEATING SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install all materials and perform all labor necessary for the complete installation of a gas-fired, vacuum vented, radiant heating system as shown on plans and specified herein, to provide a complete functional system.

B. Radiant Burner and Reflector Assembly.

C. Gas Piping and Supply System.

D. Vacuum Venting System.

E. Temperature Control System.

PART 2 - PRODUCTS

2.1 RADIANT HEATING SYSTEM

A. General

1. Gas-fired vacuum vented low intensity radiant heating system shall be as manufactured by Ambi-Rad and Co-Ray-Vac.

2. The system shall employ the proper number of firing units as indicated by the drawings. Units must be certified by the American Gas Association under American National Standard for vented radiant heaters.

3. Installation of all equipment and materials shall conform to the practices of good workmanship, in accordance with applicable requirements. The standard combustion chambers, pipe work, gas lines and electrical conduit shall be attached to or suspended from the building structure in a manner suitable to meet standards of durability and safety.

4. The combustion system will be capable of being the combustion condensing type in which the products of combustion are exhausted below the dew point of the moisture in the flue gases (140 - 180°F).

5. The overall system shall consist of (2) sub-systems containing the total of (8) ARC-32 LR btu/hr natural gas basic burner units interconnected with piping as described on the drawings and installation details, together with (2) vacuum pump packages, (2) thermostats, reflectors, hangers, turnbuckles, gas piping, and electrical wiring; and installed according to installation details, diagrams, and prints furnished.

6. Wiring must conform to the National Electrical Code and local ordinances in accordance with diagrams furnished. Reference: Manufacturer Installation Instructions.

7. Gas supply piping must meet local requirements, and be sized in accordance with BTU demand, available pressure, and the total equivalent length of pipe required (fittings included). Connection from supply line to burner unit must be made in accordance with installation details.
B. Radiant Surface

1. The heat exchanger radiant surface formed by the piping or tubing shall have at least 75 square feet of surface for each therm (100,000 BTU) of input per hour firing rate of the system.
2. All piping or tubing shall be 4" o.d. and manifold sections shall be a hot rolled 14 gauge steel tubing and all tailpipe sections to be 16 gauge steel with acid resistant pipe. Porcelain lined tubing.
3. The joining of all tubing shall be made with a stainless steel coupling.

C. Vacuum-Firing Burner

1. Each burner unit shall consist of an integral burner control device installed in a factory furnished standard combustion chamber.
2. Individual gas vacuum-firing burner units shall be of the total premix type where all of the air required for combustion is premixed before combustion actually occurs.
3. Fuel gas flow to each individual gas vacuum-firing burner unit shall be automatically limited to the supply of combustion air present, supplying only the amount of fuel gas for which there is the proper amount of air available for proper combustion. Should the flow of combustion air be impeded, the individual burner or burners so affected shall automatically modulate the fuel gas flow rate downward to match the proportionate air flow rate, thus maintaining the proper fuel gas to air proportion for good combustion.
4. All gas vacuum-firing burner units shall be equipped with a direct spark ignition. The burner shall shut off when the thermostat is satisfied.
5. All combustion air shall pass through a dust and dirt filter insuring that foreign objects will not enter into burner and/or control compartment.
6. Groups of gas vacuum-firing burner units shall be in tandem except for the end burners. The burners shall fire in an atmosphere of the flue products from preceding burners, thus adding heat at strategic points to the by-products within the tubing or pipe and providing a more even heat output.

D. Reflectors

1. Shall be of 22 gauge type 430 polished stainless steel. Note: Aluminum reflectors are not acceptable.
2. Shall be of the ‘Deep-Dish’ design whereas the bottom of the reflector is below the bottom of the piping system. It shall cover entire piping system, including at the combustion chambers, open only at the bottom.

E. Vacuum Pump

1. Vacuum pump shall be manufactured using heavy duty components to protect against condensation from the system.

F. End Vent Assembly

1. Each open end combustion chamber shall have an approved end vent.
2. Reflector in this area shall have an end cap, and be installed according to manufacturer’s installation instructions.
PART 3 - CONTROLS

3.1 TEMPERATURE CONTROL SYSTEM

A. Temperature controls shall be of the electric and electronic type as manufactured by Honeywell, Penn, or approved equal.

B. Equipment furnished in this work that is normally wired before installation shall be furnished completely wired.

C. Representatives of the temperature control sub-contractor shall furnish and install all line voltage interlock and temperature control wiring. All wiring shall comply with NEC, latest safety orders, other codes of jurisdiction, and applicable sections of the electrical specifications.

D. Drawings of temperature control systems are diagrammatic only and any apparatus not shown but required to make the system operative to the complete satisfaction of the Engineer shall be furnished and installed without additional cost.

E. Thermostats shall be mounted 66 inches above finished floor to centerline.

F. Installation: By the sub-contractor of the temperature control system, including control wiring and the following:

1. Prior to installation, submit diagrams, component data and description of sequence of operation for approval.
2. After completion of the installation, regulate and adjust all thermostats, control valves, motors, vacuum supply air and other equipment provided under this contract. A representative of the equipment supplier and owner shall be present during final acceptance test and inspection.

PART 4 - EXECUTION

4.1 GENERAL

A. Installation of all equipment and materials shall conform to the practices of good workmanship, in accordance with applicable requirements. The combustion chambers, pipe work, gas lines and electrical conduit shall be attached to or suspended from the building structure in a manner suitable to meet standards of durability and safety.

4.2 CLEARANCES

A. Clearances to combustible materials shall not exceed those outlined and printed on the burner nameplate and on the manufacturer’s specification sheet as measured from the surface of the radiant tubing or pipe.

4.3 STANDARD REFLECTORS

A. Shall be installed on all piping systems and an end cap installed to close reflector system as indicated on the system layout furnished.
COUNTY FAIRGROUNDS BUILDING
CACHE COUNTY

4.4 VENTING

A. The system shall vent all products of combustion outdoors by means of the vacuum pump. Vents shall be installed as indicated on the installation details and in accordance with local requirements. The connection between the pump inlet and tailpipe is made with an acoustic boot and clamps provided. The discharge connection is made with a no-hub coupling and 6 inch CPVC pipe.

4.5 PURGE SYSTEM

A. The control system shall be such that there is a pre-purge (before the ignition cycle of the system) of at least 10 air changes of the entire system volume, and a post-purge of a similar magnitude. A factory furnished pre-wired electric control panel shall be installed in accordance with manufacturer’s wiring diagram.

4.6 WARRANTY

A. The parts of the entire system, including controls, shall be warranted for a period of three years from the date of start-up.

END OF SECTION 15631
SECTION 15647 - ELECTRIC RADIANT WALL AND CEILING HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To -
   1. Furnish and install wall heaters as described in Contract Documents.

B. Related Sections -
   1. General Conditions and Division 01 apply to this Section.

1.2 QUALITY ASSURANCE

A. Units shall be UL listed and comply with NEC.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Fan type for recess mounting in wall.

B. 20 gauge minimum sheet metal casing.

C. Heating element shall be encased in steel finned casting and protected by thermal switch.

D. Fan motor shall be heavy duty enclosed and permanently lubricated.

E. Fan shall be precision balanced and fan-motor assembly mounted to be vibration free.

F. Units shall be controlled automatically by integral thermostat when heater is in "ON" position.

G. Heater shall have built-in fan delay.

H. Finish - Baked-on enamel.

I. Approved Manufacturers -
   1. Q' Mark
   2. Berko
   3. Markel

PART 3 - EXECUTION (NOT USED)

END OF SECTION 15647
SECTION 15670 - AIR-COOLED CONDENSING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To -
   1. Furnish and install condensing units as described in Contract Documents.

B. Related Sections -
   1. General Conditions, Division 01, and Section 15010 apply to this Section.
   2. Division 03 - Concrete slab

1.2 SUBMITTALS

A. Warranty -

1.3 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies -
   1. Each unit shall be UL labeled.

1.4 WARRANTY

A. Five-year warranty on compressors.
   1. Warranty time frame shall be five years from date of "start-up". "Start-up" date shall be recorded on warranty certificate for each unit.

PART 2 - PRODUCTS

2.1 7-1/2 TON & LARGER UNITS

A. Condenser coil shall have aluminum plate fins mechanically bonded to seamless copper tubes.
   1. Units having side inlets shall have coil guards.
   2. Coil shall be circuited for sub-cooling.

B. Fans shall be direct driven propeller upflow type.
   1. Fan motors shall have inherent overload protection, be permanently lubricated, and resiliently mounted.
   2. Each fan shall have a safety guard.
   3. Cycle fans or use solid state fan speed control for low ambient operation.
COUNTY FAIRGROUNDS BUILDING
CACHE COUNTY

C. Units shall be operable down to 0°F outdoor temperature.

D. Compressors -

1. Hermetic or semi-hermetic design with the following features
   a. Spring isolators.
   b. Crankcase heater.
   c. Compressor motor overload protection.
   d. Ring, reed or disc type valves.
   e. Service valves, back-seating type with Schraeder charging valves.

2. Semi-hermetic type shall also have -
   a. Automatically reversible oil pump.
   b. Oil sight glass.
   c. Oil pressure switch.

3. Condensing units ten tons or smaller shall have only one compressor. Condensing units larger than ten tons shall have two compressors minimum, each serving separate cooling circuit and coils.

E. Controls -

1. Factory wired and located in separate enclosure.
2. Safety devices shall consist of high and low pressure cutouts, and internal or plug type relief valves.
3. Unit shall be complete with magnetic starters.
4. Unit shall have anti-cycle timers to prevent units from starting up again for five minutes after any power interruption.

F. Casing -

1. Fully weatherproof for outdoor installation. Finish shall be weather resistant.
2. Panels shall be removable for servicing.
3. Provide openings for power and refrigerant connections.

G. Condensing units shall use R-410A refrigerant. Make one liquid line, one suction line, and one power connection to each unit for each compressor in condensing unit. Provide charging valves.

H. EER rating as defined by ARI shall be not less than 10.0.

I. Set units on neoprene type vibration isolation pads located at each corner, 4"x4"x3/4” minimum.

2.2 TWO TON THROUGH FIVE TON UNITS

A. Condenser coil shall have aluminum plate fins mechanically bonded to seamless copper or aluminum tubes.

1. Provide coil guard for unit.
2. Provide hail guard.

B. Fans shall be direct driven propeller upflow type.
   1. Fan motor shall be single or two speed, thermostatically controlled, permanently lubricated, and designed with permanent protection.
   2. Motors shall be resiliently mounted.
   3. Each fan shall have a safety guard.

C. Units shall be operable down to 20° F outdoor temperature.

D. Compressor shall be of hermetic design with the following features. Each condenser unit shall have only one compressor.
   1. Externally mounted brass service valves with charging connections.
   2. Crankcase heater.
   3. Resilient rubber mounts.
   5. Single speed

E. Controls -
   1. Factory wired and located in separate enclosure.
   2. Safety devices shall consist of high and low pressure cutout and condenser fan motor overload devices.
   3. Unit shall have anti-cycle timers to prevent units from starting up again for five minutes after any power interruption.

F. Casing -
   1. Fully weatherproof for outdoor installation. Finish shall be weather resistant.
   2. Openings shall be provided for power and refrigerant connections.
   3. Panels shall be removable for servicing.

G. Expansion Valves -
   1. Stainless steel diaphragm and same refrigerant in thermostatic elements as in system. Externally or internally equalized as required by evaporator/condensing system.
   2. Size valves to provide full rated capacity of cooling coil served.
   3. Furnished by evaporator coil/condensing unit supplier and coordinated to provide bleed holes for system pressure equalization, if required.

H. Condensing units shall use R410A refrigerant.

I. Only one liquid line, one suction line, and one power connection shall be made to each compressor. Provide charging valves.

J. EER rating as defined by ARI shall be not less than 12.0 and SEER 13.0.
COUNTY FAIRGROUNDS BUILDING  
CACHE COUNTY

K. Set each unit on neoprene isolation pads located at each corner and sized 4” x 4” x 3/4” high minimum.

2.3 APPROVED MANUFACTURERS

A. Bryant
B. Carrier
C. Day & Night
D. Lennox
E. Payne
F. Trane

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set condensing units on concrete slab.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service -

1. Condensing units shall be started up, checked out, and adjusted by Condensing Unit Manufacturer's authorized factory trained service mechanic.
2. Mechanic shall use check-out sheet provided by Manufacturer, complete and sign all items on sheet, and submit to Architect.

END OF SECTION 15671
SECTION 15681 - CONDENSING UNIT

PART 1 - GENERAL REQUIREMENTS

1.1 SECTION INCLUDES

A. Air-cooled scroll (full hermetic) condensing unit
B. Accessories and trim
C. Charge of refrigerant and oil
D. Controls and control connections
E. Refrigerant connections
F. Starters
G. Electrical power connections

1.2 REFERENCES

A. SI/ARI 520 - Standard for Reciprocating and Screw Compressor Units
B. ANSI/ASME SEC 8 - Boiler and Pressure Vessel Code
D. ANSI/UL 465 - Central Cooling Air Conditioners
E. ANSI/UL 779 - Motor-Operated Water Pumps

1.3 SUBMITTAL

A. Submit shop drawings indicating components, assembly, dimensions, weights, and loadings, required clearances, and location and size of field connections. Indicate valves, strainers, and thermostatic valves required for complete system.

B. Submit product data indicating rated capacities, weights, and all accessories. Also, submit complete wiring diagrams specifically for the unit being submitted. The wiring diagrams shall include all rated loads and recommended component sizes. No item that is not being submitted with the equipment shall appear on the diagram. Also, submit refrigerant piping diagram showing all components and connection sizes.

C. Submit manufacturer's installation instructions.
1.4 OPERATION AND MAINTENANCE DATA

A. Include start-up instructions, maintenance data, parts lists, controls, and accessories. Include trouble-shooting guide.

B. Submit maintenance data.

1.5 QUALITY ASSURANCE

A. Warranty: Includes coverage for complete assembly including materials and workmanship for a period of 12 months from start-up or 18 months from shipping.

PART 2 – PRODUCTS

2.1 EQUIPMENT MANUFACTURER

A. Technical Systems, Division of RAE Corporation

B. Edwards Engineering

C. Owner-approved equal

2.2 MANUFACTURED UNITS

A. Provide factory assembled and tested air-cooled liquid condensing units consisting of tandem scroll (full hermetic) compressors, evaporator, thermal expansion valve, refrigeration accessories, and control panel housing all power and control components. Construction and rating shall be in accordance with ANSI/ARI 590. Condensing Unit package shall have minimum capacity as scheduled here in, including all features described in the specification and/or noted on drawings. Unit to be rated at altitude and ambient design temperature as scheduled.

2.3 HOUSING AND INTERCONNECTING PIPING

A. The base frame shall be heavy duty g-90 galvanized sheet metal 12 ga. minimum. The housing shall be fabricated from heavy gauge g-90 galvanized steel removable panels.

B. The interconnecting piping shall be Type L hard copper [through 4” pipe size].

2.4 COMPRESSORS SCROLL (FULL HERMETIC)

A. Compressors shall be direct driven full hermetic, fixed compression scroll compressors with cast iron frame and cast iron scrolls; one fixed and one orbiting. Compressor Manufacturer Tandem built assembly shall be used.
B. Compressors shall have all Teflon impregnated bronze drive bearings, crankcase heaters, rotary dirt trap, rotolock fittings for discharge and suction connections. Each fitting shall have a Schrader pressure tap. The suction inlet shall be equipped with a suction screen.

C. Compressor shall have large internal volume capable of handling a minimum 22 lbs of refrigerant. Compressor shall also have inherent dynamic discharge valve to prevent backflow, and solenoid valve to prevent shutdown noise.

D. Lubrication System

1. Compressor shall have inherent centrifugal oil pump, oil filter, oil level sight glass, oil level adjustment Schrader fitting.
2. Oil shall have an initial charge of 140 oz. Of mineral oil Sontex 200-LT or Witco LP-200 only.

E. Performance

1. Compressor shall be designed to operate at suction temperatures of 10°F to 55°F for 65°F return gas, 0°F subcooling and 95°F ambient.
2. Compressor shall have minimum EER of 11.1 at standard conditions, and also operate at maximum sound power levels of 80 db(A) without discharge mufflers.
3. Compressor vibration of maximum 1.3 mills peak to peak at 60 Hz discharge pulse 3.0 psi peak to peak is required.
4. Compressor scroll members shall separate in the event of liquid or debris contamination. Tip seals are not allowed.

F. Controls

1. Compressor to have four (4) individual motor winding sensors wired to a solid-state module connected to 4 pin fusite. In addition, an inherent discharge temperature sensor shall be wired in series with the motor sensors for compressor self-protection.

G. Installation

1. Factory install an external check valve in discharge to guarantee protection against back flow in case of inherent valve failure. Install factory mounted high and low pressure cut-outs. Compressors to be mounted on neoprene rubber mounts.
2.5 CONDENSER (AIR-COOLED)

A. Provide condenser of 1/2” copper tubes with aluminum plate fins. Enhanced or Lanced fins shall not be accepted. Fins shall be formed with tube collars and mechanically expanded with fin collars for full contact for optimum heat transfer. Condenser coils shall be tested to 425 psig air pressure.
   1. Due to the critical nature of the reliability and thermal performance of the chiller system, the coil surfaces must be fully cleanable.
   2. The ability of dirt and debris to become trapped within the coil must be minimized to retain full thermal performance over the life of the machine. Enhanced or “lanced” fins are not acceptable due to the inability to be fully cleaned and the trapping of dirt, leaves, pollen, and other debris within the coil pack.
   3. The maximum coil fin spacing shall be no more than 14 fins per inch.

B. Casings and tube sheets shall be heavy gauge galvanized steel. Tube sheets shall be die formed and full collared for tube support. Headers to be constructed of heavy wall seamless copper tubing. Copper tubing to be 0.017” or 0.016” wall thickness. Fin thickness to be 0.006”.

C. Provide unit with low ambient operation down to 20 F by cycling fans based on refrigerant temperature. Cycling fans based on ambient temperature will not be allowed.

D. Provide unit with guaranteed low ambient operation in a strong wind regardless of any precipitation down to -20 F by a flooded condenser control.
   Provide heated and insulated liquid receivers with pressure relief device with the flood control. Install a flow-restricting valve in the main liquid line between the main condenser to the receiver. This valve shall restrict the flow and back up refrigerant liquid in the condenser based on refrigerant pressure.
   Install a bypass line between the hot gas line and the main liquid line to the condenser to bypass hot gas into the receiver when the refrigerant pressure continues to decrease.
   This system must be fully installed at the factory and tested before shipment as a complete system. Field installed systems requiring components to be mounted and piped in the field or in “aftermarket” shops shall not be allowed.

E. Condenser shall be provided with a separate sub-cooling circuit integral with the main circuit for each refrigerant circuit. Liquid seal shall be maintained by a trap between main header and sub-cooling circuit header.

F. Fan motor shall be open drip proof type design. Motor shall have class B insulation and have service factor for safety.

2.6 CONDENSER FANS (AIR-COOLED)

A. Provide with fan cycling head pressure control. Fans to be cycled in response to refrigerant condenser pressure. Pressure controller shall be UL listed, factory mounted and wired.
COUNTY FAIRGROUNDS BUILDING  
CACHE COUNTY

B. Fan motor shall be open drip proof type design with foot mounting suitable for vertical installation with thrust bearings and rain slinger. Motor shall have service factor for safety.

C. Provide direct drive propeller type blades. Air shall discharge vertically to minimize noise generation and air recirculation.

D. Fan motors shall be 3 phase, vertical, direct drive motors with permanently lubricated ball bearings and overload protection.

2.7 REFRIGERANT CIRCUIT

A. Provide complete refrigerant circuits, factory supplied and piped.

B. Provide for each refrigerant circuit:

1. Liquid line sight glass, and moisture indicator.
2. R-410a Rated Receiver
3. Insulated suction line.
4. Discharge line check valve.
5. Compressor service valves.
6. Suction Accumulator (VAV and 100% outside air application).
7. Liquid Line Filter Drier (sealed type)
8. Pressure relief device.

2.8 CONTROLS

A. Provide provisions for local control as specified herein. Locate on unit, mount steel control panel with hinged access, containing starters, power and control wiring, factory wired with single point power connection. Panel shall be NEMA 3R type UL 508 labeled with a 5K SCCR rating.

B. For each compressor, provide across-the-line starter, non-recycling compressor overload, starter relay. Provide manual reset current overload protection.

C. Provide the following devices on a NEMA 3R control panel face:

1. Through the door Run/Pump down switch unit.
2. Control power fuse or circuit breaker.
3. Auto compressor lead-lag control
4. Anti-short cycle timer per compressor.
5. Phase monitor to monitor over/under voltage and phasing.
D. Provide the following safety controls with indicating lights arranged so that operating any one will shut down machine and require manual reset:

1. High discharge pressure switch for each compressor.
2. Low suction pressure switch for each compressor.

E. Provide the following operating controls:

1. Contacts for compressor staging wired to terminal strip for control by others
2. Control power transformer
3. Five minute off timer prevents compressor from short cycling.
4. Hot gas bypass sized for minimum compressor loading on each circuit.
5. Alarm Dry Contacts for Refrigeration Circuit Failure Alarm

2.9 MANUFACTURER'S FIELD SERVICE

A. Supply service of factory-trained representative for a period of one day to supervise testing, dehydration and charging of machine, start-up, and instruction on operation and maintenance to Owner.

B. Supply initial charge of dry nitrogen holding charge during shipment

2.10 QUALITY CONTROL AND TESTING

A. The manufacturer shall have a quality control program in place to assure proper performance in the field. This shall include leak and pressure testing, established manufacturing standards, controls programming and testing. The manufacturer shall utilize a quality control testing facility to verify proper performance and capacity before shipment.

B. All piping must be subjected to a quality control leak test. All refrigerant piping must hold an evacuation of 500 micron minimum for at least 8hrs.

C. All fluid piping will be tested after assembly has been completed and must hold positive air pressure of 30PSI for 4 hours.

D. Microprocessor controls and their programs shall be tested on a test stand before installation into the chiller. The test stand shall be capable of applying artificial inputs / outputs to simulate field operation. The program is then verified for proper component control and communication.

E. The testing facility shall verify proper assembly including point-to-point verification of all power and control wiring, testing and setup of internal components, and installation of the microprocessor and its programming.
2.11 FIELD COMMISSIONING

A. The local mechanical contractor shall verify correct installation, verify mounting, verify control wiring and power wire and check for proper phase supplied. Unit shall then be commissioned and operated and any adjustments made to controls and safeties as needed to meet the specified performance requirements of the project.

2.12 INSTALLATION

A. The installing contractor shall be responsible for acceptance of delivery to ensure the equipment has not been damaged in transit. This includes performance of a leak check upon acceptance of delivery and checking tightness and torque of all electrical connections loosened in transit.

B. Install equipment with adequate room for safe startup and service access as well as sufficient airflow supply as to prevent the risk of recirculating air.

C. Provide for cleaning, flushing, and filling of the fluid piping as well as completion of flow balancing in all lines prior to the date of startup.

D. Provide technicians to perform startup of the equipment with supervision and training by factory personnel.

E. The installing contractor shall be responsible for provision and mounting of unit isolation or spring mounting according to the project needs.

END OF SECTION 15681
SECTION 15752 - COOLING COILS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division-15 Basic Mechanical Materials and Methods sections apply to work of this section.

1.2 SUMMARY

A. Extent of the cooling coil work is indicated by drawings and schedules, and by requirements of this section.

B. Types of terminal units required for project include the following:

1. Chilled water coils.

C. Refer to other Division-15 Sections for piping and testing, adjusting and balancing of coils, not work of this section.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of terminal units, of type and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's specifications for coils showing dimensions, capacities, ratings, performance characteristics, gages and finishes of materials, and installation instructions.

B. Shop Drawings: Submit assembly-type shop drawings showing unit dimensions, construction details, and field connection details.

C. Operation and Maintenance Data: Submit operating and maintenance instructions and spare parts lists. Include this data, product data, shop drawings in maintenance manuals; in accordance with requirements of Division 1.

1.5 REFERENCES

A. Codes and Standards:

1. ARI Compliance: Provide coil ratings in accordance with ARI Standard 410 "Forced-Circulation Air-Cooling and Air-Heating Coils".

2. ASHRAE Compliance: Test coils in accordance with ASHRAE Standard 33 "Methods of Testing Forced Circulation Air Cooling and Heating Coils".
1.6 DELIVERY, STORAGE AND HANDLING

A. Handle coils and components carefully to prevent damage, breaking, denting, and scoring. Do not install damaged coils or compartments; replace with new.

B. Store coils and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

C. Comply with Manufacturer's rigging and installation instructions for unloading terminal units, and moving them to final location.

PART 2 - PRODUCTS

2.1 COOLING COILS

A. General: Provide coils of size and in location indicated, and of capacities and having performance data as scheduled. Certify coil capacities, pressure drops, and selection procedures in accordance with ARI 410.

B. Fins: Corrugated plate sheet aluminum, 8 fins per inch maximum, 0.01” sheet thickness maximum.

C. Tubes: Copper tube, 5/8” diameter, 0.020” tube, 0.049” bend wall thickness, expand tube into fins.

D. Headers: Seamless Type K or L copper tube headers, vented and fully drainable headers and return bend (drain in every bend for every tube), brazed connections, threaded steel piping connections. Add ball type drain and vent valves to each header in field.

E. Casings: Construct of 16-ga continuous coated galvanized steel with fins recessed into channels to minimize air bypass.

F. Testing: Air tested under water to 175 psig.

G. Coil Types: Provide the following coil types as indicated, and as scheduled.

1. Cooling Coils: Six rows minimum, 0.75” maximum air pressure drop, 15 feet maximum water pressure drop, 550 fpm maximum air velocity, 7 fpm maximum water velocity.

H. Manufacturer: Subject to compliance with requirements, provide coils of one of the following:

1. Aerofin Corp.
2. Dunham-Bush, Inc.
3. Trane (The) Co.
4. Pace.
5. Super Radiator.
2.2 COIL DRAIN PANS

A. Coil Drain Pans: Provide drain pans as suggested by detail on the drawings, lower pan of 18 gauge welded 304 stainless steel, upper pans of 16 gauge galvanized steel, upper pan sections to drain to lower pan, lower pan at least 6" deep, sloped to drain, hold coil high enough to create a 6" trap off of the lower drain pan(s). Set coil into pans to catch all drips.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which terminal units are to be installed. Do not proceed with work until satisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF COILS

A. General: Install coils as indicated, and in accordance with manufacturer's installation instruction.

B. Mount coils on steel supports to form banks or stacks as indicated, brace, secure existing coil chamber. Provide steel baffles where required to prevent bypassing of air.

C. Pitch coil casings for draining, not less than 1/8" toward return connections, except where drainage feature is included in coil design.

D. Provide for each bank of cooling coils, stainless steel drain pan under each coil supported off of floor of sufficient height to allow installation of condensate trap to allow drainage of condensate from pan when installed on suction side of fan.

E. Provide for chilled water coil unit, water supply, return connection, strainer, gate valves, automatic temperature regulating valve, balancing cocks, as indicated.

3.3 ADJUSTING AND CLEANING

A. General: After construction is completed, including painting, clean unit exposed surfaces, vacuum clean terminal coils and inside of cabinets.

END OF SECTION 15752
SECTION 15855 – AIR HANDLING UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

Design, performance criteria, controls, and installation requirements for Custom Air Handling Units.

1.2 REFERENCES

B. AMCA /ANSI Standard 204: Balance Quality and Vibration Levels for Fans
C. AMCA Standard 210: Laboratory Methods of Testing Fans for Ratings
D. AMCA Standard 300: Reverberant Room Method for Sound Testing of Fans
E. AMCA Standard 500: Test Methods for Louvers, Dampers and Shutters
F. AHRI Standard 410: Forced-Circulation Air-Cooling and Air-Heating Coil
G. ASHRAE Standard 52: Gravimetric and Dust Spot Procedures for Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter
J. ASTM A-525: Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process

1.3 SUBMITTALS

A. Submit shop drawings and product data in accordance with Division 1.
B. Submittals shall include the following:
   1. Dimensioned plan and elevation view drawings, including motor starter and control cabinets, required clearances, and location of all field connections.
   2. Summary of all auxiliary utility requirements such as: electricity, water, compressed air, etc. Summary shall indicate quality and quantity of each required utility.
   3. Ladder type schematic drawing of the power and ancillary utility field hookup requirements, indicating all items that are furnished.
   4. Manufacturer’s performance of each unit. Selection shall indicate, as a minimum, the following:
      a. Input data used for selection.
      b. Model number of the unit.
      c. Net capacity.
      d. Rated load amp draw.
COUNTY FAIRGROUNDS BUILDING
CACHE COUNTY

e. Noise levels produced by equipment.
f. Fan curves.
g. Approximate unit shipping weight.

1.4 OPERATION AND MAINTENANCE DATA

A. Include data on design, inspection and procedures related to preventative maintenance. Operation and Maintenance manuals shall be submitted at the time of unit shipment.

1.5 QUALIFICATIONS

A. Manufacturer shall be a company specializing in the design and manufacture of commercial / industrial custom HVAC equipment. Manufacturer shall have been in production of custom HVAC equipment for a minimum of 5 years.

B. Each unit shall bear an ETL or UL label under UL Standard 1995 indicating the complete unit is listed as an assembly. ETL or UL listing of individual components, or control panels only, is not acceptable.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under the supervision of the owner.

1.7 SEQUENCING AND SCHEDULING

A. Coordinate work performed under this section with work performed under the separate installation contract.

1.8 WARRANTY

A. The complete unit shall be covered by a parts warranty issued by the manufacturer covering the first year of operation. This warranty period shall start upon receipt of start-up forms for the unit or eighteen months after the date of shipment, whichever occurs first.

B. The installing contractor shall provide labor warranty during the unit’s first year of operation.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Provide custom (indoor / outdoor) air handling units as manufactured by Temtrol or Governair as the basis-of-design. Equipment manufactured by Ventrol or Huntair shall be considered provided the construction specifications capacities and performance criteria are met.

2.2 GENERAL

A. Furnish and install where shown on the plans, mechanical frame style air handling units (Optional: specifically designed for OUTDOOR application) with construction features as specified below. The units shall be provided and installed in strict accordance with the specifications. All units shall be complete with all components and accessories as specified. Any exceptions must be clearly defined. The contractor shall be responsible for any additional expenses that may occur due to any exception made.
2.3 FACTORY TESTING AND QUALITY CONTROL

A. Standard Factory Tests: The fans shall be factory run tested to ensure structural integrity and proper RPM. All electrical circuits shall be tested to ensure correct operation before shipment of unit. Units shall pass quality control and be thoroughly cleaned prior to shipment.

2.4 UNIT CONSTRUCTION DESCRIPTION

A. General: Provide factory-fabricated air handling units with capacity as indicated on the schedule. Units shall have overall dimensions as indicated and fit into the space available with adequate clearance for service as determined by the Engineer. Units shall be completely assembled. Multiple sectioned units shall be shipped as a single factory assembled piece (except where shipping limitations prevent) de-mounted into modular sections in the field by the contractor. Units shall be furnished with sufficient gasket and bolts for reassembly in the field by the contractor. Unit manufacturer shall provide certified ratings conforming to the latest edition of AMCA 210, 310, 500 and AHRI 410. All electrical components and assemblies shall comply with NEMA standards. Unit internal insulation must have a flame spread rating not over 25 and smoke developed rating no higher than 50 complying with NFPA 90A, “Standard for the Installation of Air Conditioning and Ventilating Systems.” Units shall comply with NFPA 70, “National Electrical Code,” as applicable for installation and electrical connections of ancillary electrical components of air handling units. Tags and decals to aid in service or indicate caution areas shall be provided. Electrical wiring diagrams shall be attached to the control panel access doors. Operation and maintenance manuals shall be furnished with each unit. Units shall be UL or ETL listed.

B. Rigging Provision – Multiple Piece Units: Units shipped in multiple sections shall be engineered for field assembly. The base frame shall have integral lifting lugs. The lifting lugs shall be fabricated from structural steel with an appropriate rigging hole. Lifting lugs shall be located at the corner of each section (and along the sides if required) and sized to allow rigging and handling of the unit. All gasket and necessary assembly hardware shall ship loose with unit. Junction boxes with a factory supplied numbered terminal strip shall be supplied at each shipping split for reconnection of control wiring.

Unit Base - Floor: Unit perimeter base rail shall be fabricated using heavy gauge steel. C-Channel cross supports shall be welded to perimeter base steel and located on maximum 24” centers to provide support for internal components. Base rails shall include lifting lugs at the corner of the unit or each section if de-mounted. Internal walk-on floor shall be 16 gauge galvanized steel. The outer sub-floor of the unit shall be made from 20 gauge galvanized steel. The floor cavity shall be spray foam insulated with floor seams gasketed for thermal break and sealed for airtight / watertight construction. Where access is provided to the unit interior, floor openings shall be covered with walk on phenolic coated steel safety grating. Single wall floors with glued and pined insulation and no sub floor are not acceptable. Base frame shall be attached to the unit at the factory.
C. Unit Casing – The construction of the air handling unit shall consist of a (1” x 2”) steel frame with formed 16 gauge galvanized steel exterior casing panels. The exterior casing panels shall be attached to the gasketed (1 x 2) steel frame with corrosion resistant fasteners. All casing panels shall be completely removable from the unit exterior without affecting the unit’s structural integrity. (Units without framed type of construction shall be considered, provided the exterior casing panels are made from 16 gauge galvanized steel, maximum panel center lines are less than 20 inches and deflection is less than L/200 @ 8” positive pressure). The air handling unit casing shall be of the “no-through-metal” design. The casing shall incorporate insulating thermal breaks as required so that, when fully assembled, there’s no path of continuous unbroken metal to metal conduction from inner to outer surfaces. All panel seams shall be caulked and sealed for an airtight unit.

The exterior panel finish shall be: Corrosion resistant Galvanized (No paint)

D. Double Wall Liner - Each unit shall have double wall construction with 16 gauge solid G90 galvanized liner in the entire unit. 22 gauge perforated G90 galvanized liner in the entire unit. The double wall interior panel shall be removable from the outside if the unit without affecting the structural integrity of the unit.

E. Insulation - Entire unit to be insulated with a full 3” (R12.5) thick non-compressed fiberglass insulation. The insulation shall have an effective thermal conductivity (C) of .24 (BTU in. /sq. ft. °F) and a noise reduction coefficient (NRC) of 0.70 / per inch thick (based on a type "A" mounting). The coefficients shall meet or exceed a 3.0 P.C.F. density material rating. Insulation shall meet the erosion requirements of UL 181 facing the air stream and fire hazard classification of 25/50 (per ASTM-84 and UL 723 and CAN/ULC S102-M88) and meet NFPA 90A and 90B. All insulation edges shall be encapsulated within the panel. All perforated sections shall have Micromat® or equal insulation with non-woven mat facing, 5000 fpm rating and non-hygroscopic fibers as manufactured by Johns Manville or approved equal.

F. Access Doors - The unit shall be equipped with a solid double wall insulated (same as the unit casing), hinged access doors as shown on the plans. The doorframe shall be extruded aluminum, foam filled with a built in thermal break barrier and full perimeter gasket. The door hinge assembly shall be stainless steel. There shall be a minimum of two heavy duty handles per door. Provide ETL, UL 1995, and CAL-OSHA approved tool operated safety latch on all fan section access doors.

1. Access doors shall be provided with a 10 x 10 dual thermal pane safety glass window as indicated on mechanical plans.

Note: If manufacturer cannot provide thermal break door design it must be noted as an exception on the bid.
COUNTY FAIRGROUNDS BUILDING
CACHE COUNTY

2.5 UNIT COMPONENT DESCRIPTION

A. FANWALL TECHNOLOGY™ (FWT)

1. The multiple fan array systems shall include multiple, direct driven, arrangement 4 plenum fans constructed per AMCA requirements for the duty specified class III as required. Class I fans are not acceptable. Fans shall be rated in accordance with and certified by AMCA for performance. All fans shall be selected to deliver the specified airflow quantity at the specified operating Total Static Pressure and specified fan/motor speed. The fan array shall be selected to operate at a system Total Static Pressure that does not exceed 90% of the specified fan’s peak static pressure producing capability at the specified fan/motor speed. Each fan/motor cube or cell shall include a minimum 10 gauge, G 90 Galvanized steel intake wall, .100 aluminum spun fan inlet funnel, and an 10 gauge G90 Galvanized steel motor support plate rail and structure. All motors shall be standard foot mounted type TEAO selected at the specified operating voltage, RPM, and efficiency as specified or as scheduled elsewhere. Motors shall meet the requirements of NEMA MG-1 Part 30 and 31, section 4.4.2. Motors shall be as manufactured by Baldor, Siemens, or Toshiba for use in multiple fan arrays that operate at varying synchronous speeds as driven by an approved VFD. Motor HP shall not exceed the scheduled HP as indicated in the AHU equipment schedule(s). Steel cased motors and/or ODP motors are not acceptable. All motors shall include permanently sealed (L10-500,000 hr) bearings and shaft grounding to protect the motor bearings from electrical discharge machining due to stray shaft currents. Each fan/motor assembly shall be dynamically balanced to meet AMCA standard 204-96, exceeding category BV-5, to meet or exceed an equivalent Grade G.55, producing a maximum rotational imbalance of .022” per second peak, filter in (.55mm per second peak, filter in). Fan and motor assemblies submitted for approval incorporating larger than 22” wheel size and 215 T frames size motors shall be balanced in three orthogonal planes to demonstrate compliance with the G.55 requirement with a maximum rotational imbalance of .022” per second peak filter in (.55 mm per second peak, filter in). Copies of the certified balancing reports shall be provided with the unit O&M manuals at the time of shipment. Submittals that do not include a statement of compliance with this requirement will be returned to the contractor without review.

2. The fan array shall consist of multiple fan and motor “cubes” or “cells”, spaced in the air way tunnel cross section to provide a uniform air flow and velocity profile across the entire air way tunnel cross section and components contained therein. In order to assure uniform velocity profile in the AHU cross section, the fan cube dimensions must be variable, such that each fan rests in an identically sized cube or cell, and in a spacing that must be such that the submitted array dimensions fill a minimum of 90% of the cross sectional area of the AHU air way tunnel. There shall be no blank off plates or “spacers” between adjacent fan columns or rows to position the fans across the air way tunnel. The array shall produce a uniform air profile and velocity profile within the airway tunnel of the air handling unit to equal the specified cooling coil and/or filter bank face velocity by +/- 10% when measured at a point 36” from the intake side of the fan array intake plenum wall, and at a distance of 72” from the discharge side of the fan array intake plenum wall. Submittals for units providing less than the scheduled quantity of fans and/or spacing of the fans for multiple fan arrays shall submit CFD modeling of the air flow profile for pre-bid approval that indicates uniform velocity and flow across all internal components without increasing the length of the AHU unit or changing the aspect ratio of the unit casing as designed.
3. Each individual cube or cell in the multiple fan arrays shall be provided with an integral back flow prevention device that prohibits recirculation of air in the event a fan or multiple fans become disabled. The system effects for the back flow prevention device(s) shall be included in the criteria for TSP determination for fan selection purposes, and shall be indicated as a separate line item SP loss in the submittals. Submitted AHU performance that does not indicate allowance for system effects for the back flow prevention device(s) and the system effect for the fan and motor enclosure in which each fan is mounted, will be returned to the contractor disapproved and will need to be resubmitted with all of the requested information included for approval. Back Draft Damper performance data that is per AMCA ducted inlet and discharge arrangements will not be accepted. Damper data must be for the specific purpose of preventing back flow in any disabled fan cube and that is mounted directly at the inlet of each fan. Motorized dampers for this purpose are not acceptable. Submitted fan performance data which only reflect published performance for individual fans in AMCA arrangement “A” free inlet and discharge will not be accepted. AHU Manufacturers that do not manufacture the fans being submitted on must provide certified performance data for fans as installed in the AHU unit with Back Draft damper effects included. At the sole discretion of the engineer, such performance testing may be witnessed by the engineer and/or the owner’s representative.

4. Each fan motor shall be individually wired to a NEMA 3R ventilated control panel containing a single VFD for each fan in the Fanwall Array (Multi-Drive). Wire sizing shall be determined, and installed, in accordance with applicable NEC standards and local code requirements. When specified and scheduled, the multiple fan array electrical panel shall include system optimization controls to actively control fan speed and to enable and disable fans in the multiple fan array. The number of active fans in the array shall be automatically determined, and the speed of the enabled fans shall be adjusted to produce the required coincidental flow and pressure at the perimeter boundary of the unit at substantially peak efficiency. The system controls shall continuously monitor required flow and pressure and shall automatically optimize the operating array configuration and speed for peak efficiency. Fan system controls shall be provided by the AHU unit manufacturer to assure single source responsibility for fan volume controls, and shall require only an input control signal from the controls contractor for SP or flow for proper operation of the system controls. The AHU unit manufacturer shall provide a single communication interface with the BAS and shall coordinate with the controls contractor to make sure that all necessary data points are communicated.

5. At the sole discretion of the engineer, AHU manufacturers that are approved for bidding purposes only, other than the basis of design manufacturer, and that are submitting multiple fan arrays, shall test one or more of the submitted AHU’s for flow, pressure, leakage, BHP and acoustics as submitted and approved, prior to shipment. The testing shall be witnessed by an owner’s representative and approved by the engineer prior to shipment of any of the submitted AHU equipment. A test report shall be provided for each tested AHU unit and the report shall be included in the O&M manuals for the units. Test shall be made with back-draft dampers in place.

6. Each fan & motor assembly shall be removable through a 24” wide, free area, access door located on the discharge side of the fan wall array without removing the fan wheel from the motor. All fan/motor access doors shall open against pressure.
B. Heat Transfer Coils – Direct expansion coils

1. Direct expansion coils shall be constructed of seamless copper tubing mechanically expanded into fin collars. All fins shall be continuous within the coil casing to eliminate carryover inherent with a split fin design. Fins shall be die formed plate type. Headers are seamless copper with die formed tube holes. Connections shall be O.D. sweat copper and includes a refrigerant distributor. Hot gas bypass, when supplied, is piped in the field by others to avoid damage during handling and installation. Intermediate tube supports shall be supplied on coils over 44” fin length, with an additional support every 42” multiple thereafter.

2. Direct expansion coils shall have the following construction:
   Standard 5/8”:
   ( ) 5/8” o.d. x .020” wall copper tube with .028 return bends
   ( ) .008” aluminum fins
   ( ) 16 gauge 304 stainless steel casing
   ( ) Thermal Expansion Valve (remote bulb mounted by others)
   ( ) Hot Gas Bypass shall be provided.

C. Indirect Gas Heater

1. Provide indirect fired heating unit having 80% minimum thermal efficiency and incorporating Listed Gas-fired Duct Furnace manufactured by Heatco Inc. The Duct Furnace models HD(A, B, D, G, H) shall be listed by Intertek Testing Services (ITS / ETL) for operation on Natural or Propane gas to the current edition of ANSI Z83.8 Standard for Gas-Fired Duct Furnaces. Duct furnaces are for installation on the positive pressure side of the circulating air blower only.

   ( ) 20 gauge aluminized steel cabinet
   ( ) 1 inch thick, minimum 1 ½ lb/cu.ft. density thermal insulation for exterior cabinet.
   ( ) 18 gauge stainless steel tubular heat exchanger assembly
   ( ) Combustion blower to provide for positive venting of flue gases
   ( ) Air pressure switches to prove air supply for combustion before operation of gas valve
   ( ) Patented inshot gas burners with integral carryovers
   ( ) Direct spark ignition of the gas burners with remote flame sensor to prove carryover across all burners
   ( ) Listed 24 VAC redundant combination gas valve including two electric shut-off valves, gas pressure regulator, and manual shut-off two-stage
   ( ) Automatic reset type high limit switch to limit maximum outlet air temp to less than 250°F
   ( ) Manual reset flame rollout switches
   ( ) 40 VA, 24 VAC control transformer
   ( ) 1/8” NPT tapped test gauge connection in the gas manifold for measuring gas pressure
   ( ) Union fitting downstream of gas control to facilitate installation and service
   ( ) Provision for attachment of a vent system to exhaust flue gases to outdoors.

2. Provide indirect Gas-fired duct furnace(s) provided shall have a tubular heat exchanger constructed of Type 304L stainless tubes (.047 Min. Wall thickness) produced to ASTM A249. Heat exchanger design shall be suitable to withstand 3.0” w.c. total external static pressure without burner flame disturbance.
3. Duct Furnace modules shall be listed for application downstream of refrigeration and cooling systems and shall provide means for removal of condensate that occurs in the tubes during cooling operation. Heat exchanger tubes shall have (integral formed dimpled restrictors; formed turbulators) to provide for an unobstructed drainage path and tubes shall be formed to provide a positive pitch to promote condensate drainage. Drainage shall be configured so that burners and burner surfaces are not exposed to condensate.

4. Duct Furnace shall incorporate a Direct Spark Ignition control module that is design certified by a recognized national testing agency. The control shall provide:

- 100% safety shut-off
- Natural gas orifice at pressure and elevation as specified on plans
- 15 second minimum pre-purge period prior to trial for ignition
- High energy direct spark ignition of main burners
- Electronic flame supervision incorporating a 0.8 second flame failure response time.
- Up to 2 additional ignition retrials preceded by an interpurge period
- Minimum 30 second post-purge
- Automatic reset after one hour to initiate additional ignition trials if lockout occurs during heat call.
- Alarm capable contact and
- LED indicator light to provide a flash code to identify the operating condition of the control

5. Duct Furnace may be equipped for operation on a 115, 208 or 230 VAC, 1 Φ, 60 Hz power supply as specified on plans.

6. All electrical components shall be listed or recognized by a Nationally Recognized Test Laboratory (ETL, UL, CSA, etc.).

7. Duct Furnace shall be equipped with electronic modulation.

8. Air flow proving switch shall be provided and installed by other.

D. Condensate / Drain Pans - IAQ style drain pans shall be provided under all cooling coils as shown on the drawings. The drain pan shall be fabricated from 16 gauge 304 stainless steel. All pans are to be triple pitched for complete drainage with no standing water in the unit. They shall be insulated minimum 3-inch "Double Bottom" construction with welded corners. Provide stainless steel, 1-1/4" MPT drain connection extended to the exterior of the unit base rail. Units in excess of 159 inches shall have drain connections on both sides. All drain connections shall be piped and trapped separately for proper drainage.

E. Filters - Provide filters of the type indicated on the schedule. Factory fabricated filter sections shall be of the same construction and finish as the unit. Face loaded pre and final filters shall have Type 8 frames as manufactured by AAF, FARR or equal. Side service filter sections shall include hinged access doors on both sides of the unit. Internal blank-offs shall be provided by the air unit manufacturer as required to prevent air bypass around the filters. The filters shall be as manufactured by Farr, Purolator, AAF or equal. Filters shall be in compliance with ANSI/UL 900 – Test Performance of Air Filters.

1. Filter Gauge: Each Filter bank shall be furnished with: (Magnehelic / Photohelic) filter gauge with a 4 ¾” OD white static pressure dial with black figures and zero pointer adjustment. / Dwyer Series 2000 Air filter gauge Dwyer Mark 25 Inclined manometer (DWYER 250 AF).
2. Flat Racks - Filter racks shall be completely factory assembled and designed for industrial applications. Filter racks shall be fabricated from no less than 16 gauge galvanized steel. Filter racks shall be applied in low efficiency filter applications and will be either upstream or side accessible. Side accessible filter racks shall have an oversized access door on the exterior of the air handler, centered on the filter rack for easy filter removal. Upstream access filter racks shall have one central access cover per row of filters centered in the unit for easy access. Filter racks over 72” in length shall require an angle center reinforcement support. Filter racks shall be designed for a maximum of 500 fpm, or meet or exceed the area specified in the mechanical schedule.

3. Medium Efficiency Pleated Filters - Filters shall be 2” thick, 30% efficient. Filter media shall be 100% synthetic. The filter shall have an average efficiency of 25-30% and an average arrestance of 90-92%. The filters shall be listed as Class II under UL Standard 900. Filters shall be tested per ASHRAE Standard 52-76. The effective media shall not be less than 4.6 square feet of media per 1.0 square foot of filter face area, and shall contain not less than 15 pleats per linear foot. Initial resistance at 500 fpm approach shall not exceed 0.28” wg.

F. Dampers – Temtrol TD-6 or approved equal. Provide Class 1 rated, ultra low leak dampers (less than 3 cfm/sq ft. @ 1” w.g.) as indicated on the unit drawings. Low leakage dampers shall have extruded aluminum airfoil blades. Flat or formed metal blades are not acceptable. The damper blade shall incorporate santoprene rubber edge seals and zinc plated or stainless steel tubular steel shaft for a non-slip operation. Shaft bearings shall be spherical – non corrosive nylon to eliminate friction and any metal to metal contact. Damper jamb seals shall be UV rated, nylon glass reinforced or stainless steel spring arcs designed for a minimum air leakage and smooth operation. Damper linkage shall be concealed within a 16 gauge galvanized steel frame. (Operator furnished and installed by others).

2.6 ELECTRICAL POWER AND CONTROLS

A. All electrical and automatic control devices not previously called out or listed below are to be furnished and installed in the field by OTHERS.

B. All wiring shall be (75°C) Insulated copper wires.

C. The unit shall feature a mounted permanent nameplate displaying at a minimum the manufacturer, serial number, model number and current and amps voltage. The unit must have an ETL or UL Listing and bear the appropriate mark.

D. Conduit shall consist of a combination of EMT or flexible metal conduit as required. Liquidtite flexible metal conduit may be used outside the air tunnel for wet locations.

E. The unit shall feature a main non-fused disconnect of the proper amp rating to allow shutoff of all electrical motors and control items.

F. Unit Convenience Features

1. Each section (specified sections) shall be equipped with a vapor-proof 100 watt service light with guard.

2. Lights shall be controlled by one light switch mounted adjacent to the supply air fan access door.
3. Furnish a 120 volt GFI duplex convenience outlet on the exterior of the unit as indicated on the unit drawing.
4. Lights, switches and outlets shall be wired through a transformer fused disconnect package.

G. Smoke Detector – A factory mounted and wired reset ionization type smoke detector(s) shall be located in return air stream (and discharge air stream) shall be provided.

END OF SECTION 15855
SECTION 15869 - EXHAUST FANS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To -
   1. Furnish and install exhaust fans as described in Contract Documents.

B. Related Sections -
   1. General Conditions, Division 01, and Section 15010 apply to this Section.

1.2 QUALITY ASSURANCES

A. Requirements of Regulatory Agencies -
   1. Bear AMCA seal and UL label.

PART 2 - PRODUCTS

2.1 CEILING MOUNTED EXHAUST FANS

A. Acoustically insulated housings.

B. Include shatterproof integral back-draft damper with no metal to metal contact.

C. True centrifugal wheels.

D. Entire fan, motor, and wheel assembly shall be easily removable without disturbing housing.

E. Suitably ground motors and mount on rubber-in shear vibration isolators.

F. Provide wall or roof cap, as required.

G. Approved Manufacturers -
   1. Cook-Gemini
   2. Greenheck Sp
   3. Panasonic
   4. Acme

2.2 INLINE FAN

A. Duct mounted supply, exhaust or return fans shall be of the centrifugal, direct driven or belt driven in-line type.

B. The fan housing shall be of the square design, constructed of heavy gauge galvanized steel and shall include square duct mounting collars.
C. Fan construction shall include two removable access panels located perpendicular to the motor mounting panel. The access panels must be of sufficient size to permit easy access to all interior components.

D. The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced.

E. Motors shall be permanently lubricated and carefully matched to the fan loads. Motors shall be readily accessible for maintenance.

F. A NEMA 1 disconnect switch shall be provided as standard. Factory wiring shall be provided from motor to the handy box.

G. All fans shall bear the AMCA Certified Ratings Seal for both sound and air performance.

H. Each fan shall bear a permanently affixed manufacturer’s nameplate containing the model number and individual serial number for future identification.

I. Motors in the airstream shall have fan wheel mounted to motor shaft and support for weight. Motors and drives that are mounted out of the airstream shall provide the following:

1. Drives shall be sized for a minimum of 150% of driven horsepower.
2. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
3. Motor pulleys shall be adjustable for final system balancing.

J. Approved Manufacturers -

1. Acme
2. PennBarry
3. Cook
4. Greenheck
5. Twin City
6. Carnes

PART 3 - EXECUTION

3.1 INSTALLATION

A. Anchor fan units securely to structure or curb.

END OF SECTION 15869
SECTION 15887 - DISPOSABLE FILTERS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To -
   1. Furnish and install filters used in air handling units.

B. Related Sections -
   1. General Conditions and Division 01 apply to this Section.
   2. Filters other than in air handling units specified in Sections specifying equipment in which filters are installed.

PART 2 - PRODUCTS

2.1 AIR HANDLING UNIT FILTERS

A. 2 inch thick, medium efficiency, standard size, disposable type pre-formed pleated design, having at least 4.5 sq ft of filtering media per sq ft of face area.

B. Media shall be reinforced non-woven cotton fabric, treated with adhesive similar to "Vyclad B" and continuously laminated to supporting steel wire grid conforming to configuration of pleats.

C. Media pack shall be sealed in a chipboard frame or beverage board.

D. Filters shall have rated average efficiency of 30 to 35% on ASHRAE Test Standard 52-76 and MERV 8 with 3.0 to 10.0 µm partial size arrestive and be capable of operating with variable face velocities up to 500 FPM without impairing efficiency.

E. Initial resistance shall not exceed 0.30 inches w.g. at 500 FPM or 0.14 inch w.g. at 300 FPM. Filter shall be listed Class 2 by UL.

F. Approved Manufacturers -
   1. Type 30/30 by Farr Co
   2. Mark 80 by Serv-Aire
   3. HC Type 40 by Envoleat
   4. DP2-40 by Air Guard

END OF SECTION 15887
SECTION 15890 - LOW-PRESSURE STEEL DUCTWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To -

1. Furnish and install above-grade ductwork and related items as described in Contract Documents.

B. Related Sections -

1. General Conditions, Division 01, and Section 15010 apply to this Section.
2. Section 15010 - Smoke testing
3. Section 15895 - Underground Ductwork
4. Section 15893 - High Pressure Ductwork
5. Section 15970 - Temperature control damper actuators and actuator linkages

PART 2 - PRODUCTS

2.1 DUCTS


B. Kitchen hood exhaust ductwork shall be fabricated in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and NFPA 96.

1. Construct of 16 gauge, carbon steel or 18 gage stainless steel, using continuous external welded joints.

2.2 DUCT JOINTS

A. Ducts with sides up to and including 36 inches shall be fabricated using SMACNA T-1 and T-3 joints.

B. Duct sizes over 36 inches shall be fabricated using SMACNA T-24 flange joints or prefabricated systems as follows -

1. Ducts with sides over 36 inches to 48 inches -
   a. Transverse duct joint system by Ductmate/25, Nexus, or WDCI (Lite) (SMACNA “E” or “G” Type connection).
   b. Approved Manufacturers -
      1) Ductmate Industries Inc., 10760 Bay Meadows Drive, Sandy, UT 84092 (801) 571-5308; Stockton, CA (800) 344-3270 - Pittsburgh, PA (800) 245-3188
      2) Nexus, Exanno Corp., P.O. Box 729, Buffalo, NY 14206 (714) 849-0545
      3) WDCI, P.O. Box 10868, Pittsburgh, PA 15236 (800) 248-2355.
2. Ducts 48 inches & larger -
   a. Ductmate/35, Nexus, or WDCI (Heavy) (SMACNA “J” Type connection).
   b. Approved Manufacturers -
      1) Ductmate Industries Inc., 10760 Bay Meadows Drive, Sandy, UT 84092 (801) 571-5308; Stockton, CA (800) 344-3270 - Pittsburgh, PA (800) 245-3188
      2) Nexus, Exanno Corp., P.O. Box 729, Buffalo, NY 14206 (714) 849-0545
      3) WDCI, P.O. Box 10868, Pittsburgh, PA 15236 (800) 248-2355.

2.3 ACCESS DOORS IN DUCTS

   A. At each manual outside air damper and at each motorized damper, install factory built insulated access door with hinges and sash locks. Locate doors within 6 inches of installed dampers.

   B. Fire damper access doors shall have a minimum clear opening of 12” x 12” or as specified on Drawings to easily service fire damper. Doors shall be within 6 inches of fire dampers and in Mechanical Room if possible. Each fire or fire/smoke damper access door shall be labeled with ½” in height and read “Fire Damper” or “Fire Smoke Damper”.

   C. Approved Manufacturers -
      1. AirBalance - Fire/Seal #FSA 100
      2. Air Control Products - HAD-10
      3. Cesco-Advanced Air - HAD-10
      4. Ductmate Industries Inc - “Sandwich” access door
      5. Kees Inc - ADH-D.
      6. Louvers & Dampers - #SMD-G-F
      7. Nailor-Hart Industries Inc. - Series 0831
      8. National Controlled Air Inc - Model AD-FL-1

2.4 ACCESS DOORS IN CEILINGS

   A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specifications Section, apply to this section.

   B. This Section includes access doors for installation in the following types of construction:
      1. Gypsum drywall.

   C. Provide fire-rated access doors.

   D. SUBMITTALS:
      1. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
         a. Product data in form of manufacturer’s technical data and installation instructions for each type of access door assembly, including setting drawings, templates, instructions, and directions for installation of anchorage, devices
            1) Include complete schedule, including types, general locations, sizes, wall and ceiling construction details, finishes, latching or locking provisions, and other data pertinent to installation.
E. Single-Source Responsibility: Obtain access doors for entire project from one source from a single manufacturer.

F. Fire-Resistance Ratings: Wherever a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in Underwriters Laboratories, Inc.’s “Building Materials Directory” for rating shown.

1. Provide UL label on each fire-rated access door.

G. Size Variations: Obtain Engineer’s acceptance of manufacturer’s standard size units, which may vary slightly from size indicated. Figure 24 x 24 during bid, if no size is given.

H. Coordination: Furnish inserts and anchoring devices that must be built into other work for installation of access doors. Coordinate delivery with other work to avoid delay.

I. Verification: Examine the plans for all fire and fire/smoke dampers and concealed equipment. The contractor is responsible for providing fire rated or non rated as need requires.

J. Manufacturers: Subject to compliance with requirements, provide access doors by one of the following:

1. J.L. Industries
3. Milcor, Inc.
4. Nystrom, Inc.
5. The Williams Brothers Corp.

K. General: Furnish each access door assembly manufactured as an integral unit, complete with all parts, and ready for installation.

L. Steel Access Doors and Frames: Fabricate units of continuous welded steel construction unless otherwise indicated. Grind welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of support shown.

M. Frames: Fabricate from 16-gage steel.

1. Fabricate frame with exposed flange nominal 1-inch wide around perimeter of frame for units installed in the following construction:
   a. Drywall finish.

2. For gypsum drywall, furnish perforated frames with drywall bead.

N. Flush Panel Doors: Fabricate from not less than 14-gage sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175°. Finish with manufacturer's factory-applied prime paint.

1. For fire-rated units, provide manufacturer's standard insulated flush panel/doors, with continuous piano hinge and self-closing mechanism.
O. Locking Devices: Furnish flush, screwdriver-operated cam locks of number required to hold door in flush, smooth plane when closed.

1. Provide one cylinder lock per access door. Furnish 2 keys per lock. Key all locks alike, unless otherwise scheduled.

P. Comply with manufacturer's instructions for installation of access doors.

Q. Coordinate installation with work of other trades.

R. Adjust hardware and panels after installation for proper operation.

S. Remove and replace panels or frames that are warped, bowed, or otherwise damaged.

2.5 FLEXIBLE EQUIPMENT CONNECTIONS

A. 30 oz closely woven UL approved glass fabric, double coated with neoprene.

B. Fire retardant, waterproof, air-tight, resistant to acids and grease, and withstand constant temperatures of 250° F.

C. Approved Manufacturers -
   1. Cain - N-100
   2. Duro Dyne - MFN
   3. Ventfabrics - Ventglas

2.6 CONCEALED CEILING DAMPER REGULATORS

A. Approved Manufacturers -
   1. Cain
   2. Duro Dyne
   3. Metco Inc
   4. Vent-Lock - #666
   5. Young - #303

2.7 VOLUME DAMPERS

A. In Main Ducts -
   1. 16 gauge galvanized steel, opposed blade type with 3/8 inch pins and end bearings. Blades shall have 1/8 inch clearance all around.
   2. Damper shall operate within acoustical duct liner.
   3. Provide channel spacer equal to thickness of duct liner.
   4. Approved Manufacturers -
      a. Air Balance - Model AC-2
      b. Air Control Products - CD-OB
      c. American Warming - VC-2-AA
      d. Greenheck - VCD-1100
COUNTY FAIRGROUNDS BUILDING
CACHE COUNTY

e. Safe-air - Model610
f. Vent Products - 5100

B. In Sheet Metal Branch Ducts -

1. Extruded aluminum, opposed blade type. When in open position, shall not extend beyond damper frame.
2. Maximum blade length 12 inches.
3. Damper Regulator shall be concealed type with operation from bottom or with 90 degrees miter gear assembly from side.
4. Approved Manufacturers -
   a. Air Control Products - TCD-OB
   b. Air Guide - OB
   c. Air-rite - Model ST-3
   d. Arrow - OBDAF-207
   e. Reliable Metals - OBD-RO
   f. Safe-air - Models BDR, 612
   g. Tuttle & Bailey - A7RDDM
   h. Young - 820-AC

C. Dampers above removable ceiling and in Mechanical Rooms shall have locking quadrant on bottom or side of duct. Otherwise, provide concealed ceiling damper regulator and cover plate.

2.8 MOTORIZED OUTSIDE AIR DAMPERS

A. Damper Blades -

1. 18 gauge galvanized steel or equivalent aluminum with replaceable rubber blade edges, 9 inches wide maximum.
2. End seals shall be flexible metal compression type.
3. Opposed blade type.

B. Make provision for damper actuators and actuator linkages to be mounted external of air flow.

C. Approved Manufacturers & Models -

1. American Warming - VC-2-AAVA
2. Arrow - OBDAF-207
3. Greenheck - VCD-2100
4. Honeywell - D641
5. Johnson - D1300
6. Louvers & Dampers - TSD400
7. Ruskin - CD36 or CD60
8. Vent Products - 5800

2.9 BACKDRAFT DAMPER

A. Backdraft blades shall be nonmetallic and shall be neoprene coated fiberglass.

B. Stop shall be galvanized steel screen or expanded metal, ½ inch mesh.
C. Frame shall be galvanized steel or extruded aluminum alloy.

D. Approved Models & Manufacturers -

1. Air Control Products - FBD
2. American Warming - BD-15
3. Ruskin - NMS2

2.10 DUCT HANGERS

A. 1" x 18 gauge galvanized steel straps or steel rods shall comply with UMC and SMACNA or on Drawings and detailed, and spaced not more than 8 feet apart. Do not use wire hangers.

B. Attaching screws to wood trusses shall be 1-1/2 inch No. 10 round head wood screws. Nails not allowed.

C. Attaching to steel structures shall be C-Clamp.

2.11 DIRTY FILTER MANOMETERS

A. Dwyer No. 451F.

2.12 MAGNEHELIC GAUGE

A. Dwyer Series 2001-AF complete with standard accessories and vent valves.

2.13 DUCT SILENCERS

A. Air Filter Corp - AIRSAN
B. Industrial Acoustic Co
C. Titus Products Div
D. United McGill Corp

2.14 DUCT SEALER

A. Cain - Duct Butter or Butter Tak
B. Design Polymeric - DP 1010
C. DSC - Stretch Coat
D. Duro Dyne - S2
E. Hardcast - #601 Iron-Grip or Peel-N-Seal Tape
F. Kingco - 15-325
PART 3 - EXECUTION

3.1 INSTALLATION

A. Ducts -

1. Straight and smooth on inside with joints neatly finished unless otherwise directed.
2. Duct panels through 48 inch dimension having acoustic duct liner need not be crossbroken or beaded.
3. Crossbreak unlined ducts and duct panels larger than 48 inch or bead 12 inches on center.
4. Securely anchor ducts to building structure with specified duct hangers attached with screws or C-clamps.
5. Brace and install ducts so they shall be free of vibration under all conditions of operation.
6. Ducts shall not bear on top of structural members.
7. Make duct take-offs to branches, registers, grilles, and diffusers as detailed on Drawings.
8. Ducts shall be large enough to accommodate inside acoustic duct liner. Dimensions shown on Drawings are net clear inside dimensions after duct liner has been installed.
10. Install internal ends of slip joints in direction of flow. Make joints air tight using specified duct sealer.
11. Cover horizontal and longitudinal joints on exterior ducts with two layers of Hardcast tape installed with Hardcast HC-20 adhesive according to Manufacturer's recommendations.
12. Paint ductwork visible through registers, grilles, and diffusers flat black.

B. Each access door shall have a label with letters no less than ½” in height reading "Fire Damper".

C. Install flexible inlet and outlet duct connections to each furnace, fan, fan coil unit, and air handling unit.

D. Install concealed ceiling damper regulators.

1. Paint cover plates to match ceiling tile.
2. Damper regulators will not be required for dampers located directly above removable ceilings or in Mechanical Rooms.

E. Provide each take-off with an adjustable volume damper to balance that branch.

1. Anchor dampers securely to duct.
2. Install dampers in main ducts within insulation.
3. Dampers in branch ducts shall fit against sheet metal walls, bottom and top of duct, and be securely fastened. Cut duct liner to allow damper to fit against sheet metal.
4. Where concealed ceiling damper regulators are installed, provide a cover plate.

F. Install grilles, registers, and diffusers. Level floor registers and anchor securely into floor.
G. Air Turns -

1. Permanently installed, consisting of single thickness curved metal blades or vanes arranged to permit air to make abrupt turn without appreciable turbulence, in 90 degree elbows of above ground supply and return ductwork.
2. 4-1/2 inch wide minimum vane rail. Do not use junior vane rails.
3. Quiet and free from vibration when system is in operation.

3.2 TESTING FOR LEAKAGE:

A. General: After each duct system is completed, test for duct leakage in accordance with SMACNA “High Pressure Duct Standards–3rd Edition, Chapter 10–Testing for Leakage”. Repair leaks and repeat tests until total leakage is less than 1% of system design air flow.

END OF SECTION 15891
SECTION 15892 - NON METAL DUCTWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To -
   1. Furnish and install supply air branch duct runouts to diffusers as described in Contract Documents.

B. Related Sections -
   1. General Conditions, Division 01, and Section 15010 apply to this Section.
   2. Section 15 891 - Volume dampers and sheet metal ducts

PART 2 - PRODUCTS

2.1 DUCTS

A. Formable, flexible, circular duct which shall retain its cross-section, shape, rigidity, and shall not restrict air flow after bending.

B. Nominal 1-1/2 inches thick, 3/4 lb/cu ft density fiberglass insulation with air-tight, polyethylene or polyester core, sheathed in seamless foil vapor barrier jacket factory installed over flexible assembly.

C. Assembly, including insulation and vapor barrier, shall meet Class I requirement of NFPA 90A and be UL 181 rated, with flame spread of 25 or less and smoke developed rating of 50 or under.

2.2 APPROVED MANUFACTURERS

A. ANCO-FLEX

B. Flex-Aire - PF/UPC

C. Flexible Air Movers Inc

D. Thermaflex

E. Codywest - Type NIL-M

F. Flex Master - Type 8M
PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct in fully extended condition free of sags and kinks, using four foot maximum lengths. Ductwork shall not be used for 45° to 90° elbows.

B. Make duct connections by coating exterior of duct collar for 3 inches with duct sealer and securing duct in place over sheet metal collar with ½ inch wide metal cinch bands and sheet metal screws.

END OF SECTION 15892
SECTION 15896 - DUCT LINING

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To -
   1. Furnish and install, as described in Contract Documents, acoustical lining of -
      a. Above ground metal ductwork including fresh air, supply air, return air, mixed air,
         transfer air, relief air and exhaust air. Combustion air ducts are not included.
      b. Elbows, fittings, and diffuser drops.

B. Related Sections -
   1. General Conditions, Division 01, and Section 15010 apply to this Section.
   2. Section 15290 - External thermal duct insulation.

1.2 SYSTEM DESCRIPTION

A. Duct dimensions shown on Drawings are for free area inside insulation.

PART 2 - PRODUCTS

2.1 DUCT LINER

A. 1½ inch thick, 1-1/2 lb density fiberglass. (R-6.2) minim shall meet ASTM 1071 for air
   velocity and ASTM 1338 for microbial growth.

B. Approved Manufacturers -
   1. CSG - Ultralite
   2. Knauf - Type E-M
   3. Manville - Lina-Coustic
   4. Owen Corning Fiberglass - Aeroflex

2.2 ADHESIVE

A. Water Base Type -
   1. Cain - Hydrotak
   2. Duro Dyne - WSA
   3. Kingco - 10-568
   4. Miracle - PF-101
   5. Mon-Eco - 22-67
   6. Techno Adhesive - 133

B. Solvent Base (non-flammable) Type -
   1. Cain - Safetak
   2. Duro Dyne - FPG
COUNTY FAIRGROUNDS BUILDING
CACHE COUNTY

3. Kingco - 15-137
4. Miracle - PF-91
5. Mon-Eco - 22-24
6. Techno Adhesive - 'Non-Flam' 106

C. Solvent Base (flammable) Type -

1. Cain - HV200
2. Duro Dyne - MPG
3. Kingco - 15-146
4. Miracle - PF-96
5. Mon-Eco - 22-22
6. Techno Adhesive - “Flammable” 106

2.3 MECHANICAL FASTENERS

A. Approved Manufacturers -

1. AGM Industries Inc - "DynaPoint" Series DD-9 pin
2. Cain
3. Duro Dyne
4. Omark dished head "Insul-Pins"
5. Grip nails may be used if each nail is installed by "Grip Nail Air Hammer" or by "Automatic Fastener Equipment" in accordance with Manufacturer's recommendations.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install mat finish surface on air stream side. Secure insulation to cleaned sheet metal duct with continuous 100% coat of adhesive and with 3/4 inch long mechanical fasteners 12 inches on center maximum unless detailed otherwise on Drawings. Pin all duct liner.

B. Accurately cut liner and thoroughly coat ends with adhesive. Butt joints tightly. Top and bottom sections of insulation shall overlap sides. If liner is all one piece, folded corners shall be tight against metal. Ends shall butt tightly together.

3.2 FIELD QUALITY CONTROL

A. If insulation is installed without longitudinal and end joints butted together, installation will be rejected and work removed and replaced with work that conforms to this Specification.

3.3 ADJUSTING, CLEANING

A. Keep duct liner clean and free from dust. At completion of project, vacuum duct liner if it is dirty or dusty.

END OF SECTION 15896
SECTION 15911 - FIRE AND FIRE/SMOKE DAMPERS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To

1. Furnish and install fire or fire/smoke dampers at penetrations of fire rated walls, floors, & ceilings, at ducts, registers, grilles, or louvers as described in Contract Documents.

B. Related Sections

1. General Conditions, Division 01, and Section 15010 apply to this Section.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies

1. Dampers shall conform to UL and NFPA requirements and bear UL label.
2. Dampers shall be approved by State Fire Authorities where so required.
3. Fire damper installation shall conform to details shown in SMACNA Fire Damper Guide and as required by local codes.

1.3 MAINTENANCE

A. Extra Materials

1. Leave six fusible links of each rating type used on Project with Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Fire Dampers

1. At Walls & Floors - Type "B" with 212 deg F link unless otherwise indicated on Drawings.
2. Ceilings -
   a. Radiation type ceiling fire damper with 212 deg F link unless otherwise indicated on Drawings.
   b. Approved Manufacturers -
      1) Air Balance Inc
      2) Cesco
      3) Pottorf
      4) Safe Air Inc
      5) Ultra Safe
COUNTY FAIRGROUNDS BUILDING
CACHE COUNTY

B. Combination Smoke & Fire Dampers -

1. At the wall and ceiling.
   a. Folding blade type.
   b. Motorized damper to operate at 115V and draw 0.2 amps maximum.
   c. Damper shall close on -
      1) Signal from smoke detectors
      2) Power failure
      3) Failure of fusible link.
   d. Minimum of 10 ga galvanized steel sleeve with 18 ga closure and damper blades.
      Blades shall fold into compact package completely out of air stream.
   e. Furnish 212/F UL listed fusible link.
   f. Damper serviceable from access door located on either side of damper.
   g. Approved Manufacturers -
      1) Ruskin
      2) Equal by Prefco or Pottorff

2.2 ACCESS DOORS IN CEILINGS

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

B. This Section includes access doors for installation in the following types of construction:

   1. Gypsum drywall.

C. Provide fire-rated access doors.

D. Submittals:

   1. General: Submit the following in accordance with Conditions of Contract and Division
      1 Specification Sections.
      a. Product data in form of manufacturer's technical data and installation instructions
         for each type of access door assembly, including setting drawings, templates,
         instructions, and directions for installation of anchorage, devices.
         1) Include complete schedule, including types, general locations, sizes, wall
            and ceiling construction details, finishes, latching or locking provisions, and
            other data pertinent to installation.

E. Single-Source Responsibility: Obtain access doors for entire project from one source from a
   single manufacturer.

F. Fire-Resistance Ratings: Wherever a fire-resistance classification is indicated, provide access
   door assembly with panel door, frame, hinge, and latch from manufacturer listed in
   Underwriters Laboratories, Inc.'s "Building Materials Directory" for rating shown.

   1. Provide UL label on each fire-rated access door.

G. Size Variations: Obtain Engineer's acceptance of manufacturer's standard size units, which
   may vary slightly from sized indicated. Figure 24 x 24 during bid, if not size is given.
H. Coordination: Furnish inserts and anchoring devices that must be built into other work for installation of access doors. Coordinate delivery with other work to avoid delay.

I. Verification: Examine the plans for all fire and fire/smoke dampers and concealed equipment. Provide the sizes for required access doors and concealed equipment. The contractor is responsible for providing fire rated or non-rated as need requires.

J. Manufacturers: Subject to compliance with requirements, provide access doors by one of the following:

1. J.L. Industries
3. Milcor, Inc.
4. Nystrom, Inc.
5. The Williams Brothers Corp.

K. General: Furnish each access door assembly manufactured as an integral unit, complete with all parts, and ready for installation.

L. Steel Access Doors and Frames: Fabricate units of continuous welded steel construction unless otherwise indicated. Grind welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of support shown.

M. Frames: Fabricate from 16-gage steel.

1. Fabricate frame with exposed flange nominal 1-inch wide around perimeter of frame for units installed in the following construction:
   a. Drywall finish.

2. For gypsum drywall, furnish perforated frames with drywall bead.

N. Flush Panel Doors: Fabricate from not less than 14-gage sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees. Finish with manufacturer's factory-applied prime paint.

1. For fire-rated units, provide manufacturer's standard insulated flush panel/doors, with continuous piano hinge and self-closing mechanism.

O. Locking Devices: Furnish flush, screwdriver-operated cam locks of number required to hold door in flush, smooth plane when closed.

1. Provide one cylinder lock per access door. Furnish 2 keys per lock. Key all locks alike, unless otherwise scheduled.

P. Comply with manufacturer's instructions for installation of access doors.

Q. Coordinate installation with work of other trades.

R. Adjust hardware and panels after installation for proper operation.
S. Remove and replace panels or frames that are warped, bowed, or otherwise damaged.

PART 3 - EXECUTION (NOT USED)

END OF SECTION 15911
SECTION 15940 - AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To -

1. Furnish and install wall supply registers, return air grilles, ceiling diffusers, louvers connected to ductwork, and registers as described in Contract Documents.
2. Quality of grilles installed in metal doors.

B. Products Furnished But Not Installed Under This Section -

1. Door grilles for wood doors.

C. Related Sections -

1. General Conditions, Division 01, and Section 15010 apply to this Section.
2. Division 06 - Installation of door grilles for wood doors.
3. Division 08 - Furnishing and installing of grilles in metal doors.

1.2 MAINTENANCE

A. Extra Materials -

1. Leave tool for removing core of each different type of grille for building custodian.

PART 2 - PRODUCTS

2.1 SUPPLY GRILLES & REGISTERS

A. Approved Manufacturers -

1. Air Control Products
2. Krueger
3. Metalaire
4. Titus
5. Tuttle & Bailey

2.2 CEILING RETURN

A. Approved Manufacturers -

1. Air Control Products
2. Anemostat
3. Krueger
4. Metalaire
5. Titus
6. Tuttle & Bailey
2.3 LOW SIDEWALL RETURN GRILLES

A. Approved Manufacturers -
   1. Air Control Products
   2. Anemostat
   3. Metalaire
   4. Titus
   5. Tuttle & Bailey

2.4 CEILING DIFFUSERS

A. Approved Manufacturers -
   1. Air Control Products
   2. Krueger
   3. Titus
   4. Tuttle & Bailey

2.5 LOUVERS

A. Extruded aluminum, with blades welded or screwed into frames and ½ inch mesh 16 gauge aluminum bird screen.

B. Frames shall have mitered corners.

C. Louvers shall be recessed, flanged, stationary, or removable as noted on Drawings.

D. Approved Manufacturers -
   1. Air Control Products
   2. Airolite
   3. American Warming
   4. Ruskin
   5. Vent Products

PART 3 - EXECUTION

3.1 INSTALLATION

A. Anchor securely into openings.

END OF SECTION 15940
SECTION 15970 - DIRECT DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 – GENERAL

1.1 WORK INCLUDED

A. Furnish a totally native BACnet-based system, including a Microsoft 10 compatible operator’s workstation. The operator’s workstation, all building controllers, application controllers, and all input/output devices shall communicate using the protocols and network standards as defined by ANSI/ASHRAE Standard 135–2008, BACnet. In other words, all workstations and controllers, including unitary controllers, shall be native BACnet devices. No gateways shall be used for communication to controllers installed under this section. Gateways may be used for communication to existing systems or to systems installed under other sections.

B. Provide all necessary BACnet-compliant hardware and software to meet the system’s functional specifications. Provide Protocol Implementation Conformance Statement (PICS) for Windows-based control software and every controller in system, including unitary controllers.

C. Prepare individual hardware layouts, interconnection drawings, and software configuration from project design data.

D. Implement the detailed design for all analog and binary objects, system databases, graphic displays, logs, and management reports based on control descriptions, logic drawings, configuration data, and bid documents.

E. Design, provide, and install all equipment cabinets, panels, data communication network cables needed, and all associated hardware.

F. Provide and install all interconnecting cables between supplied cabinets, application controllers, and input/output devices.

G. Provide and install all interconnecting cables between all operator’s terminals and peripheral devices (such as printers, etc.) supplied under this section.

H. Provide complete manufacturer’s specifications for all items that are supplied. Include vendor name of every item supplied.

I. Provide supervisory specialists and technicians at the job site to assist in all phases of system installation, startup, and commissioning.

J. Provide a comprehensive operator and technician training program as described herein.

K. Provide as-built documentation, operator’s terminal software, diagrams, and all other associated project operational documentation (such as technical manuals) on approved media, the sum total of which accurately represents the final system.

L. Provide new sensors, dampers, valves, and install only new electronic actuators. No used components shall be used as any part or piece of installed system.
1.2 SYSTEM DESCRIPTION

A. A distributed logic control system complete with all software and hardware functions shall be provided and installed. System shall be completely based on ANSI/ASHRAE Standard 135-2008. This system is to control all mechanical equipment, including all unitary equipment such as gas furnaces, cabinet heaters, AC units, etc., and all air handlers, condensers, and any other listed equipment using native BACnet-compliant components. Non-BACnet-compliant or proprietary equipment or systems (including gateways) shall not be acceptable and are specifically prohibited.

B. Operator’s workstation software shall use Microsoft Windows 10 as the computer operating system. The Energy Management and Control System (EMCS) application program shall be written to communicate specifically utilizing BACnet protocols. Software functions delivered on this project shall include password protection, scheduling (including optimum start), alarming, logging of historical data, full graphics including animation, after-hours billing program, demand limiting, and a full suite of field engineering tools including graphical programming and applications. Systems using operating systems other than that described above are strictly prohibited. All software required to program application specific controllers and all field level devices and controllers will be left with the owner. All software passwords required to program and make future changes to the system will also become the property of the owner. All software required to make any program changes anywhere in the system, along with scheduling and trending applications, will be left with the owner. All software passwords required to program and make future changes to schedules, trends and related program changes will also become the property of the owner. All software required for all field engineering tools including graphical programming and applications will be left with the owner. All software passwords required to program and make future changes to field engineering tools, including graphical programming and applications will be left with the owner.

C. Building controllers shall include complete energy management software, including scheduling building control strategies with optimum start and logging routines. All energy management software and firmware shall be resident in field hardware and shall not be dependent on the operator’s terminal. Operator’s terminal software is to be used for access to field-based energy management functions only. Provide zone-by-zone direct digital logic control of space temperature, scheduling, runtime accumulation, equipment alarm reporting, and override timers for after-hours usage.

D. Room sensors shall be provided with digital readout that allow the user to view room temperature, view outside air temperature, adjust the room setpoint within preset limits and set desired override time. User shall also be able to start and stop unit from the digital sensor. Include all necessary wiring and firmware such that room sensor includes field service mode.

E. All application controllers for every terminal unit (RTU, VAV, HP, UV, etc.) air handler, all central plant equipment, and any other piece of controlled equipment shall be fully programmable. Application controllers shall be mounted next to controlled equipment and communicate with building controller through BACnet LAN.
1.3 APPROVED MANUFACTURERS

A. The bid shall be the BACtalk system from Alerton, Clima-Tech and engineer approved. All programming, graphics, system data, and operator interface equipment shall be from accessible from all the operators software located on the workstations and system server computers. Other manufacturers may bid based upon meeting all requirements of the specification and receiving approval from the engineer 10 days prior to bid. A paragraph-by-paragraph comparison of base bid specified system versus alternative system—along with five references of similar projects (include project name, contact, phone number, location, consultant, value of contract, and a full comprehensive description of the control system and how it operates—shall be submitted 65 days prior to bid for review process. If approved, other manufacturers’ bids shall be shown as an add / deduct on the bid form.

1. Approved Control Manufacturers
   a. Alerton
   b. Clima-Tech

1.4 QUALITY ASSURANCE

A. The Building Automation System (BAS) system shall be designed, installed, commissioned, and serviced by manufacturer authorized and trained personnel. System provider shall have an in-place support facility within 2 hours response time of the site with technical staff, spare parts inventory, and necessary test and diagnostic equipment. System provider shall have a minimum of 10 years’ experience with the current equipment manufacture.

The contractor shall provide full-time, on-site, experienced project manager for this work, responsible for direct supervision of the design, installation, start-up and commissioning of the BAS system.

The Bidder shall be regularly engaged in the design, installation and maintenance of BAS systems and shall have demonstrated technical expertise and experience in the design, installation and maintenance of BAS systems similar in size and complexity to this project. Bidders shall provide a list of at least 10 projects, similar in size and scope to this project completed within the past 3 years.

B. Materials and equipment shall be manufacturer’s latest standard design that complies with the specification requirements.

C. All BAS peer-to-peer network controllers, central system controllers and local user displays shall be UL Listed under Standard UL 916, category PAZX.

D. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

E. Control system shall be engineered, programmed and supported completely by representative’s local office that must be within 100 miles of project site.
1.5 REFERENCE STANDARDS

A. The latest edition of the following standards and codes in effect and amended as of supplier's proposal date, and any applicable subsections thereof, shall govern design and selection of equipment and material supplied:

1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
4. UL 916 Underwriters Laboratories Standard for Energy Management Equipment. Canada and the US.
6. FCC Part 15, Subpart J, Class A.
8. UL-864 UUKL listing for Smoke Controls for any equipment used in smoke control sequences.

B. City, county, state, and federal regulations and codes in effect as of contract date.

C. Except as otherwise indicated, the system supplier shall secure and pay for all permits, inspections, and certifications required for his work, and arrange for necessary approvals by the governing authorities.

1.6 SUBMITTALS

A. Drawings

1. The system supplier shall submit engineered drawings, control sequence, and bill of materials for approval.
2. Drawings shall be submitted in the following standard sizes: 11” x 17” (ANSI B).
3. Eight complete sets (copies) of submittal drawings shall be provided.
4. Drawings shall be available on CD-ROM.

B. System Documentation. Include the following in submittal package:

1. System configuration diagrams in simplified block format.
2. All input/output object listings and an alarm point summary listing.
3. Electrical drawings that show all system internal and external connection points, terminal block layouts, and terminal identification.
5. Manufacturer's instructions and drawings for installation, maintenance, and operation of all purchased items.
6. Overall system operation and maintenance instructions—including preventive maintenance and troubleshooting instructions.
7. For all system elements—operator’s workstation(s), building controller(s), application controllers, routers, and repeaters—provide BACnet Protocol Implementation Conformance Statements (PICS) as per ANSI/ASHRAE Standard 135-2001.
8. Provide complete description and documentation of any proprietary (non-BACnet) services and/or objects used in the system.
9. A list of all functions available and a sample of function block programming that shall be part of delivered system.
C. Project Management

1. The vendor shall provide a detailed project design and installation schedule with time markings and details for hardware items and software development phases. Schedule shall show all the target dates for transmission of project information and documents, and shall indicate timing and dates for system installation, debugging, and commissioning.

1.7 WARRANTY

A. Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of one year from completion of system acceptance.

B. Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the vendor. The maximum acceptable response time to provide this service at the site shall be 24 hours, Monday through Friday and 48 hours on Saturday and Sunday.

C. This warranty shall apply equally to both hardware and software.

1.8 RELATED WORK IN OTHER SECTIONS

A. Refer to Division 0 and Division 1 for related contractual requirements.

B. Refer to Section 23 00 00 for General Mechanical Provisions.

C. Refer to Section 26 00 00 for General Electrical Provisions.

PART 2 – PRODUCTS

2.1 ADVANCED WORKSTATION (AWS)

A. General structure of workstation interaction shall be a standard client/server relationship with web server embedded in the server for browser only access. Server shall be used to archive data and store system database. The AWS shall support operation in a virtualized server environment. Thick and web clients shall access server for all archived data.

1. A single server license shall:
   a. Allow a minimum of 50 thick client seats/installations.
   b. Allow a minimum of 200 web client users.
   c. Not restrict system size based on point count (BACnet or Integration).

B. Data Displays

1. Data displays shall render all data associated with project as called out on drawings and/or object type list supplied. Graphic files shall be created using digital, full color photographs of system installation, AutoCAD or Visio drawing files of field installation drawings, and wiring diagrams from as-built drawings.

2. Data displays shall render all data using iconic graphic representations of all mechanical equipment. System shall be capable of displaying graphic file, text, trendlog, and dynamic object data together on each display and shall include animation. Information shall be labeled with descriptors and shall be shown with the appropriate engineering units. All information on any display shall be dynamically updated without any action by the user.
3. Data display frame shall allow user to change all field-resident AWS functions associated with the project, such as setpoints, weekly schedules, exception schedules, etc., from any screen, no matter if that screen shows all text or a complete graphic display. This shall be done without any reference to object addresses or other numeric/mnemonic indications.

4. Analog objects shall be displayed with operator modifiable units. Analog input objects may also be displayed as individual graphic items on the display screen as an overlay to the system graphic.

5. All displays and programming shall be generated and customized by the local use energy management and control system (EMCS) supplier and installer. Systems requiring factory development of graphics or programming of DDC logic are specifically prohibited.

6. AWS shall be supplied with a library of standard graphics, which may be used unaltered or modified by the operator. AWS shall include a library of equipment graphic components to assemble custom graphics. Systems that do not allow customization or creation of new graphic objects by the operator (or with third-party software) shall not be allowed.

7. A navigation tree for building, equipment and system diagnostic centric display organization shall be available from data display view. The tree navigation contents shall be customizable on a per-user and per-group basis.

8. Each display may be protected from viewing unless operator credentials have the appropriate access level. An access level may be assigned to each display and system object. The menu label shall not appear on the graphic if the operator does not have the appropriate security level.

9. Data displays shall have the ability to link to content outside of the EMCS system. Such content shall include, but is not limited to launching external files in their native applications (for example, a Microsoft Word document).

10. A single system software license can support a minimum of 200 user accounts and web access.

11. Data displays shall support:
   a. Graphic items with custom geometry that offer both color gradient shading and variable opacity in scale to system variables and range setpoints.
   b. Clear and custom geometry navigation buttons to provide intuitive navigation to system display or external URLs.
   c. Graphic files in JPG, PNG, and GIF file types.
   d. Viewing of 1,024 system data points in a single screen.
   e. Customizable mouse-over information of graphic items.
   f. Right click capability to directly access system functionality, such as Schedule, Trendlogs, and Alarms associated with a display object selected.

C. Password Protection

1. Provide security system that prevents unauthorized use unless operator is logged on. Access shall be limited to operator’s assigned functions when user is logged on. This includes displays as outlined above.

2. AWS shall provide security for a minimum of 200 users. Each user shall have an individual User ID, User Name, and Password. Entries are alphanumeric characters only and are case sensitive (except for User ID). User ID, User Name, and Password shall be stored in an encrypted form.

3. Each user shall be allowed individual assignment of only those control functions, menu items, navigation tree, and user-specific system start display, as well as restricted access to discrete BACnet devices to which that user requires access.
COUNTY FAIRGROUNDS BUILDING
CACHE COUNTY

4. All passwords, user names, and access assignments shall be adjustable via Server and Thick client. Password shall be adjustable via the web client.

5. Users shall also have a set access level, which defines access to displays and individual objects the user may control. System shall include 10 separate and distinct access levels for assignment to users.

6. The AWS and Thick Client shall include an Auto Logout feature that shall automatically logout user when there has been no keyboard or mouse activity for a set period of time. Time period shall be adjustable by system administrator. Auto Logout may be enabled and disabled by system administrator. Operator terminal shall display message on screen that user is logged out after Auto Logout occurs.

7. The system shall permit the assignment of an effective date range, as well as an effective time of day, that the User IDs are permitted to authenticate.

D. Operator Activity Log

1. An Operator Activity Log that tracks all operator changes and activities shall be included with AWS. System shall track what is changed in the system, who performed this change, date and time of system activity, and value of the change before and after operator activity. Operator shall be able to display all activity, sort the changes by user and also by operation. Operator shall be able to print the Operator Activity Log display.

2. Log shall be gathered and archived to a hard drive on AWS as needed. Operator shall be able to export data for display and sorting in a spreadsheet.

3. System shall have the option to require user comment recording in the Operator Activity Log upon any system point change.

4. Operator Activity log shall be accessible via the Web Client for viewing, sorting, filtering, and Printing.

E. Scheduling

1. AWS, Thick Client and Web Client shall show all information in easy-to-read daily format including calendar of this month and next. All schedules shall show actual ON/OFF times for day based on scheduling priority. Priority for scheduling shall be events, holidays and daily, with events being the highest.

2. Holiday and special event schedules shall display data in calendar format. Operator shall be able to schedule holidays and special events directly from these calendars.

3. Operator shall be able to change all information for a given weekly or exception schedule if logged on with the appropriate access privileges.

4. AWS and Thick Client shall include a Schedule Wizard for set up of schedules. Wizard shall walk user through all steps necessary for schedule generation. Wizard shall have its own pull-down selection for startup or may be started by right-clicking on value displayed on graphic and then selecting Schedule.

5. Scheduling shall include optimum start based on outside air temperature, current heating/cooling setpoints, indoor temperature and history of previous starts. Each and every individual zone shall have optimum start time independently calculated based on all parameters listed. User shall input schedules to set time that occupied setpoint is to be attained. Optimum start feature shall calculate the startup time needed to match zone temperature to setpoint. User shall be able to set a limit for the maximum startup time allowed.

6. Schedule list shall show all schedules currently defined. This list shall include all standard, holiday and event schedules. In addition, user shall be able to select a list that shows all scheduled points and zones.
COUNTY FAIRGROUNDS BUILDING
CACHE COUNTY

7. Display of all three schedules must show all ON times for standard, holiday and event schedules in different colors on a given day. In addition, OFF times for each must also be shown in additional colors. User shall be able to select from standard calendar what days are to be scheduled and same display shall show all points and zones affected. User shall be able to set time for one day and select all days of the week that shall be affected as a recurrence of that same schedule for that given day.

8. Any displayed data that is changeable by the operator may be selected using the right mouse button and the schedule shall then be selectable on the screen. Selection of the schedule using this method shall allow the viewing of the assigned schedule allow the point to be scheduled.

9. Schedule editor shall support drag-n-drop events and holidays onto the schedule calendar.

10. Schedule editor shall support drag-n-drop events default to a two-hour period, which can then be adjusted by the user.

11. Schedule editor shall support drag-n-drop holidays default for OFF all day and can be edited for multiple-day holidays.

12. Schedule editor shall support the view of affected zones when adding or editing timed events of a schedule.

13. The web client shall have the ability to search a list of all scheduled points and zones to access the schedule calendar.

14. Schedule time blocks shall present schedule detail via mouse-over information.

F. Alarm Indication and Handling

1. AWS shall provide visual, printed, and email means of alarm indication. Printout of alarms shall be sent to the assigned terminal and port. Alarm notification can be filtered based on the User ID’s authorization level.

2. Web client shall display a persistent alarm state for the system regardless of the data view including points in alarm but not acknowledged, and points that have gone into alarm and returned to normal without being acknowledged.

3. Alarm History shall provide log of alarm messages. Alarm log shall be archived to the hard disk of the AWS. Each entry shall include a description of the event-initiating object generating the alarm. Description shall be an alarm message of at least 256 characters in length. Entry shall include time and date of alarm occurrence, time and date of object state return to normal, time and date of alarm acknowledgment, and identification of operator acknowledging alarm.

4. Alarm messages shall be in user-definable text (English or other specified language) and shall be delivered either to the operator’s terminal, client or through remote communication using email (Authenticated SMTP supported).

5. AWS, Thick Client, and Web Client shall allow for set up of alarms. UI shall walk user through all steps necessary for alarm generation. Alarm creation may be started by right-clicking on value displayed on graphic and then selecting Alarm setup.

6. Web client shall support color-coded indication of current alarms as follows:
   a. Red indicator shows number of active alarms that have not been acknowledged.
   b. Yellow indicator shows number of alarms that are still active but have been acknowledged.
   c. Blue indicator shows number of alarms that have returned to normal but have not been acknowledged.
   d. Color-coded indicators, when selected by the user, navigate to a pre-filtered view of alarm history.
   e. Alarm history can be filtered by color-coded indicator states.

7. Alarm annunciation includes navigation link to a user-selected display or URL.
8. Any displayed data that is changeable by the operator may be selected using the right mouse button and the alarm shall then be selectable on the screen. Selection of the alarm using this method shall allow the viewing of the alarm history or allow the creation of a new alarm.

G. Trendlog Information

1. AWS shall periodically gather historically recorded data stored in the building controllers and store the information in the system database. Stored records shall be appended with new sample data, allowing records to be accumulated. Systems that write over stored records shall not be allowed unless limited file size is specified. System database shall be capable of storing up to 50 million records before needing to archive data. Samples may be viewed at the web client. All trendlog records shall be displayed in standard engineering units.

2. AWS shall be capable of trending on an interval determined by a polling rate, or change-of-value.

3. AWS, Thick client, or Web Client shall be able to add and edit trendlogs and the setup information. This includes the information to be logged as well as the interval at which it is to be logged. All operations shall be password protected. Viewing may be accessed directly from any and all graphics on which a trended object is displayed.

4. AWS and Thick Client shall include a Trendlog Wizard for setup of multiple trend logs simultaneously. Wizard shall walk user through all necessary steps. Wizard shall have its own pull-down selection for startup, or may be started by right-clicking on value displayed on graphic, and then selecting Trendlogs from the displayed menu.

5. AWS shall be capable of using Microsoft SQL as the system database.

6. Any displayed data that is changeable by the operator may be selected using the right mouse button and the trendlog shall then be selectable from a menu on the screen. Selection of the trendlog using this method shall allow the viewing of the trendlog data in the DataViewer.

7. DataView shall provide:
   a. Software that is capable of graphing the trend-logged object data shall be included.
   b. Access and ability to create, edit and view are restricted to users by user account credentials.
   c. Specific and repeatable URL defines the trendlog(s) views for browser bookmarking and email compatibility.
   d. Call out of trendlog value at intersection of trend line and mouse-over vertical axis.
   e. Trendlog or Energy log and companion logs can be configured to display on one of two independent vertical scales embedded in the display.
   f. Click zoom for control of data set viewed along either graph axis.
   g. User-specifiable start and end dates as well as a fast scroll features that supports click zoom of macro scale view of the data for quickly finding data set based on visual signature.
   h. User export of the viewed data set to MS Excel.
   i. Web browser-based help.
   j. Optional min/max ranges (Upper Control Limits, Lower Control Limits) for each value.
H. Energy Log Information

1. AWS shall be capable of periodically gathering energy log data stored in the field equipment and archive the information. Archive files shall be appended with new data, allowing data to be accumulated. Systems that write over archived data shall not be allowed unless limited file size is specified. Display all energy log information in standard engineering units.

2. All data shall be stored in database file format for direct use by third-party programs. Operation of system shall stay completely online during all graphing operations.

3. AWS operator shall be able to change the energy log setup information as well. This includes the meters to be logged, meter pulse value, and the type of energy units to be logged. All meters monitored by the system may be logged. System shall support using flow and temperature sensors for BTU monitoring.

4. AWS shall display data in tabular format form for both consumption and peak values. Data shall be shown in hourly, daily, weekly, monthly and yearly formats. In each format, the user shall be able to select a specific period of data to view.

5. Web client shall display data in tabular format and graphical format. Data shall be shown in hourly, daily, weekly, monthly and yearly formats. In each format, the user shall be able to select a specific period of data to view.

I. Demand Limiting

1. AWS shall include demand limiting program that includes two types of load shedding. One type of load shedding shall shed/restore equipment in binary fashion based on energy usage when compared to shed and restore settings. The other type of shedding shall adjust operator-selected control setpoints in an analog fashion based on energy usage when compared to shed and restore settings. Shedding may be implemented independently on each and every zone or piece of equipment connected to system.

2. Binary shedding shall include minimum of five (5) priority levels of equipment shedding. All loads in a given priority level shall be shed before any loads in a higher priority level are shed. Load shedding within a given priority level shall include two methods. In one, the loads shall be shed/restored in a “first off-first on” mode, and in the other the loads are just shed/restored in a “first off-last on” (linear) fashion.

3. Analog shed program shall generate a ramp that is independently used by each individual zone or individual control algorithm to raise the appropriate cooling setting and lower appropriate heating setting to reduce energy usage.

4. AWS shall be able to display the status of each and every load shed program. Status of each load assigned to an individual shed program shall be displayed along with English description of each load.

J. Tenant Activity

1. AWS shall include program that monitors after-hours overrides by tenants, logs that data, and generates a bill based on usage and rate charged for each tenant space. Tenant Activity program shall be able to assign multiple zones, from a list of every zone connected to system, to a particular tenant. Every zone is monitored for after-hours override usage and that data logged in AWS. Operator may then generate a bill based on the usage for each tenant and the rate charged for any overtime use.

2. Configuration shall include entry of the following information for use in logging and billing:
   a. Tenant’s contact name and address
b. One or multiple tenant zones that make up a total tenant space, including a separate billing rate for each separate zone

c. Minimum and maximum values an event duration and event limit

d. Property management information

e. Overall billing rate

f. Seasonal adjustments or surcharge to billing rate

g. Billing notification type including, but not limited to printer, file and email

h. Billing form template

3. Logging shall include recording the following information for each and every tenant event:
   a. Zone description
   b. Time the event begins
   c. Total override time
   d. Limits shall be applied to override time

4. A tenant bill shall be generated for a specific period using all the entered configuration data and the logged data. User with appropriate security level shall be able to view and override billing information. User shall be able to select a billing period to view and be able to delete events from billing and edit a selected tenant activity event’s override time.

K. Reports

1. AWS shall be capable of periodically producing reports of trendlogs, alarm history, tenant activities, device summary, energy logs, and override points. The frequency, content, and delivery are to be user adjustable.

2. All reports shall be capable of being delivered in multiple formats including text- and comma-separated value (CSV) files. The files can be printed, emailed, or saved to a folder, either on the server hard drive or on any network drive location.

L. Configuration/Setup

1. Provide means for operator to display and change system configuration. This shall include, but not be limited to system time, day of the week, date of daylight savings set forward/set back, printer termination, port addresses, modem port and speed, etc. Items shall be modified using understandable terminology with simple mouse/cursor key movements.

M. Field Engineering Tools

1. AWS shall include field engineering tools for programming all controllers supplied. All controllers shall be programmed using graphical tools that allow the user to connect function blocks on screen that provide sequencing of all control logic. Function blocks shall be represented by graphical displays that are easily identified and distinct from other types of blocks. Graphical programming that uses simple rectangles and squares is not acceptable.

2. User shall be able to select a graphical function block from menu and place on screen. Provide zoom in and zoom out capabilities. Function blocks shall be downloaded to controller without any reentry of data.
3. Programming tools shall include a real-time operation mode. Function blocks shall
display real-time data and be animated to show status of data inputs and outputs when in
real-time operation. Animation shall show change of status on logic devices and
countdown of timer devices in graphical format.
4. Field engineering tools shall also include a database manager of applications that include
logic files for controllers and associated graphics. Operator shall be able to select unit
type, input/output configuration and other items that define unit to be controlled. Supply
minimum of 250 applications as part of workstation software.
5. Field engineering tool shall include Device Manager for detection of devices connected
anywhere on the BACnet network by scanning the entire network. This function shall
display device instance, network identification, model number, and description of
connected devices. It shall record and display software file loaded into each controller. A
copy of each file shall be stored on the computer’s hard drive. If needed, this file shall be
downloaded to the appropriate controller using the mouse.
6. AWS shall automatically notify the user when a device that is not in the database is added
to the network.
7. AWS shall include backup/restore function that will back up entire system to selected
medium and then restore system from that medium. The system shall be capable of
creating a backup for the purpose of instantiating a new client PC.
8. The system shall provide a means to scan, detect, interrogate, and edit third-party BACnet
devices and BACnet objects within those devices.

N. Workstation Hardware
   1. Provide operator’s workstation(s) at location(s) noted on the plans.
   2. AWS Server Minimum Requirements
      a. 64-bit OS
      c. 2 GHz (or better), dual-core or quad-core processors
      d. 4 GB RAM or higher
      e. 3 GB of hard drive space required for base installation without application data
      f. Network interface card (10/100/1000 Mbps)

O. Software
   1. At the conclusion of the project, contractor shall leave with owner a electronic copy that
      includes the complete software operation system and project graphics, setpoints, system
      parameters, etc. This backup shall allow the owner to completely restore the system in the
      case of a computer malfunction.

P. Web Client
   1. EMCS supplier shall provide an HTML5-based browser access to the AWS as part of
      standard installation. User must be able to access all displays of real-time data that are
      part of the AWS using a standard web browser. Web browser shall tie into the network
      through owner-supplied Ethernet network connection. The web client shall support a
      minimum of 200 users with a single license.
   2. Browser shall be standard version of Microsoft Internet Explorer v10.0 or later, Firefox
      v19.0 or later, Chrome v24.0 or later, and Safari v7.1.1 or later. No special vendor-
supplied software shall be needed on computers running browser. Data shall be displayed
      in real-time and update automatically without user interaction.
3. Web pages shall be automatically generated using HTML5 from the data display files that reside on the AWS. Any system that requires use of an HTML editor for generation of web pages shall not be considered.

4. Access through web client or thick client shall utilize the same hierarchical security scheme as the AWS. User shall be asked to log on once the client makes connection to the AWS. Once the user logs on, any and all changes that are made shall be tracked by the AWS. The user shall be able to change only those items he or she has authority to change. A user activity report shall show any and all activity of the users who have logged on to the system, regardless of whether those changes were made using a web client, thick client or through the AWS.

5. Shall provide User Session Management including the ability to view all connected user sessions to the web client, see how long they have been active/inactive for each unique session, and force log-out for any or all sessions.

6. Shall provide menu-style navigation access to primary features, i.e. alarm history, DataViewer, Search scheduled points and Zones, System Activity, User Session Management, and Top Display

7. Web client shall, at a minimum, support the following tablets:
   a. Android platform:
      1) Google Nexus
      2) Samsung Galaxy Note
   b. Apple platform
      1) Ipad
      2) Apple Ipad Mini

2.2 BUILDING CONTROLLER

A. General Requirements

1. BACnet Conformance
   a. Building Controller shall be approved by the BTL as meeting the BACnet Building Controller requirements.
   b. Please refer to section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

2. Building controller shall be of scalable design such that the number of trunks and protocols may be selected to fit the specific requirements of a given project.

3. The controller shall be capable of panel-mounted on DIN rail and/or mounting screws.

4. The controller shall be capable of providing global control strategies for the system based on information from any objects in the system, regardless if the object is directly monitored by the building controller module or by another controller.

5. The controller shall be capable of running up to six (6) independent control strategies simultaneously. The modification of one control strategy does not interrupt the function or runtime others.

6. The software program implementing the DDC strategies shall be completely flexible and user-definable. All software tools necessary for programming shall be provided as part of project software. Any systems utilizing factory pre-programmed global strategies that cannot be modified by field personnel on-site, using a wide area network (WAN) or downloaded through remote communications are not acceptable. Changing global strategies using firmware changes is also unacceptable.
7. Programming shall be object-oriented using control function blocks and support DDC functions. All flowcharts shall be generated and automatically downloaded to controller. Programming tool shall be supplied and be resident on workstation. The same tool shall be used for all controllers.

8. The programming tool shall provide means to graphically view inputs and outputs to each program block in real-time as program is executing. This function may be performed using the operator’s workstation or field computer.

9. Controller shall have 6,000 Analog Values and 6,000 Binary Values.

10. Controller IP configuration can be done via a direct USB connect with an operator’s workstation or field computer.

11. Controller shall have at a minimum a Quad Core 996Ghz processor to ensure fast processing speeds.

12. Global control algorithms and automated control functions shall execute using a 64-bit processor.

13. Controller shall have a minimum of 1 GB of DDR3 SDRAM on a 533Mhz bus to ensure high speed data recording, large data storage capacity and reliability.

14. Controller shall support two (2) on-board EIA-485 ports capable of supporting various EIA-485 protocols including, but not limited to BACnet MS/TP and Modbus.
   a. Ports are capable of supporting various EIA-485 protocols including, but not limited to BACnet MS/TP and Modbus.

15. Controller shall support two (2) ports—each of gigabit speed—Ethernet (10/100/1000) ports.
   a. Ports are capable of supporting various Ethernet protocols including, but not limited to BACnet IP, FOX, and Modbus.

16. All ports shall be capable of having protocol(s) assigned to utilize the port’s physical connection.

17. The controller shall have at a minimum four (4) onboard inputs, two (2) universal inputs and two (2) binary inputs.

18. Schedules
   a. Building controller modules shall provide normal seven-day scheduling, holiday scheduling and event scheduling.
   b. Each building controller shall support a minimum of 380 BACnet Schedule Objects and 380 BACnet Calendar Objects.

19. Logging Capabilities
   a. Each building controller shall log as minimum 2,000 objects at 15-minute intervals. Any object in the system (real or calculated) may be logged. Sample time interval shall be adjustable at the operator’s workstation.
   b. Logs may be viewed both on-site or off-site using WAN or remote communication.
   c. Building controller shall periodically upload trended data to networked operator’s workstation for long-term archiving if desired.
   d. Archived data stored in database format shall be available for use in third-party spreadsheet or database programs.

20. Alarm Generation
   a. Alarms may be generated within the system for any object change of value or state (either real or calculated). This includes things such as analog object value changes, binary object state changes, and various controller communication failures.
   b. Each alarm may be dialed out as noted elsewhere.
c. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator’s terminal or off-site using remote communications.

d. Controller must be able to handle up to 2,000 alarm setups stored as BACnet event enrollment objects, with system destination and actions individually configurable.

21. Demand Limiting

a. Demand limiting of energy shall be a built-in, user-configurable function. Each controller module shall support shedding of up to 1,200 loads using a minimum of two types of shed programs.

b. Load shedding programs in building controller modules shall operate as defined in section 2.1.J of this specification.

22. Tenant Activity Logging

a. Tenant Activity logging shall be supported by a building controller module. Each independent module shall support a minimum of 380 zones.

b. Tenant Activity logging shall function as defined in section 2.1.K of this specification.

B. BACnet MS/TP

1. BACnet MS/TP LAN must be software-configurable from 9.6 to 115.4Kbps

a. Each BACnet MS/TP LAN shall support 64 BACnet devices at a minimum.

b. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

C. BACnet IP

1. The building controller shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP internetwork, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the local area network (LAN).

2. Must support interoperability on WANs and campus area networks (CANs), and function as a BACnet Broadcast Management Device (BBMD).

3. Each controller shall support at a minimum 128 BBMD entries.

4. BBMD management architecture shall support 3,000 subnets at a minimum.

5. Shall support BACnet Network Address Translation.

6. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

D. Expansion Ports

1. Controller shall support two (2) expansion ports.

a. Combining the two on-board EIA-458 ports with fully loaded expansion ports, the controller shall support six (6) EIA-485 trunks simultaneously.

2. Expansion cards that mate to the expansion ports shall include:

a. Dual port EIA-485 card.

b. LON network card.
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CACHE COUNTY

E. Niagara Framework

1. Controller shall utilize the Tridium Niagara Framework.  
   a. Niagara Framework shall be version 3.8 or newer.  
   b. All Niagara licensing shall be stored on a removable MicroSD card for fast in-field 
      replacement of controller.

2. The Niagara License for the controllers shall be an open license.  
   a. The controller shall be programmable via Niagara Workplace programming tool.  
   b. The controller shall be programmable via an Niagara embedded Workplace 
      programming tool.

F. Power Supply

1. Input for power shall accept between 17 and 30VAC, 47 and 63Hz.
2. Optional rechargeable battery for shutdown of controller including storage of all data in 
   flash memory.
3. On-board capacitor will ensure continuous operation of real-time clocks for minimum of 
   14 days.

G. Controller shall be in compliance with the following:

1. UL 916 for open energy management
2. FCC Class B
3. ROHS
4. IEC 60703
5. C-Tick Listed

H. Controller shall operate in the following environmental conditions:

1. -4 to 149 °F (-20 to 65 °C) without optional battery, or 32 to 122 °F (0 to 50 °C) with 
   optional battery.
2. 0 to 95% relative humidity (RH), non-condensing.

2.3 CENTRAL PLANT AND AIR HANDLER APPLICATION CONTROLLERS

A. Provide one or more native BACnet application controllers for each air handler and provide 
   native BACnet application controllers as needed for central plant control that adequately 
   cover all objects listed in object list. All controllers shall interface to building controller through 
   either MS/TP LAN using BACnet protocol, or Ethernet LAN using BACnet over Ethernet or BACnet 
   TCP/IP. No gateways shall be used. Controllers shall include input, output and self- contained 
   logic program as needed for complete control of units. Controllers shall be fully programmable 
   using graphical programming blocks. Programming tool shall be resident on operator 
   workstation and be the same tool as used for the building controller. No auxiliary or non- 
   BACnet controllers shall be used.

B. BACnet Conformance

1. Application controllers shall be approved by the BTL as meeting the BACnet Advanced 
   Application Controller requirements.
2. Please refer to section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

3. Standard BACnet object types supported shall include, as a minimum, Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Multi-state Values, Device, File, and Program object types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

C. Application controllers shall include universal inputs with 12-bit resolution that accept 3K and 10K thermistors, 0–10VDC, Platinum 1000 ohm RTD, 0–5VDC, 4–20mA and dry contact signals. Any input on a controller may be either analog or digital with a minimum of three inputs that accept pulses. Controller shall also include support and modifiable programming for interface to intelligent room sensor with digital display. Controller shall include binary and analog outputs on board. Analog outputs with 12-bit resolution shall support either 0–10VDC or 0–20mA. Binary outputs shall have LED indication of status. Software shall include scaling features for analog outputs. Application controller shall include 20VDC voltage supply for use as power supply to external sensors.

1. All outputs must have onboard Hand-Off-Auto (HOA) switches and a status indicator light. HOA switch position shall be monitored. Each analog output shall include a potentiometer for manually adjusting the output when the HOA switch is in the Hand position.

2. The position of each and every HOA switch shall be available system wide as a BACnet object property.

D. All program sequences shall be stored on board application controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller up to 20 times per second (minimum of 10 times per second) and capable of multiple PID loops for control of multiple devices. All calculations shall be completed using floating-point math and system shall support display of all information in floating-point nomenclature at operator’s terminal.

1. The following control blocks shall be supported:
   a. Natural Log
   b. Exponential
   c. Log base 10
   d. X to the power of Y
   e. Nth square root of X
   f. 5th Order Polynomial Equations
   g. Astronomical Clock (sunrise/sunset calculation)
   h. Time based schedules

E. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely using modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using programming tools as described in operator’s terminal section.
F. Application controller shall include support for intelligent room sensor (see Section 2.10.B.) Display on intelligent room sensor shall be programmable at application controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode, based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.

G. Schedules

1. The controller shall support a minimum of 3 BACnet Schedule Objects and have a real time clock on board with battery backup to maintain time through a power loss.

H. Logging Capabilities

1. Controller shall support a minimum of 50 trendlogs. Any object in the controller (real or calculated) may be logged. Sample time interval shall be adjustable at the operator’s workstation.
2. Controller shall periodically upload trended data to system server for long-term archiving if desired. Archived data stored in (MS Jet Database or SQL) database form and shall be available for use in third-party spreadsheet or database programs.

I. Alarm Generation

1. Alarms may be generated within the controller for any object change of value or state (either real or calculated). This includes things such as analog object value changes, and binary object state changes.
2. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator’s terminal or off-site using remote communications.
3. Controller must be able to handle up to 25 alarm setups stored as BACnet event enrollment objects, with system destination and actions individually configurable.

J. The controller processor shall be a 32-bit processor.

K. The packaging of the controller shall provide operable doors to cover the terminals once installation is complete. The housing of the controller shall provide for DIN rail mounting and also fully enclose circuit board.

2.5 TERMINAL UNIT APPLICATION CONTROLLERS (FURNACE SYSTEM, CABINET HEATER)

A. Provide one native BACnet application controller for each piece of unitary mechanical equipment that adequately covers all objects listed in object list for unit. All controllers shall interface to building controller through MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of unit.
B. BACnet Conformance

1. Application controllers shall, as a minimum, support MS/TP BACnet LAN types. They shall communicate directly using this BACnet LAN at 9.6, 19.2, 38.4 and 76.8 Kbps, as a native BACnet device. Application controllers shall be approved by the BTL as meeting the BACnet Application Specific Controller requirements and support all BACnet services necessary to provide the following BACnet functional groups:
   a. Files Functional Group
   b. Reinitialize Functional Group
   c. Device Communications Functional Group

2. Please refer to Section 22.2, BACnet Functional Groups in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

3. Standard BACnet object types supported shall include, as a minimum, Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File, and Program Object Types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

C. Application controllers shall include universal inputs with 10-bit resolution that can accept 3K and 10K thermistors, 0–5VDC, 4–20mA, dry contact signals and a minimum of 3 pulse inputs. Any input on controller may be either analog or digital. Controller shall also include support and modifiable programming for interface to intelligent room sensor. Controller shall include binary outputs on board with analog outputs as needed.

D. All program sequences shall be stored on board controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller 10 times per second and shall be capable of multiple PID loops for control of multiple devices. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely through modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using same programming tools as building controller and as described in operator workstation section. All programming tools shall be provided and installed as part of system.

E. Application controller shall include support for intelligent room sensor (see Section 2.10.B.) Display on room sensor shall be programmable at controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.

2.6 WIRELESS MS/TP TRANSCEIVER

A. BACnet Conformance

1. Wireless MS/TP Transceiver shall meet BACnet Addendum q of ANSI/ASHRAE 135-2008 requirements.

2. Support multiple BACnet Application Specific Controllers (B-ASC) to a Transceiver MS/TP trunk.
COUNTY FAIRGROUNDS BUILDING
CACHE COUNTY

3. Support multi-transceiver mesh wireless network topology
4. Wireless MS/TP Transceiver shall, at a minimum, support MS/TP BACnet LAN types. They shall communicate directly through this BACnet LAN at 9.6, 19.2, 38.4 and 76.8 Kbps, as a B-ASC BACnet device.
5. Standard BACnet object types supported shall include, as a minimum, Analog Value, Binary Value, Device, File, and Program Object Types.
6. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

B. Wireless MS/TP Transceiver hardware shall:

1. Include a 32 Bit processor
2. Include two selectable internal antennae with perpendicular orientation
3. Support external antenna using industry standard SMA connector type
4. Support connection to 2.4 GHz (IEEE Std 802.15.4-2003 compliant) Wireless Wall Sensors (Battery powered).
5. Meet the requirements of Listed Underwriters Laboratory for Open Energy Management Equipment (PAZX) under the UL Standard for Safety 916.
6. Meet the requirements of EMC Directive (European CE Mark) EN 60950.
7. Meet the requirements for FCC Part 15, Class B.
9. Be powered by 24VAC power.

C. Wireless MS/TP Transceiver firmware shall:

1. All configuration and point data shall be stored on board transceiver in Flash Memory.
2. No batteries shall be needed to retain configuration data.
3. Configuration of Wireless MS/TP Transceiver shall be completely modifiable in the field over installed BACnet LANs or remotely using modem interface.
4. Wireless MS/TP communication shall be encrypted to 128 bit AES encryption standard.

D. Wireless wall sensors shall be supported by the Wireless MS/TP Transceiver

1. Support up to Fifty (50) wireless wall sensors simultaneously.
2. Wireless wall sensors shall operate in the 2.4 GHz (IEEE Std 802.15.4-2003 compliant) radio frequency
3. Support temperature, temperature and humidity, and temperature, setpoint and after-hours override wireless wall sensor types.
4. Wireless communication shall be encrypted to 128 bit AES encryption standard

E. Wireless Wall Sensor

1. Wireless wall sensor shall use solid-state sensor(s) and shall be packaged in aesthetically pleasing enclosure.
2. Sensor shall provide override function, warmer/cooler dial for set point adjustment. Override time shall be stored in controller and be adjustable on a zone-by-zone basis. Adjustment range for warmer/cooler lever shall also be stored in EEPROM on controller.
3. There shall be a mechanical means the lock the wall sensor to the base to prevent theft and vandalism.
4. The wireless range in open air shall meet or exceed 300 ft. The strength of the wireless signal must be indicated at the wireless sensor to aid in placement and trouble shooting.
5. The receiver shall have a wireless communications received light that indicates the proper communication is occurring.
6. The wireless wall sensor and receiver must be paired in an addressable mean to facilitate easy replacement and reassignment.
7. Temperature shall be accurate to +/- 0.5 degree Celsius from 12–30 degrees Celsius.
8. Humidity sensor shall be accurate to +/-3% RH from 11–89% RH.
9. Shall run on two AA Lithium batteries; providing a minimum battery life of 5 years. Low battery power shall be indicated on the unit via an LED and also readable as a BACnet Object.
10. Shall use 2.4 GHz radio frequency (IEEE Std 802.15.4-2003 compliant)
11. Wireless communication shall be encrypted to 128 bit AES encryption standard.

2.7 TOUCH SCREEN COMMUNICATING THERMOSTAT

A. BACnet Conformance

1. Touch screen communicating thermostats shall be approved by the BTL as meeting the BACnet Application Specific Controller requirements.
2. Touch screen Communicating Thermostats shall, at a minimum, support MS/TP BACnet LAN types. They shall communicate directly through this BACnet LAN at 9.6, 19.2, 38.4 and 76.8 Kbps, as a native BACnet device.
3. Standard BACnet object types supported shall include, as a minimum, Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File, and Program Object Types.
4. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

B. Touch screen Communicating Thermostat hardware shall:

1. Include a 32 Bit processor
2. Include a backlit touch screen for the user interface, buttons are not allowed.
3. Include Three (3) universal inputs with 12-bit resolution that can accept 3K and 10K Type II thermistors, 0-10VDC, 0–5 VDC, 4-20mA, and dry contact signals. Inputs on controller may be either analog or digital.
4. Include built-in temperature sensor.
5. Include built-in humidity sensor.
6. Include Six (6) relay outputs on board.
7. Include Two (2) analog outputs with 12-bit resolution. Each auto-detecting for 0-10 V or 4-20 mA control signals.
8. Meet the requirements of Listed Underwriters Laboratory for Open Energy Management Equipment (PAZX) under the UL Standard for Safety 916.
9. Meet the requirements of EMC Directive (European CE Mark) EN 60950.
10. Meet the requirements for FCC Part 15, Class B.
11. Be powered by 24VAC power.

C. Wireless sensors shall be supported by the Touch screen Communicating Thermostat

1. Support up to eight (8) magnetic contact switches with CR2032-battery powered wireless transmitter.
COUNTY FAIRGROUNDS BUILDING
CACHE COUNTY

2. Support up to three (3) passive infrared (PIR) motion detectors with 140-degree detection angle and AAA battery-powered wireless transmitter.
3. Meet the requirements for FCC Part 15, Class B.
4. Individual wireless sensor inputs can be used by fully programmable DDC to create custom sequence of operations in controller.
5. Sensors operate in the 433.92 MHz wireless frequency with 50-foot range.

2.8 AUXILIARY CONTROL DEVICES

A. Temperature Sensors

1. All temperature sensors to be solid-state electronic, interchangeable with housing appropriate for application. Wall sensors to be installed as indicated on drawings. Mount 48 inches above finished floor. Duct sensors to be installed such that the sensing element is in the main air stream. Immersion sensors to be installed in wells provided by control contractor, but installed by mechanical contractor. Immersion wells shall be filled with thermal compound before installation of immersion sensors. Outside air sensors shall be installed away from exhaust or relief vents, not in an outside air intake, and in a location that is in the shade most of the day.

B. Intelligent Room Sensor with Touchscreen

1. Hardware
   a. Room sensor shall include:
      1) Backlit touchscreen LCD digital display
      2) Temperature sensor
      3) Humidity sensor
      4) Programmable Status Light indicator
      5) CO2 sensor or BACnet MS/TP communication up to 115.2kbps
   b. Temperature sensor shall be a Uni-Curve Type II thermistor with an accuracy of +/- 0.36 °F (0.3 °C) at calibration point over the range of 32 to 158 °F or better.
   c. Humidity sensor shall have an accuracy of +/-3% from 10 to 90% relative humidity (RH) or better, non-condensing.
   d. The intelligent room sensor’s Status Light indicator shall have a minimum of four (4) colors (blue, red, amber and green) that will cast a glow onto the wall below the sensor to be used as visual indicator to the occupants of the condition of the system. The color and on/off state of the Status Light indicator shall be fully programmable.
   e. CO2 sensor shall have an accuracy of +/- 30 ppm over the range of 0–5000 ppm or better.
   f. CO2 sensor shall utilize Automatic Baseline Correction to maintain sensor calibration without the need for manual calibration.
   g. The user shall interact with the smart sensor using a touchscreen, with no buttons allowed.
   h. The intelligent room sensor shall have provisions for a tamper proof installation requiring tools to be removed from the wall.
   i. The touchscreen shall have a surface hardness of Mohs 7 or greater to prevent being easily scratched.
   j. Controller shall function as room control unit, and allow occupant to raise and lower setpoint, and activate terminal unit for override use—all within limits as programmed by building operator.
2. Display Content
   a. The intelligent room sensor shall simultaneously display room setpoint, room temperature, and outside temperature at each controller.
   b. The intelligent room sensor shall have the ability to add or remove from the display time-of-day, room humidity, and indoor air temperature to customize the view for the customer.
   c. The intelligent room sensor must have the capability to show temperatures in degrees Fahrenheit or degrees Celsius.
   d. A communication loss or improper communications wiring shall be displayed on the LCD screen to aid in trouble shooting.
   e. Information about the version of firmware shall be displayable on the LCD screen.
   f. A cleaning mode will be provided to allow for the touchscreen to be cleaned without inadvertently making changes to system parameters.
   g. The intelligent room sensor shall have the ability to display the status of a lighting zone and control the on/off state of the zone from the touchscreen using a tenant-accessible display page.
   h. The intelligent room sensor shall have the ability to display the status of a window zone (e.g., blinds) and control the on/off state of the zone from the touchscreen using a tenant-accessible display page.
   i. After Hours Override shall:
      1) Override time may be set and viewed in 30-minute increments.
      2) Override time countdown shall be automatic, but may be reset to zero by occupant from the sensor.
      3) Time remaining shall be displayed.
      4) Display shall show the word “OFF” in unoccupied mode unless a function button is pressed.

3. Other Modes
   a. The intelligent room sensor shall also allow service technician access to hidden functions for advanced system configuration. This functionality shall be accessed-protected with a configurable PIN number.
   b. Field Service Mode shall allow access to common parameters as dictated by the application’s sequence of operations. The parameters shall be viewed and set from the intelligent room sensor with no computer or other field service tool needed.
   c. If the intelligent room sensor is connected to VAV controller, Balance Mode shall allow a VAV box to be balanced and all air flow parameters viewed. The balancing parameters shall be viewed and set from the intelligent room sensor with no computer or other field service tool needed.

4. Intelligent Room Sensor shall be in compliance of the following:
   a. UL Standard for Safety 916
   b. FCC Part 15.107 & 109, Class B, CFR47-15
   c. EMC Directive 89/336/EEC (European CE Mark)

2.9 ELECTRONIC ACTUATORS AND VALVES (insert as required, sample requirements follow)

A. Quality Assurance for Actuators and Valves
   1. UL Listed Standard 873 and C.S.A. Class 4813 02 certified.
   2. NEMA 2 rated enclosures for inside mounting, provide with weather shield for outside mounting.
3. Five-year manufacturer’s warranty. Two-year unconditional and three-year product defect from date of installation.

B. Execution Details for Actuators and Valves

1. Furnish a Freeze-stat and install “Hard Wire” interlock to disconnect the mechanical spring return actuator power circuit for fail-safe operation. Use of the control signal to drive the actuators closed is not acceptable.
2. Each DDC analog output point shall have an actuator feedback signal, independent of control signal, wired and terminated in the control panel for true position information and troubleshooting. Or the actuator feedback signal may be wired to the DDC as an analog input for true actuator position status. Not required on all applications.
3. VAV box damper actuation shall be floating type or analog (2–10VDC, 4–20mA).
4. Booster-heat valve actuation shall be floating type or analog (2-10vdc, 4-20ma).
5. Primary valve control shall be analog (2–10VDC, 4–20mA).

C. Actuators for damper and control valves 0.5–6 inches shall be electric unless otherwise specified, provide actuators as follows:

1. UL Listed Standard 873 and Canadian Standards association Class 481302 shall certify actuators.
2. NEMA 2 rated actuator enclosures for inside mounting. Use additional weather shield to protect actuator when mounted outside.
3. Five-year manufacturer’s warranty. Two-year unconditional and Three year product defect from date of installation.
4. Mechanical spring shall be provided when specified. Capacitors or other non-mechanical forms of fail-safe are not acceptable.
5. Position indicator device shall be installed and made visible to the exposed side of the actuator. For damper short shaft mounting, a separate indicator shall be provided to the exposed side of the actuator.
6. Overload Protection: Actuators shall provide protection against actuator burnout by using an internal current limiting circuit or digital motor rotation sensing circuit. Circuit shall insure that actuators cannot burn out due to stalled damper or mechanical and electrical paralleling. End switches to deactivate the actuator at the end of rotation are acceptable only for butterfly valve actuators.
7. A Pushbutton gearbox release shall be provided for all non-spring actuators.
8. Modulating actuators shall be 24VAC and consume 10VA power or less.
9. Conduit connectors are required when specified and when code requires it.

D. Damper Actuators:

1. Outside air and exhaust air damper actuators shall be mechanical spring return. Capacitors or other non-mechanical forms of fail-safe are not acceptable. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the damper as required.
2. Economizer actuators shall utilize analog control 2–10VDC, floating control is not acceptable.
3. Electric damper actuators (including VAV box actuators) shall be direct shaft-mounted and use a V-bolt and toothed V-clamp causing a cold weld effect for positive gripping. Single bolt or set-screw type fasteners are not acceptable.
4. One electronic actuator shall be direct shaft-mounted per damper section. No connecting rods or jackshafts shall be needed. Small outside air and return air economizer dampers may be mechanically linked together if one actuator has sufficient torque to drive both and damper drive shafts are both horizontal installed.

5. Multi-section dampers with electric actuators shall be arranged so that each damper section operates individually. One electronic actuator shall be direct shaft-mounted per damper section. (See below execution section for more installation details.)

E. Control Dampers.

1. The sheet metal contractor shall furnish and size all automatic control dampers unless provided with packaged equipment. The sheet metal contractor shall install all dampers unless provided with packaged equipment.

2. All dampers used for modulating service shall be opposed blade type and arranged for normally open or normally closed operation as required. The damper is to be sized so that, when wide open, the pressure drop is a sufficient amount of its close-off pressure drop for effective throttling.

3. All dampers used for two-position or open-close control shall be parallel blade type arranged for normally open or closed operation as required.

4. Damper linkage hardware shall be constructed of aluminum or corrosion-resistant zinc and nickel-plated steel and furnished as follows:

5. Bearing support bracket and drive blade pin extension shall be provided for each damper section. Sheet metal contractor shall install bearing support bracket and drive blade pin extension. Sheet metal contractor shall provide permanent indication of blade position by scratching or marking the visible end of the drive blade pin extension.

6. Drive pin may be round only if V-bolt and toothed V-clamp is used to cause a cold weld effect for positive gripping. For single bolt or set-screw type actuator fasteners, round damper pin shafts must be milled with at least one side flat to avoid slippage.

7. Damper manufacturer shall supply alignment plates for all multi-section dampers.

2.10 ENCLOSURES

A. All controllers, power supplies and relays shall be mounted in enclosures.

B. Enclosures may be NEMA 1 when located in a clean, dry, indoor environment. Indoor enclosures shall be NEMA 12 when installed in other than a clean environment.

C. Enclosures shall have hinged, locking doors.

D. Provide laminated plastic nameplates for all enclosures in any mechanical room or electrical room. Include location and unit served on nameplate. Laminated plastic shall be 0.125 inches thick and appropriately sized to make label easy to read.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this Section may properly commence.

B. Notify the owner’s representative in writing of conditions detrimental to the proper and timely completion of the work.
C. Do not begin work until all unsatisfactory conditions are resolved.

3.2 INSTALLATION (GENERAL)

A. Install in accordance with manufacturer's instructions.

B. Provide all miscellaneous devices, hardware, software, interconnections, installation, and programming required to ensure a complete operating system in accordance with the sequences of operation and point schedules.

3.3 LOCATION AND INSTALLATION OF COMPONENTS

A. Locate and install components for easy accessibility; in general, mount 48 inches above floor with minimum 3 feet of clear access space in front of units. Obtain approval on locations from owner’s representative prior to installation.

B. All instruments, switches, transmitters, etc., shall be suitably wired and mounted to protect them from vibration, moisture, and high or low temperatures.

C. Identify all equipment and panels. Provide permanently mounted tags for all panels.

D. Provide stainless steel or brass thermowells suitable for respective application and for installation under other sections, and sized to suit pipe diameter without restricting flow.

3.4 INTERLOCKING AND CONTROL WIRING

A. Provide all interlock and control wiring. All wiring shall be installed neatly and professionally, in accordance with Specification Division 16 and all national, state and local electrical codes.

B. Provide wiring as required by functions as specified and as recommended by equipment manufacturers, to serve specified control functions. Provide shielded low capacitance wire for all communications trunks.

C. Control wiring shall not be installed in power circuit raceways. Magnetic starters and disconnect switches shall not be used as junction boxes. Provide auxiliary junction boxes as required. Coordinate location and arrangement of all control equipment with the owner's representative prior to rough-in.

D. Provide auxiliary pilot duty relays on motor starters as required for control function.

E. Provide power for all control components from nearest electrical control panel or as indicated on the electrical drawings; coordinate with electrical contractor.

F. All control wiring in the mechanical, electrical, telephone and boiler rooms to be installed in raceways. All other wiring to be installed neatly and inconspicuously per local code requirements. If local code allows, control wiring above accessible ceiling spaces may be run with plenum-rated cable (without conduit). Reference drawings for conduit responsibility for thermostat conduits and roof stubs.

3.5 DDC OBJECT TYPE SUMMARY

A. Provide all database generation.
B. Displays

1. System displays shall show all analog and binary object types within the system. They shall be logically laid out for easy use by the owner. Provide outside air temperature indication on all system displays associated with economizer cycles.

C. Run Time Totalization

1. At a minimum, run time totalization shall be incorporated for each monitored supply fan, return fan, exhaust fan, hot water and chilled water pumps. Warning limits for each point shall be entered for alarm and or maintenance purposes.

D. Trendlog

1. All binary and analog object types (including zones) shall have the capability to be automatically trended.

E. Alarm

1. All analog inputs (High/Low Limits) and selected binary input alarm points shall be prioritized and routed (locally or remotely) with alarm message per owner's requirements.

F. Database Save

1. Provide backup database for all standalone application controllers on disk.

3.6 FIELD SERVICES

A. Prepare and start logic control system under provisions of this section.

B. Start up and commission systems. Allow sufficient time for startup and commissioning prior to placing control systems in permanent operation.

C. Provide the capability for off-site monitoring at control contractor's local or main office. At a minimum, off-site facility shall be capable of system diagnostics and software download. Owner shall provide phone line for this service for one year or as specified.

D. Provide owner's representative with spare parts list. Identify equipment critical to maintaining the integrity of the operating system.

3.7 AS-BUILT DOCUMENTATION REQUIRED

A. When project is completed and operating, provide as-built drawings matching the final operating system.

3.8 TRAINING

A. Provide application engineer to instruct owner in operation of systems and equipment.

B. Provide system operator’s training to include (but not be limited to) such items as the following: modification of data displays, alarm and status descriptors, requesting data, execution of commands and request of logs. Provide this training to a minimum of three persons.
C. Provide on-site training above as required, up to 16 hours as part of this contract.

D. Provide tuition for at least one individual to attend for a one-week factory training class. If applicable, costs for travel, lodging and meals will be the responsibility of the owner.

3.9 DEMONSTRATION

A. Demonstrate complete operating system to owner's representative.

B. Provide certificate stating that control system has been tested and adjusted for proper operation.

END OF SECTION 15970
PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION (Air Handler, Gas Furnace and Cabinet Heater)

A. Performance Requirements.

1. Room wall sensor shall control occupied status of fan system based on heating, ventilating and cooling set points. Fan shall run continuously in occupied modes and cycle in “unoccupied” mode.
2. Room wall sensor shall cycle fan in Unoccupied heating mode.
3. Room wall sensor heating, ventilating and cooling set points shall control space temperature by activating heating/cooling and economizer damper equipment. Sensor and controls provide automatic change over between heating/cooling and ventilation.
4. Economizer shall open the fresh air damper to minimum position in occupied mode. On temperature rise, the economizer shall modulate the fresh damper open to maintain a mix air temperature of 45 to 60 degrees F. Above 65 degrees F, the economizer shall go to closed position.
5. The CO2 sensor in the return air shall modulate the fresh air and return air dampers to maintain the space CO2 level at 900ppm and below in occupied position the damper is. In unoccupied position the fresh air damper is closed and the return is open.
6. The building pressure sensor shall be set at .05” WC to stage the two (2) building relief fans on.
7. The cabinet heater shall modulate the stages ‘ON’ to maintain space set point. The BAS shall send a 4-20MA or 070VOC signal to stage the heater equipment.

B. The IT Rooms and Kitchen equipment spaces shall be monitored. The room space sensor shall alarm when the IT room is hot or the kitchen make-up air unit is supplying untampered (heating and cooling) air into the kitchen.

C. The two restroom fans shall be controlled ‘ON and OFF’ with the BMS, a motion sensor, and a fan status.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

(NOT USED)

END OF SECTION 15985
DIVISION 16 - ELECTRICAL
16001 Electrical General Provisions
   Substitutions and Substitute Equipment (16001-12)
16050 Basic Electrical Materials and Methods
16052 Existing Facilities and Equipment
16055 Electric Service Connection
16060 Grounding and Bonding
16072 Electrical Supports and Seismic Restraints
16075 Electrical Identification
16110 Conduit Raceways
16120 Conductors and Cables
16130 Boxes, Pull Boxes, and Conduit Bodies
16140 Wiring Devices
16145 Lighting Control Devices
16150 Electrical Wiring Connections
16215 Electrical Power Monitoring and Control
16289 Surge Protection Device
16410 Enclosed Switches and Circuit Breakers
16420 Enclosed Controllers and Starters
16430 Overcurrent Protective Devices
16441 Electrical Service and Distribution Switchboards
16442 Panelboards
16511 Interior Lighting
16521 Exterior Lighting
16700 Auxiliary Introduction (16700-800)
16714 Data System Conduit
16715 Data Equipment and Cabling System Expansion
16716 Telephone System (Conduit Only)
16717 Telephone Equipment and Cabling System
16721 Fire Alarm System
16722 Sound Re-Enforcing and Recording systems
16786 Television Surveillance System
SECTION 16001 - ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This is Division 16 of the project specifications; this coupled with the drawings are to be used in the construction of this project. Each section recorded hereafter makes reference to the electrical systems, equipment, materials, connections, etc., and apply to all the work making reference and/or titled Electrical and/or Electrical Contract Documents.

C. Architectural, Structural, Mechanical and other applicable and related documents are considered a part of the electrical documents insofar as they apply as if referred to in full.

1.2 SCOPE OF WORK

A. The scope of this project is to construct a complete electrical system for the Cache County Fairgrounds Building. Each area shall be developed electrically to give proper illumination, power utilization, auxiliary networks, etc. When the project is complete all systems integrate into a total electrical network making the building a usable facility.

B. The auxiliary systems: Intercommunication Tele/media System (includes intercom, telephone, class schedule, signal, etc.), Fire Alarm, Television, Sound System, Data, Security, etc., cover the entire indicated facility and must function as a unit to meet the needs of all occupants. Thence, the equipment supplier, the installer, and the constructor shall work toward that end. Anything short of this objective will not meet the intent of the project, i.e., each system shall be complete and effectively perform the function for which it was designed.

C. Extent of electrical work is indicated on drawings and/or specified in Division 16 sections of the specification. Provide all labor, materials, equipment, supervision and service necessary for a complete electrical system. Work includes, but is not necessarily limited to, the following items:

1. 16050 - Basic Electrical Materials and Methods
2. 16052 - Existing Facilities and Equipment
3. 16055 - Electric Service Connection
4. 16060 - Grounding and Bonding
5. 16072 - Electrical Supports and Seismic Restraints
6. 16075 - Electrical Identification
7. 16110 - Conduit Raceways
8. 16120 - Conductors and Cables
9. 16130 - Boxes, Pull Boxes, and Conduit Bodies
10. 16145 - Lighting Control Devices
11. 16150 - Electrical Wiring Connectors
12. 16215 - Electrical Power Monitoring
13. 16289 - Transient Voltage Suppression
COUNTY FAIRGROUNDS BUILDING
CACHE COUNTY

14. 16410 - Enclosed Switches and Circuit Breakers
15. 16420 - Enclosed Controllers and Starters
16. 16430 - Overcurrent Protective Devices
17. 16441 - Electrical Service and Distribution Switchboards
18. 16442 - Panelboards
19. 16511 - Interior Lighting
20. 16521 - Exterior Lighting
21. 16700-800 - Auxiliary Introduction
22. 16715 - Data Equipment and Cabling System
23. 16717 - Telephone Equipment and Cabling System
24. 16721 - Fire Alarm System
25. 16722 - Sound Re-Enforcing and Recording Systems
26. 16786 - Television Surveillance System

D. Use of standard industry symbols together with the special symbols, notes, and instructions indicated on the drawings describe the work, materials, apparatus and systems required as a portion of this work.

1.3 CONTRACT DOCUMENTS AND EXAMINATION OF THE SITE

A. Each bidder shall study the construction documents (plans and specifications), visit the site of the proposed work to fully acquaint himself with the conditions relating to the construction, so that he understands the difficulties, and restrictions attending the execution of the work to be placed under contract. From all of the above information, together with the cost of equipment, materials, labor, etc., the bidder shall then assemble and submit his cost to complete the project. The failure or omission of any bidder to receive or examine any contract documents, form, instrument, addendum or other document or to visit the site and acquaint himself with existing conditions shall in no way relieve any bidder from obligations with respect to his bid or to the contract. Written addendums (formally issued) become a part and parcel to the construction documents. The submission of a bid shall be taken as prima facie evidence of compliance with this section.

1.4 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

A. Any person contemplating submitting a bid shall familiarize himself with the drawings, specifications and project site. If for any reason, the bidder of the proposed contract, is in doubt as to the true meaning of any part of the drawings, specifications, or other contract documents, or finds discrepancies in, or omissions from, the drawings and specifications he shall submit a written request for an interpretation, correction and/or clarification to Architect/Engineer. The person submitting the request shall be responsible for its prompt delivery. Any interpretation or correction of the contract documents prior to bid shall be made only by addenda duly issued. An oral statement by anyone on any provision in the contract documents prior to the bidding is declared invalid.

B. After acceptance of the contract, the Contractor shall meet the intent, purpose and function of the contract documents and no changes shall be made to the contract documents, except it be in writing and/or a drawing, over the signature of the engineer and/or his representative. Any costs of materials, labor and equipment arising therefrom, shall be made known to the owner’s representative (Project Manager and/or the General Contractor) within 24 hours or the costs become the responsibility of the Contractor.
1.5 LAW AND REGULATION

A. The bidder's attention is directed to the fact of all applicable laws, ordinances and rules and regulations of all authorities having jurisdiction over construction of the project shall apply to contract throughout, and they shall be deemed to be included in the contract of the same as though here written out in full.

1.6 CONSTRUCTION OBSERVATIONS:

A. During the course of construction of this project, the engineer shall visit the project site periodically on an as-needed basis. The construction observation intervals may vary depending on the progress and/or stage of construction and to observe the electrical conduit rough-in above or below grade, setting of the main and branch panels, auxiliary units and panels, surface mounted items, setting of equipment, equipment connections, etc. However, written field questions are encouraged and welcomed throughout the course of construction and shall be answered promptly in writing, to keep the project construction on schedule. The project foreman should have the building plans, construction schedules, etc., affixed in mind, so the electrical systems being assembled, the setting of equipment, of parts and pieces, related to the project are anticipated, to prevent delays or emergencies.

B. The engineer shall make one (1) final inspection. The contractor shall notify the engineer that the installation is complete, i.e., the systems are operating and have been tested and balanced, and everything is complete and operational, all equipment connections have been made and the owner’s representatives have been trained. At this time the engineer, the contractor, and the owner’s representative shall schedule a time to walk the project for evaluation, and record in writing the items found to be incomplete. The contractor shall make the corrections within one (1) week after this inspection. If at the conclusion of the observation tour the owner and engineer determine that additional visits are required to complete the project, the contractor shall reimburse the engineer at the rate of $600 for each site visit required, plus out of pocket expenses, until all items are acceptable to the engineer and owner. The contractor shall pay the engineer in advance of each inspection.

C. Before scheduling an additional visit, the contractor shall report to the engineer that all systems are complete, and the project is ready for the owner’s acceptance.

1.7 OFFICIAL, AGENT AND EMPLOYEES OF THE OWNER NOT PERSONALLY LIABLE

A. It is agreed, by and between the parties hereto that in no event shall any official, officer, employee, or agent of the Owner in any way be personally liable or responsible for any covenant or agreement herein contained whether expressed or implied, nor for any statement, representation or warranty made herein or in any connection with this agreement.

1.8 SUBLETTING AND SUBCONTRACTING

A. This Bidder is responsible for the construction stated or defined in this Contract and, as such, shall abide by the Subletting and Subcontracting Fair Practices Act as set forth and outlined in the General Conditions, Designation of Subcontractors.
1.9 CONTRACTOR COORDINATION

A. In the course of installing the systems defined in the contract documents, the contractor shall closely follow the plans, details and specifications (contract documents). The system design has been a careful and laborious undertaking, with the intent purpose of producing a system and/or systems that will serve the owner well with minimum maintenance. The contractor shall adhere as close as possible to the plans, details and specifications for each system. Questions and suggestions are encouraged as the project is being assembled. If for any reason, the contractor desires to deviate from the defined information, because he discovers a way to improve the system, make the system more easily assembled, make it operate more efficiently, etc., the contractor shall present the changes to the engineer. Systems are designed to perform a specific function; the smallest change in assembly may change the function. If the engineer agrees with the change he will authorize the contractor to proceed. Contractor cooperation and coordination is appreciated. If the contractor proceeds with construction without the designer’s authorization, it shall be reworked, in accordance to plans and specifications, at the contractor’s expense.

1.10 QUALITY ASSURANCE

A. Comply with the requirements of State and Local Ordinances. If a conflict occurs between these requirements and the contract documents, the most stringent requirements shall govern. The contractor accepts this responsibility upon submitting his bid, and no extra charge will be allowed after the contract is awarded. This shall not be construed as relieving the Contractor from complying with any requirements of the contract documents which may be in excess of the aforementioned requirements, and not contrary to same.

B. Obtain all permits, inspections, etc. required by authority having jurisdiction. Include all fees in bid. Furnish a certificate of approval to the Owner's Representative from the Inspection Authority at completion of the work.

C. Employ only qualified craftsmen with at least three years of experience (in power equipment, conduit work, high voltage equipment, etc.). Workmanship shall be neat, have a good mechanical appearance and conform to best electrical construction practices. Provide a competent superintendent to direct the work at all times. Any person found incompetent by the General Contractor, Engineer, Architect, or Owner, shall be discharged from the project and replaced by satisfactory personnel.

D. Contractor shall have a current state contracting license applicable to type of work to be performed under this contract.

1.11 MATERIALS AND WORKMANSHIP

A. All materials and equipment furnished and installed shall be first quality, new and meet the standards of NEMA, IPCEA, LS, UL, NFPA, UBC, OSHA, NEC, and shall bear their label wherever standards have been established and label service is available. Where materials and equipment are specified by manufacturer’s name, the type and quality required is thereby denoted. The Architect shall be afforded every facility deemed necessary to inspect and examine the materials and apparatus being installed to prove the material quality and skill/competency of workmanship.
1.12 DEMOLITION, PATCH AND REPAIR

A. The Contractor is responsible for all block-outs, demolition, patching and repair of all finished interior surfaces pertaining to the installation of this particular phase of work. All repaired surfaces shall be finished (painted, etc) to match the adjacent materials, finished and color.

B. When conduit passes through a ceiling and/or floor, block-out as required and/or core-drill - do not break out with a hammer of any type. The hole shall not be larger than half inch (½") more than the diameter of the conduit.

C. When conduit is indicated to be installed below an existing concrete slab, cut the slab with a diamond saw and/or cutting tool. Do not just rip up the surface unless the entire section is removed.

D. When conduit is to be installed below asphalt, concrete, lawn, etc. the surface shall be cut, not ripped up, with a back-hoe or other equipment (i.e., mechanically cut then remove material).

E. Seal around all electrical equipment penetrating outside walls, roofs, unheated spaces, air plenums, cold boxes, etc., with Dow Corning Silicone RTV foam.

F. Hard Surfaces: whenever demolition or excavation is required for the installation of the electrical system, it is the responsibility of the Contractor to make repairs and/or replacement of hard finish surfaces such as concrete, asphalt, etc.

G. The method of patching and repair shall follow good construction practices. All finished surfaces shall match materials, and finish (surface texture and finish - paint, etc.) wherein the demolition occurred.

H. Lawn replacement resulting from excavation is to be included in the bid.

1.13 EXCAVATION AND BACKFILL

A. The Electrical Contractor is responsible for all excavation and backfill related to the installation for Division 16. All work shall comply with the conditions stated herein and those noted in the Architectural Section under Earthwork.

B. When conduit is indicated to be installed below an existing concrete slab, cut the slab with a diamond saw and/or cutting tool. Do not just rip up the surface unless the entire section is removed.

C. When conduit is to be installed below an asphalt, concrete, lawn, etc., the surface shall be mechanically cut, then removed (i.e., not ripped up with a back-hoe or other equipment).

D. Backfill: The Contractor shall backfill the excavated areas with the material removed provided it does not contain rocks larger than 0.15-inch in diameter. If the excavated material is larger than indicated, the excavated area shall be filled with sand.
E. Backfill materials shall be put in place in 4-inch lifts and compacted to 98% of the maximum dry density of ASTM 698 over the entire area of the fill.

F. After the backfill is complete the finished surface shall match the adjacent surfaces, depth, quality finish, etc. (asphalt, concrete, grass, etc.).

1.14 PROGRESS AND COORDINATION OF WORK

A. The electrical work shall be laid out in advance of construction to eliminate unnecessary cutting, drilling, channeling, etc. Perform necessary cutting, drilling or channeling with care. Use skilled mechanics of the trades involved and repair damage to building or equipment at no additional cost to the Owner. Cutting, drilling or channeling through work performed by other trades shall only be done with the consent of the General Contractor. Cutting, drilling or channeling through structural members shall only be done with the approval of the Architect.

B. Cooperate with other trades to coordinate locations of electrical outlets and apparatus.

C. Perform for other trades, the electrical wiring and connections for all devices or apparatus where not specified herein or indicated on the drawings. Consult the Architectural and Mechanical drawings to avoid hiding switches, outlets and other equipment behind doors, cabinets, counters, heating equipment, etc. Buried electrical devices and/or connections shall be relocated as directed by Engineer and/or authority having jurisdiction, at no additional cost to the Owner.

D. Where conduit, outlets or apparatus are to be cast in concrete or encased, it must be located and secured by a journeyman or foreman present at the point of installation. He shall check the locations of the electrical items before and after the concrete and masonry installation and shall relocate displaced items.

E. No changes shall be made in the design or location of apparatus unless specifically approved in writing.

1.15 COORDINATION WITH CEILING AND MECHANICAL SUBCONTRACTORS

A. Meet at least twice with the Ceiling Contractor. The first meeting shall accomplish coordination of all ceiling types with the specified light fixtures. The second meeting shall be held at the project site prior to installing the ceiling to coordinate the fixture layout in each area, and to determine if the depth will allow the installation of the fixture. If a conflict occurs with the layout or depth, the Engineer shall be contacted immediately so the conditions can be adjusted. A letter confirming the second meeting shall be sent to the Engineer with a copy to the Architect.

B. Meet at least once with the Mechanical Contractor prior to fabrication and installation of the ductwork to coordinate the depth and location of light fixtures and ductwork in all areas. All conflicts must be resolved before light fixtures are released for shipment. A letter confirming this meeting shall be sent to the Engineer with a copy to the Architect.
1.16 SUBMITTALS OF EQUIPMENT FOR APPROVAL

A. SHOP DRAWINGS AND PRODUCT DATA BEING INSTALLED IN THE PROJECT:
   After the contract is awarded, but prior to manufacture or installation of any equipment, prepare complete Shop Drawings and Brochures for materials and equipment as required by each section of this specification. A brief submittal description of equipment that is approved for installation (bid documents or addendums), is given below. Refer to identified sections for detailed submittal requirements.

   1. Metallic and Non-Metallic Conduit (Section 16110)
   2. Conductors and Cables (Section 16120)
   3. Boxes, Pull Boxes, and Conduit Bodies (Section 16130)
   4. Motion Devices, Dimmer Controls (Section 16145)
   5. Power Logic and Power Conditioners (Section 16215)
   6. Surge Protection Device (Section 16289)
   7. Motor and Circuit Disconnect Switches (Section 16410)
   8. Motor Controllers and Starters (Section 16420)
   9. Overcurrent Protective Devices (Section 16430)
  10. Main Service Disconnect and Distribution Switchboards (Section 16441)
  11. Branch Panelboards (Section 16442)
  12. Interior Building Light Fixtures, Ballasts, etc. (Section 16511)
  13. Exterior Building Lighting (Section 16521)
  14. Data Equipment and Cabling (Section 16715)
  15. Telephone Equipment and Cables (Section 16717)
  16. Fire Alarm System (Section 16721)
  17. Sound Re-Enforcing and Recording System (Section 16722)
  18. Television Surveillance System (Section 16786)

   This list is not all inclusive. The contractor shall submit product information for all items being installed on the project, contained in the drawings or elsewhere in this specification.

B. The electrical foreman, to acquaint himself with the project, is asked to review the shop drawings prior to submission to confirm size, voltages, loads, etc. This cooperative effort will prevent problems from occurring during the course of construction. Any problems that may arise shall be phoned to the engineer and noted in writing and submitted with the shop drawings.

C. Submit complete, bound submittal in a looseleaf binder large enough for all items (8 copies) to Architect. Prior to submission of the Shop Drawings and Project Data, review and certify that they are in compliance with the Contract Documents. Verify all dimensional information to insure proper clearance for installation of equipment. Check all materials and equipment after arrival on the job site and verify compliance with the Contract Documents.

D. A minimum period of two weeks, exclusive of transmittal time, will be required each time a Shop Drawing and/or Brochure is submitted or resubmitted for review. This period shall be considered by the Contractor when scheduling submittal data.
E. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from the Contract Document's requirements. It shall be clearly understood that the noting of some errors but overlooking others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived, or superceded in any way by the review of the Shop Drawings and Brochures.

F. Certifications shall be written or in the form of rubber stamp impressions as follows:

I hereby certify that this Shop Drawing and/or Brochure has been checked prior to submittal and that it complies in all respects with the requirements of the Contract Drawings and Specifications for this Project.

(Name of Electrical Subcontractor)

Signed

Position Date

Observe the following rules when submitting Shop Drawings and Brochures.

1. Each Shop Drawing shall indicate in the lower right hand corner, and each Brochure shall indicate on the front cover the following: Title of the sheet or brochure, name and location of the building; names of the Architect and Electrical Engineer, Contractor, Subcontractors, Manufacturer, Supplier/Vendor, etc., date of submittal, and the date of correction and revision. Unless the above information is included, the submittal will be returned for re-submittal.

2. Shop Drawings shall be done in an easily legible scale and shall contain sufficient plans, elevations, sections, and isometrics to clearly describe the equipment or apparatus, and its location. Drawings shall be prepared by an Engineer/Draftsman skilled in this type of work. Shop Drawings shall be drawn to at least 1/4"-1-0" scale.

3. Brochures to be submitted shall be published by the Manufacturers and shall contain complete and detailed engineering and dimensional information. Brochures submitted shall contain only information relevant to the particular equipment or materials to be furnished. The Contractor shall not submit catalogs which describe several different items in addition to those items to be used, unless all irrelevant information is marked out, or unless relevant information is clearly marked. Brochures from each manufacturer shall be identified and submitted separately.

1.17 OPERATION AND MAINTENANCE MANUALS

A. Provide operating instructions and maintenance data books for all equipment and materials furnished under this Division.

B. Submit four copies of operating and maintenance data books for review at least four weeks before final review of the project. Assemble all data in a completely indexed volume or volumes and identify the size, model, and features indicated for each item.
COUNTY FAIRGROUNDS BUILDING
CACHE COUNTY

C. The binder (sized to the material) shall be a 2” slide lock unit (Wilson-Jones B3-367-44). The cover shall be engraved with the job title in ½” high letters and the name and address of the Contractor in 1/4” high letters. Provide the same information in 1/8” letters on the spine.

D. Include complete cleaning and servicing data compiled in clearly and easily understandable form. Show serial numbers of each piece of equipment, complete list of replacement parts, motor ratings, etc. Each unit shall have its own individual sheet. (Example: If two items of equipment A and D appear on the same sheet, an individual sheet shall be provided for each unit specified.)

E. Include the following information where applicable:

1. Identifying name and mark number.
2. Certified outline Drawings and Shop Drawings.
3. Parts lists.
4. Performance curves and data.
5. Wiring diagrams.
6. Manufacturer’s recommended operating and maintenance instructions.
7. Vendor’s name and address for each item.

1.18 RECORD DRAWINGS

A. Maintain at the job site, on a daily basis, a complete set of "Record Drawings", reflecting an accurate dimensional record of all buried or concealed work. Mark "Record Drawings" to show the precise location of concealed work and equipment, including concealed or embedded conduit and junction boxes and all changes and deviations in the work from that shown on the Contract Documents. This requirement shall not be construed as authorization for the Contractor to make changes in the layout or work without definite authorization for such changes. The "Record Drawings" for daily recording shall consist of a set of blue line prints of the Contract Drawings.

B. Record dimensions clearly and accurately, delineating the work as installed; identify locations by at least two dimensions to permanent reference points.

C. Certify the "Record Drawings" for correctness by placing and signing the following certifications on the first sheet:

"CERTIFIED CORRECT (3/8" high letters)

By ___________________________ Date ___________________________
(Name of General Contractor)

By ___________________________ Date ___________________________
(Name of Electrical Contractor)
D. GUARANTEE: Ensure that electrical system installed under this contract is in proper working order and in compliance with drawings, specifications and/or authorized changes. Without additional charge, replace any work or materials which develop defects, except from ordinary wear and tear, within one year from the date of substantial completion. Exception: Incandescent and fluorescent lamps shall be guaranteed for a period of two months from the date of substantial completion.

1.19 CLEAN-UP

A. Clean up all equipment, conduit, fittings, packing cartons and other debris that is a direct result of the installation of the work of this Division.

B. Clean fixtures, interiors and exteriors of all equipment, and raceways. Replace all filters in electrical equipment upon request for Substantial Completion.

1.20 POWER OUTAGE

A. All power outages required for execution of this work shall occur during non-standard working hours and/or at the convenience of the Owner. Include all costs or overtime work in the base bid.

B. Submit written request at least 7 days in advance of scheduled outage and proceed with outage only after receiving authorization from the Owner's Representative.

C. Keep all outages to an absolute minimum. This includes the existing office building.

1.21 STORAGE AND PROTECTION OF MATERIALS

A. Provide storage space for storage of materials and apparatus and assume complete responsibility for all losses due to any cause whatsoever. In no case shall storage interfere with traffic conditions in any public thoroughfare or constitute a hazard to persons in the vicinity. Protect completed work, work under way, and apparatus against loss or damage.

1.22 CONCRETE PADS AND ASPHALT

A. The Electrical Contractor shall provide the concrete (5-bag mix) and/or asphalt except as noted in the contract documents. This may also include that which is needed to replace any and all removed through demolition. It shall match the existing as to type, quality and thickness.

1.23 ELECTRICAL-MECHANICAL COORDINATION

A. General - All disconnect means, motor controllers, electrical controls, signal devices, etc., for mechanical equipment as noted in Division 15 of the specifications shall be furnished, installed, wired, and connected under Division 16. All pressure switches, thermostats, solenoid valves, damper motors, smoke duct detectors, etc. shall be supplied and installed under the Mechanical Division for electrical connection under this Division. Connection diagrams will be supplied as hereafter explained.
B. If the substitution of equipment in Division 15 results in a change to the contract documents and/or changes to the installation requirements (not covered by the contract change orders), then the Division 15 contractor shall reimburse the Division 16 contractor for additional work required.

C. If the substitution of equipment in Division 16 results in a change to the contract documents and/or changes to the installation requirements (not covered by the contract change orders), the complete responsibility for costs shall be assigned to the section of these specifications under which the equipment is furnished.

1.24 EQUIPMENT CONNECTION DIAGRAM

A. Submittal data for each individual electrically operated or electrically controlled item of equipment or device furnished under Division 15 and/or 16 of the contract documents shall include complete electrical wiring diagrams and elementary control diagrams (ladder form) showing all internal and external wiring connections and services. The submittal data shall itemize all electrical characteristics that are of a special nature or critical to the electrical installation or control system. Such equipment and devices will not be considered for approval until these requirements are met.

PART 2 - PRODUCTS

2.1 GENERAL

A. PRODUCTS are specified by Manufacturer name, description, and/or catalog number and shall be supplied as such.

B. DISCREPANCIES between equipment specified and the intended function of equipment shall be brought to the attention of the Engineer in writing prior to bidding. Failure to report any conflict, including catalog numbers, discontinued products, etc., does not relieve the Contractor from meeting the intent of the contract documents, nor shall it change the contract cost. If the Contractor is unable to interpret any part of the plans and/or specifications, or should he find discrepancies therein, he shall bring this to the attention of the Engineer, who will issue interpretation and/or additional instructions to Bidders before the project is bid.

C. MANUFACTURERS AND SUBSTITUTE ITEMS: Provide products of manufacturers specified. Manufacturer's catalog numbers and descriptions establish the quality of product required.

D. Provide only equipment specified in the contract documents or approved by addendum.

2.2 LISTED EQUIPMENT

A. Provide and install materials, devices, appliances, equipment, etc. that conforms to applicable standards or is indicated to be acceptable by the established standards of the Underwriter’s laboratories, Inc., or other electrical product testing laboratories which are accredited by the department.
B. The statement in Item “A” above is being interpreted by the State Electrical Inspector as follows: It is understood that many specialty items such as power panels, light fixtures, devices and other building components are not available with a UL label covering the entire piece of equipment. The State will impose no requirement that an item of equipment be UL labeled unless it is available as a UL labeled item from at least two manufacturers. Electrical components of unlabeled equipment, such as motors, shall be labeled if they are available from at least two manufacturers.

C. If any building component is available with a UL label from at least two manufacturers, an identical or similar unlabeled component shall not be acceptable for installation. Should any such component be installed, it shall be replaced with a UL labeled component, before the building will be accepted by the Electrical Engineer.

D. Consequently, it shall be the sole responsibility of the Contractor (through project suppliers and equipment manufactures) to purchase and install only equipment bearing the UL label whenever the equipment so labeled is available. The Contractor (should any equipment be installed without the proper UL label) shall bear the entire cost of correction to the satisfaction of the authority having jurisdiction.

2.3 SUBSTITUTIONS AND SUBSTITUTE EQUIPMENT

A. Substitute equipment is encouraged if it is truly an equal to the specified items.

1. The designer has taken time and effort to analyze, evaluate and prove to himself that the specified unit will perform the function needed, wherein it is placed. This means the responsibility for the function of the specified equipment rests with the designer, who knows and understands what is to be accomplished.

2. If a supplier and/or the contractor desires to substitute equipment in place of specified item, he may do so, but he takes upon himself or herself the full responsibility that the substituted equipment will equal all of the performing characteristics, functions, etc., and/or exceed the performance of the specified item. The substitute equipment shall be of such a physical size and weight that it will mount in the designated location without alterations to the building and the structure will carry the load. If for any reason the substituted equipment requires alterations or modification, in any form to the building and/or the structure, the costs shall be paid by the contractor and/or those requesting the substitutions.

3. Those interested in requesting a substitution shall state the Manufacturer’s catalog numbers and descriptions establish the quality of product required. Substitutions will be considered if a duplicate written application (2-copies) is at the office of the Engineer eight (8) working days prior to day of bidding. The application shall include the following: 1) A statement certifying that the equipment proposed is equal to that specified; that it has the same electrical and physical characteristics, compatible dimensions, and meets the functional intent of the contract documents; 2) the specified and submittal catalog numbers of the equipment under consideration; 3) A pictorial and specification brochure.
4. Because of the short bidding period, (from issuance of drawing to bid date), between the substitution request and the bid date, the designer does not have adequate time to make a full evaluation of substitute equipment. Therefore, those requesting the substitution must accept full responsibility for the items being submitted for substitution (operating characteristics, physical size, weight, output, not increase the load, etc.). If at any time during the course of construction, even up into the final completion, if the designer finds the equipment does not meet the design criteria, comply with the performance, etc., those requesting the substitution and the contractor have the responsibility to remove the substituted equipment and install the specified item at their expense. There shall be no cost assessed to the owner and/or the designer and the replacement will not delay the completion of the project.

B. Discrepancies between equipment specified and the intended function of equipment shall be brought to the attention of the Engineer in writing prior to bidding. Failure to report any conflict, including catalog numbers, discontinued products, etc., does not relieve the Contractor from meeting the intent of the contract documents, nor shall it change the contract cost. If the Contractor is unable to interpret any part of the plans and/or specification, or should he find discrepancies therein, he shall bring this to the attention of the Engineer, who will issue interpretation and/or additional instruction to Bidders before the project is bid.

C. Any conflict arising from the use of substituted equipment shall be the responsibility of the contractor, who shall bear all costs required to make the equipment comply with the intent of the contract documents.

D. Samples may be required for non-standard or substituted items before installation during construction. Provide all samples as required.

E. No materials or apparatus may be substituted after the bid opening, except where the equipment specified has been discontinued. This substitution may be made by a change order.

F. Approved equipment shall be so noted, in writing in a formally issued Project Addendum.

2.4 INCENTIVE BIDS AND UNIT PRICES

A. Suppliers of materials, equipment, and systems are encouraged to submit incentive bids by grouping several products under one bid. However, at the request of the Architect and/or Engineer, the supplier shall submit a unit price to add or delete a particular unit, (panel, light fixture, fire alarm panel, etc.) from his quotation so that other components might be considered in the bid.

2.5 SPARE PARTS

A. Provide spare parts (fuses, overload heaters, diffusers, lamps, etc.) as specified. Transmit a list indicating all spare parts to Owner’s Representative prior to substantial completion. Submit copy of transmittal letter to Engineer.

B. Fuses: Provide one spare set of fuses for each size and one spare set of each additional group of five (this includes fuses for bolted pressure and HV units).
C. Thermal Overloads: Provide one spare set of thermal overload heaters of each type used in the magnetic starters.

D. Auxiliary Systems: One (1) spare heat detector and three (3) smoke detectors shall be provided for the system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Layout electrical work in advance of construction to eliminate unnecessary cutting, drilling, channeling, etc. Where such cutting, drilling, or channeling becomes necessary for proper installation; perform with care. Use skilled mechanics of the trades involved. Repair damage to building and equipment at no additional cost to the contract. Cutting work of other Contractors shall be done only with the consent of that Contractor. Cutting structural members shall not be permitted.

B. Since the drawings of floor, wall, and ceiling installation are made at small scale, outlets, devices, equipment, etc., are indicated only in their approximate location unless dimensioned. Locate outlets and apparatus symmetrically on floors, walls and ceilings where not dimensioned, and coordinate such locations with work of other trades to prevent interferences. Verify all dimensions on the job. Do not scale the electrical drawings, but refer to the architectural and mechanical shop drawings and project drawings for dimensions as applicable.

C. Perform for other trades, the electrical wiring and connection for all devices, equipment or apparatus. Consult Architectural, Mechanical, and other applicable drawings, and all applicable shop drawings to avoid switches, outlets, and other equipment from being hidden behind doors, cabinets, counters, heating equipment, etc. Relocate buried electrical devices and/or connections as directed at no additional cost.

D. All electrical networks, power, auxiliary, etc., systems shall be installed in conduit; see Section 16110.

E. Where conduit, outlets or apparatus are to be embedded in concrete, they shall be located and secured at the defined point. Check locations of the electrical items before and after concrete and/or masonry installation and relocate displaced items.

F. Provide block-outs, sleeves, demolition work, excavation, etc., required for installation of work specified in this Division. Opening shall be core drilled and/or saw cut and shall be no longer than required. Seal around conduit and on equipment inside and out with a silicone compound.

G. Roof Flashing: Where raceways penetrate roofing or similar area, provide 26 ga. galvanized iron roof jack, sized to fit tightly to raceway for weather tight seal, and with flange extending to a minimum of 9 inches under roofing on all sides. Coordinate all work with roofing contractor.
H. Patching and Repair

1. The Contractor is responsible for all block-outs, demolition, patching and repair of all finished interior and exterior surfaces pertaining to the installation of this particular phase of work. All surfaces shall be finished (textured, painted, etc.) to match the adjacent materials.

2. Hard Surfaces: Whenever demolition or excavation is required for the installation of the electrical system, it should be the responsibility of the Contractor to make repairs and/or replacements of hard finish surfaces such as concrete, asphalt, etc.

3. Lawn replacement is also included as a part of this section.

4. The method of patching and repair should follow good construction practices. All surfaces shall match materials and finish wherein the demolition occurred when construction is complete.

I. All electrical powered equipment specified on this project, whether specified in the architectural, mechanical, or electrical specification, shall be electrically connected and made operational. Confirm voltage, amperage, and phases.

3.2 COMPLETION OF WORK AND TESTING

A. Before energizing any circuits, make megger ground tests on conductors, bus duct and fused disconnects with the distribution breakers open. These readings shall be recorded by circuit number identification and submitted in triplicate to the Owner's Representative before the system is energized.

B. Before final inspection, but after the electrical installation is complete, the Electrical Contractor shall remove neutral grounding connection from main distribution panel and demonstrate to authority having jurisdiction and Owner's Representative, with an ohmmeter, that the electrical system neutral is grounded through main panel location only. Neutral shall be reconnected after the test is complete.

C. Emergency Power System: In the presence of the Owner's Representative, test the emergency power system, in its entirety, by transferring from normal to emergency power no less than six times to prove proper operation of all equipment, devices, light fixtures, etc. that are powered by this system. If an emergency generator or power pack is used, the factory representative should be present during the test. Write a letter to the Owner's Representative confirming the conditions of this test.

D. High potential tests per I.P.C.E.A., shall be made on all high voltage conductors after installation. A written report of same shall be made in duplicate to the Architect.

E. Test Equa potential grounding system throughout the building and report the results.

F. Auxiliary Systems - Each system defined in Contract Documents shall be made operational by the factory representative. The Factory Representative shall confirm the operation of each component (speaker, stand by power, etc.) and report in writing (triplicate) his confirmation of the systems status of operation.
3.3 FINAL REVIEW

A. At the time of final review, the project foreman shall accompany the reviewing party, and remove coverplates, panel covers and other access panels as requested, to allow review of the entire electrical system.

3.4 PROJECT FINALIZATION AND START-UP

A. Upon completion of equipment and system installation, notify equipment Factory Representative and Subcontractors for system start-up.

B. Each Factory Representative and Subcontractor shall assist in start-up to examine their respective system and remain at the site until the total system operation is accepted by the Owner's Representative.

C. The Factory Representative and/or System Subcontractor shall give personal instruction on operation and maintenance of their equipment to the Owner's maintenance and/or operation personnel. To certify acceptance of operation and instruction by the Owner's Representative, the contractor shall prepare a written statement as follows:

1. This is to certify that the Factory Representative and/or System Subcontractor for each of the systems installed below have performed start-up and final check out of their respective systems is satisfactory.

D. System Operating Report: After the facility has been in operation for 10 days, submit with a letter of guarantee a triplicate record of a voltage reading and ammeter reading on each phase of the feeder for the main and all branch panels, motors, outside lighting, etc. to the facility (these readings shall be taken with all equipment operating). A second report shall be made on equipment that has a load over 20 Amp 1-pole in the mechanical room, kitchen, shops, etc. when in operation.

1. This dated system operating report shall be submitted to the Owner's representative for distribution to the engineer and a copy placed in each maintenance manual.
   a. Electrical Load Readings:
      - Demand kw
      - Panel H3 Amp
      - Panel F2 Amp
      - Panel MDP Amp
      - Panel H4 Amp
      - Panel F3 Amp
      - Panel H1 Amp
      - Panel F1 Amp
      - Panel F4 Amp
      - Panel H2 Amp
      etc. identify and record the load on each panel and motor loads 3/4 hp and larger.

2. If there are any abnormal conditions, they shall be brought to the attention of the Engineer in writing as a part of this submittal.
3. Submit with the load readings for the motors, a list of motors with the size of overload heaters used for each motor. This includes thermal switches.
4. As a part of this document, submit a copy of each Auxiliary Systems test reports (Telephone, Fire Alarm, Sound, Data, etc.) with the proper signatures (See 3.2F).

   System Factory Representative
   (List Systems Included) (List name and address of Factory Representative)
5. The Owner’s Representative has received complete and thorough instruction in the operation and maintenance of each system (See 3.4C).

| Owner's Representative Contractor or Electrical Foreman |

6. Report that each emergency light fixture has proven operational by killing the circuit and visually confirming the fixture illuminates (See 3.2G).
7. The Owner’s Representative has received and accepted all spare parts as heretofore required by contact (See 2.5).
8. Submit meggar OHM, equipotential, and high potential test reports (See 3.2A, 3.2D, 3.2E).
9. Send copy of acceptance to Architect/Engineer.

END OF SECTION 16001
1.1 MATERIALS AND METHODS

A. Materials and methods common to this project are listed below and shall be followed as closely as practicable using acceptable construction practices and specified products. This section indicates conditions and practices that should become a part of this project.

1. Materials: The materials installed on this project shall be new, noted in this specification and shall be installed in the course of construction, except, they be changed in writing over the signature of the designer.

2. Method: The method of installation shall follow current acceptable electrical practices under the direction of a licensed journeyman electrician. This will be further explained in the body of the specification.

3. Notes: The notes on the plans are a part of the contract documents; a conflict between the specification and the drawings, the specifications rule.

1.2 EQUIPMENT CONNECTIONS

A. The Contractor shall install an electric service to the subject project as shown on the plans and described herein.

B. Extent of electrical connection for equipment includes final electrical connection of all equipment (supplied under this or any other division or by the owner) having electrical requirements. Make final connections for all owner furnished equipment. See other applicable Divisions of specification for building, namely, mechanical, plumbing, temperature control wiring requirements, kitchen equipment, etc.

C. Refer to Division-15 sections for motor starters and controls furnished integrally with equipment.

D. Refer to Division-15 section for control system wiring; not work of this section, except as noted on the electrical plans.

E. Refer to sections of other Divisions for specific individual equipment power requirements.

1.3 QUALITY ASSURANCE

A. CODE COMPLIANCE: Comply with applicable portions of NEC, state, and local codes as to type products used and installation of electrical power connections.

B. UL LABELS: Provide electrical connection products and materials which have been UL-listed and labeled.
PART 2 - PRODUCTS

2.1 GENERAL

A. For each electrical connection indicated, provide complete assembly of materials, including but not necessarily limited to; raceways, conductors, cords, cord caps, wiring devices, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, solderless wire nuts, and other items and accessories as needed to complete splices, terminations, and connections as required. See Section 16110, Conduit Raceways; Section 16140, Wiring Devices; and Section 16120 Conductors and Cables for additional requirements. Provide final connections for equipment consistent with the following:

1. Permanently installed fixed equipment - flexible seal-tight conduit from branch circuit terminal equipment, or raceway; to equipment, control cabinet, terminal junction box or wiring terminals. Totally enclose all wiring in raceway.
2. Movable and/or portable equipment - wiring device, cord cap, and multi-conductor cord suitable for the equipment and in accordance with NEC requirements (Article 400).
3. Other methods as required by National Electrical Code and/or as required by special equipment of field conditions.

END OF SECTION 16050
SECTION 16052 - EXISTING FACILITIES AND EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Existing facility, whether standing alone or an addition to a standalone, or if the existing building is a part of a new facility, the bidder shall consider the existing unit a part of this project. All electrical equipment, panels, apparatus, luminaires, conduit/conductors, boxes, devices, etc., are to be removed, reworked, added to, extended, etc., as noted on the contract documents to make a complete and operable facility. The contractor shall also include in his bid an allowance to cover items that may be concealed in wall, ceiling, or floor, that must be rerouted, relocated, etc., to maintain or extend existing systems to keep them operable.

B. When the project is completed all systems, apparatus, etc., shall be made operable and left in normal operating order.

1.2 EXISTING EQUIPMENT

A. General: The electrical conditions in the existing facility are part of this project, and all costs, changes, extensions, additions, etc., pertaining thereto shall be included in the base bid.

B. Disconnect all equipment that obstructs and/or is to be relocated. Reconnect when reset.

C. The new electrical equipment and apparatus shall be coordinated and connected into the existing system as required. Auxiliary systems shall comply unless otherwise specified.

D. Conduit and wire installed in existing structures shall be concealed. Exceptions shall be an approval of Architect. (See demolition and patching sections).

E. All electrical equipment and apparatus in the building not remodeled shall be connected as per specifications and left in working conditions.

F. Existing raceways shall be used where possible, except as noted.

G. All vacated or unused power, communication, signal, control wiring or cabling, etc., shall have wire pulled out of conduit back to branch panel or the first active outlet. The conductors/cabling become the property of the contractor and shall be removed from the site.

H. All circuits, conduit and/or cables that are not used in the remodeling shall be removed back to the first accessible junction box where it shall be tied off, taped and labeled spare and what it connects to.

I. Obtain permission from the building maintenance director before penetrating any ceiling floor, and wall surfaces.

J. Any and all equipment having electrical systems that require disconnecting and reconnection, at the same or another location throughout the course of construction, shall be included as part of this contract.

END OF SECTION 16052
SECTION 16055- ELECTRIC SERVICE CONNECTION

PART 1 - GENERAL

1.1 ELECTRICAL SERVICE SYSTEM

A. Provide, install and coordinate an electric service to the facility as shown on the drawings and specified herein.

B. The Contractor shall contact Rocky Mountain Power relative to the installation of the electric service for the new building and reworking the existing service to the existing office. The electrical contractor is responsible to include in his bid any costs assessed by the serving utility to provide electric service. These costs shall be included in the base bid. Confirm the location of the point of service.

C. The service conduit shall be installed as stated in the contract document, confirm size with the serving utility.

D. Provide and install the service metering equipment, shown on the plans and/or required by the serving utility, and/or as specified in the contract documents.

E. Construction Lighting and Power is a part of the General Conditions.

F. Permanent power shall be connected as soon as the main service and panel are installed.

G. Service feeders installed in PVC and/or RMC (see Section 16110) shall be shrouded with Red 5-bags concrete 3” minimum cover with #3 rebar at all corners.

H. Phase Rotation: When the permanent service has been established, the contractor shall check the rotation of all motors and confirm proper rotation. Each motor shall have a correct rotation. Any costs arising from a reversed motor shall be the Electrical Contractors.

1.2 SERVICE CONNECTIONS

A. Provide and install the lugs, cable, labor, etc. necessary for the connection of the service power and/or transformers for the project.

1.3 MAKING ELECTRICAL CONNECTIONS

A. Make electrical connections to all equipment provided under Divisions 15 and/or 16, as it was shown on either the mechanical or electrical plans. The connection shall be in accordance with connector manufacturer's written instructions and with recognized industry practices, and complying with requirements of NEC and NECA's "Standard of Installation" to ensure that product fulfill requirements.

B. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams.

C. Coordinate installation of electrical connections for equipment with equipment installation work.
D. Verify all electrical loads (voltage, phase, full load amperes, number and point of connections, minimum circuit ampacity, etc.) for equipment furnished under other Divisions of this specification, by reviewing respective shop drawings furnished under each division. Meet with each subcontractor furnishing equipment requiring electrical service and review equipment electrical characteristics. Report any variances from electrical characteristics noted on the electrical drawings in writing to Architect before proceeding with rough-in work.

E. Obtain and review the equipment shop drawings to determine particular final connection requirements before rough-in begins for each equipment item.

F. Confirm the rotation of all electric motors when making the final connection. Motors running in the reverse direction are the responsibility of this contractor.

G. Refer to basic materials and methods Section 16120, Conductors, for identification of electrical power supply conductor terminations.

END OF SECTION 16055
SECTION 16060 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Provide grounding as specified by NEC, as noted herein, and as indicated on drawings. Types of grounding in this section include the following:

1. Underground Metal Water Piping
2. Grounding Electrodes
3. Separately Derived Systems
4. Concrete Encased Electrode (UFER)
5. Service Equipment
6. Enclosures
7. Systems
8. Equipment
9. Other items indicated on drawings

B. "G" in the conduit symbol denotes a green ground (to match indicated conductor sizes) which shall be installed in the conduit with other conductors. It shall connect to an insulated ground bar in the panel.

C. “G” in all conduit, apparatus, equipment, etc. outside the building denotes a #10 bare ground interconnecting all outside equipment having an electrical connection.

D. A green ground conductor shall be installed in all non-metallic conduit runs.

E. Install insulated ground conductors as indicated on the plans.

F. Requirements of this section apply to electrical grounding work specified elsewhere in these specifications.

1.2 QUALITY ASSURANCE

A. Comply with NEC as applicable to electrical grounding and ground fault protection systems. Comply with applicable ANSI and IEEE requirements. Provide products which have been UL listed and labeled.

1.3 SUBMITTALS

A. None required.
PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS

A. GENERAL: Except as otherwise indicated, provide each electrical grounding system as specified herein, and as shown on drawings, including but not necessarily limited to, cables/wires, connectors, terminals (solderless lugs), grounding rods/electrodes and plate electrodes, bonding jumper braid, and other items and accessories needed for complete installation.

B. Where materials or components are not otherwise indicated, comply with NEC, NEMA and established industry standards for applications indicated.

C. Install an isolated ground bar in branch panels.

2.2 ELECTRICAL GROUNDING CONDUCTORS

A. Unless otherwise indicated, provide electrical grounding conductors for grounding connections matching power supply wiring materials and sized according to NEC.

B. When conductor sizes are increased due to voltage drop (i.e., distance) the ground size shall be increased proportionately in size per NEC.

2.3 GROUND RODS

A. GROUND RODS: Steel with copper welded exterior, 5/8" dia. x 8 ft (quantity as per Code).

PART 3 - EXECUTION

3.1 INSTALLATION OF GROUNDING SYSTEMS

A. Install electrical grounding systems in accordance with manufacturer's written instructions and with recognized industry practices to ensure grounding devices comply with requirements.

B. Install braided type bonding jumpers with ground clamps on water meter piping to electrically bypass water meter.

C. Install clamp-on connectors only. Thoroughly clean metallic contact surfaces, to ensure electrical conductivity and circuit integrity.

D. Provide grounding for the entire raceway, enclosure, equipment and device system in accordance with NEC. All non-metallic raceways shall include copper grounding conductor sized in accordance with NEC.

E. Provide a continuous service entrance ground conductor that interconnects the major ground points, namely ground rods (quantity of two, driven exterior to building), by means of bonding to water main, and by means of bonding (Cad-Weld) to building structural steel. If the conductor is not continuous each joint shall be Cad-Welded. The Cad-Weld constitutes a continuous conductor.
F. In addition to water main and ground rods provided to meet this specification, each location grounded to water main or ground rod shall have a Concrete Encased Electrode (UFER) ground. A Concrete Encased Electrode (UFER) ground shall consist of a minimum of 25 feet of No. 4 AWG bare copper cable (or per local code) embedded in concrete (feeder encasement, footing, floor slab, etc.) so that all portions of the cable are between 2" and 4" from the earth and with the center of the cable bonded to the ground rod or pipe.

G. All luminaire poles shall be grounded with a No. 10 stranded green ground.

H. See drawings for additional grounding requirements.

END OF SECTION 16060
SECTION 16072 - ELECTRICAL SUPPORTS AND SEISMIC RESTRAINTS

PART 1 - SUPPORT

1.1 GENERAL

A. All electrical equipment, distribution panels, motor control centers, conduit, device boxes, apparatus, etc., shall be securely anchored in place as specified herein and/or in accordance with state, local, and seismic codes.

1. Work of this section includes supports, anchors, sleeves, and seals required for a complete raceway support system, including but not limited to: clevis hangers, riser clamps, C-clamps, beam clamps, one and two hold conduit straps, offset conduit clamps, expansion anchors, toggle bolts, threaded rods, U-channel strut systems, and all associated accessories.

2. Quality Assurance: Comply with NEC and local codes as applicable to construction and installation of electrical supporting devices. Comply with applicable requirements of ANSI/NEMA Std. Pub. No. FB 1, “Fittings and Supports for Conduit and Cable Assemblies”. Provide electrical components which are UL-listed and labeled.

3. Manufactured Supporting Devices and Raceways: Provide manufactured mounting brackets (such as Caddy #SDG or SDB - D - 16); complying with manufacturer’s standard materials, design and construction in accordance with published product information, and as required for a complete installation; and as herein specified. See drawing details for additional requirements.

4. Tie-wire is not acceptable.

5. Supporting of equipment may be noted in other sections of the specifications.

B. Wall supported equipment shall be mounted on an angle support bracket with anchors into or through the wall as perimeter (the latter mounting is preferred, but must be approved by the architect), with two 1/2” rods up to the structure from the outermost corners of the mounting frame tied-off to the building structure. This would be likened unto a transformer. Wall mounted electrical panels shall be mounted directly to the wall.

C. For hanging of conduit, see Section 16110.

D. Installation of Supporting Devices for all types of Raceways: Install hangers, anchors, sleeves, and seals as required, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NECA, NEC and ANSI/NEMA for installation of supporting devices.

1. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

2. Install hangers, supports, clamps and attachments to support piping properly from building structures. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze type hangers where possible.
3. RACEWAYS (ALL TYPES): Support raceways which are rigidly attached to structure at intervals not to exceed 8 feet on center and within 12" of each junction box, outlet or fitting. Support raceway (as it is installed) in accordance with the following:

<table>
<thead>
<tr>
<th>NUMBER OF RUNS</th>
<th>MIN. ¾” TO 1-1/2”</th>
<th>1-1/2” &amp; LARGER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Full straps, clamps or hangers.</td>
<td>Hanger</td>
</tr>
<tr>
<td>2</td>
<td>Full straps, clamps or hangers.</td>
<td>Mounting Channel</td>
</tr>
<tr>
<td>3</td>
<td>Mounting Channel</td>
<td>Mounting Channel</td>
</tr>
</tbody>
</table>

4. Support suspended raceways on trapeze hanger system, or individually by means of threaded rod and straps, clamps, or hangers suitable for the application. Do not use "tie wire" as a portion of any raceway support system; do not support raceway from ceiling support wires.

5. Install electrical raceways where indicated; in accordance with manufacturer’s written instructions, applicable requirements of NEC and NECA “Standard of Installation”, and in accordance with the following

6. Coordinate with other work, including metal and concrete deck work, as necessary to interface installation of electrical raceways and components.

7. Coordinate the campus ground equipment installation with existing structures, trees, lawn sprinkler systems, etc.

8. Install raceway in accordance with the following:
   a. Provide a minimum of 12” clearance from flues, steam and hot water piping, etc.

E. FLOOR MOUNTED EQUIPMENT: Provide rigid attachment of all floor mounted equipment to the floor slab or structural system. Provide 5/8” bolts or expansion anchors at each 90 degrees corner and at intervals not to exceed 48” on center along entire perimeter of the equipment. Provide rigid attachment for all floor mounted switchboards, panelboards, power and control equipment, motor control centers, dimmer cabinets, transformers, oil switches, battery packs and racks, and similar equipment furnished under Section 16.

F. BURIED CONDUIT: Conduit installed in the earth shall be laid on undisturbed soil and/or compacted fill. The first six (6) inches of cover shall be sand. See Excavation and Backfill - see Section 16110-C6.

G. Concrete slabs, bases, curbs, etc., for electrical apparatus shall be provided and installed under this contract. The concrete shall be 5-bag mix, except as noted.

1. The contractor shall provide and install an 8 x 8 x 4 concrete base for the transformer (confirm size and depth with the service utility) at the indicated location.

2. Unless otherwise noted, provide a 4” high concrete base for all main panels, motor control centers, transformers, engine generators, etc. Extend base 4” beyond equipment or mounting rails on all sides or as shown on the drawings. Coordinate the pad dimension with the equipment to be located thereon.

3. Concrete pole bases (detailed on the plans) shall be provided under Division 16. Coordinate size and location of all bases and furnish all required anchor bolts, sleeves and templates as required to obtain a proper installation.

4. All concrete used on this project shall be 5-bag mix and/or as specified in the concrete section of the Architectural Section.
PART 2 - SEISMIC BRACING

2.1 GENERAL

A. The General Conditions, Supplementary General Conditions, Alternates and Addenda, Applicable Drawings and the Technical Specifications shall apply to all work under this division.

B. This seismic bracing section shall conform to the conditions governing the area within the structure being built under local and/or state UBC Seismic Requirements.

2.2 SCOPE OF WORK

A. The materials covered by these specifications consist of furnishing all labor, material and equipment necessary to complete the seismic bracing for all work provided under section 16000.

B. The work shall include all electrical isolated and non-isolated equipment, fixtures, raceways, etc.

2.3 CODES - REGULATIONS

A. In the installation of this work, comply in every way with the requirements of the laws, ordinances and rules of the system design and installation shall be based on seismic zone III of the Uniform Building Code, 1991 edition and other standards listed below.

B. Reference Standards:

1. IBC current edition, especially Sec. 2336
2. NFPA bulletin 90A, current edition
3. UL Standard 181
4. Tri-services manual, fazel et al 1978

C. If a conflict occurs between these rules and this specification, the rules are to govern. Accept this condition upon submitting bid, and no extra charge will be allowed after the contract is awarded. This shall not be construed as relieving the contractor from complying with any requirements on the plans or specifications which may be in excess of requirements of the hereinbefore mentioned rules and not contrary to same. Contractor shall bear all costs arising from the installation of any materials or equipment which is in conflict with the above mentioned codes or ordinances.

D. Obtain approvals, inspections, etc., required by code. All fees shall be included in the contract price. The contractor shall furnish a certificate of approval to the Owner's Representative from the inspection authority at completion of the work.
2.4 MATERIALS AND WORKMANSHIP

A. All materials and equipment furnished and installed shall be first quality, new and meet the standards of NEMA, IPCEA, LS, UL, NFPA, UBC, UOSH, NEC, and shall bear their label wherever standards have been established and label service is available. Where materials and equipment are specified by manufacturer's name, and type and quality required is thereby denoted. The Owner's Representative shall be afforded every facility, deemed necessary to inspect and examine the materials and apparatus being installed to provide their quality, skill and competency of workmanship.

B. Workmanship shall be the best quality of its kind for the respective industries, trades, crafts and practices and shall be acceptable in every respect to the Owner's Representative. Nothing contained herein shall relieve the contractor from making good and perfect work in all details of construction.

C. The contractor shall work in harmony with the Owner's Representative and with other contractors, companies or individuals working in connection with this project. Imperfections or errors by other contractors shall not relieve responsibility of this contractor. Store materials orderly and clean up without interference.

2.5 QUALITY ASSURANCE

A. The contractor shall be held responsible for purchasing and installing vibrator isolators, flexible connections, rigid steel frames, concrete inertia bases, anchors, inserts, hangers, and attachments, seismic bracing and snubbers as required for seismic control and prevention of the transmission of vibration for both isolated and non-isolated systems.

B. Manufacturers and suppliers approved for use by the contractors Mason Industries, Inc., Korfund, and Amber/Booth Company.

C. The approved manufacturer or supplier shall be totally responsible for the fabrication and operation of the seismic bracing components specified herein for all isolated equipment, non-isolated equipment, fixtures, raceways, etc.

2.6 GUARANTEE

A. The entire electrical system installed under this contract shall be left in proper working order and be in compliance with the drawings, specifications and/or authorized changes to the satisfaction of the Owner's Representative. Without additional charge, replace any work or materials which develop defects, except from ordinary wear, within one year from the date of substantial completion. A written guarantee covering the above provisions shall be signed as delivered to the architect after the project has final acceptance by the inspecting authority.
PART 3 - PRODUCTS

3.1 ISOLATED EQUIPMENT

A. All vibration isolated equipment shall be mounted on rigid steel frames or concrete bases. 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. The snubbers shall consist of interlocking steel members restrained by shock absorbent rubber materials compounded to bridge bearing specifications.

B. Elastomeric, 50 durometer, materials shall be replaceable and a minimum of 3/4” thick. Snubbers shall be manufactured with an air gap between hard and resilient materials of not less than 1/8” nor more than 1/4”. Snubbers shall be installed with factory set clearances.

C. The capacity of the seismic snubbers at 3/8” deflection shall be 3 to 4 times the load assigned to the mount grouping in its immediate area.

3.2 NON-ISOLATED EQUIPMENT, RACEWAYS, ETC.

A. All non-isolated equipment shall be installed according to 1991 Uniform Building Code Sec. 2312 (g): Cp Factor Table 23J, I Factor Table 23K. In addition the vertical forces, restraint requirements shall be computed as .5g the value of the lateral forces.

B. All non-isolated raceway shall be protected against seismic disturbances except as noted below:

1. All electrical conduit less than 2” inside diameter.

PART 4 - EXECUTION

4.1 SEISMIC REQUIREMENTS

A. All electrical work shall be braced, snubbed or supported to withstand seismic disturbances and remain operational. Furnish all labor, materials and equipment to provide protection against seismic disturbances and remain in place.

4.2 SHOP DRAWING SUBMITTAL AND REVIEW

A. Submit complete, bound submittal in a looseleaf binder large enough for all items (8 copies) to architect after award of contract. All such submittals shall include, but are not necessarily limited to, the following:

1. Complete engineering calculations and shop drawings, prepared and stamped by a licensed engineer (UBC 302-6) for all seismic requirements for all equipment that is to restrain raceways, etc.
2. The type, size and deflection of each isolator proposed for items in this specification and on the drawings.
3. Details for all the isolators and seismic bracing with snubber proposed for items in this specification and on the drawings.
4. Details for steel frames and concrete inertia bases to be used in conjunction with the isolation of the items in this specification and drawings.
5. Clearly outlined procedures for installing and adjusting the isolators, seismic bracing and snubbers.
6. The size, loading and location of raceway supports with either a plan or complete description of the system.

B. All items must be submitted at the same time. Partial submittals will not be accepted. Binders and indexes will remain in possession of engineer, architect, contractor and sub-contractor.

C. Review is for assistance and interpreting the design concept. Changes in requirements will not be made in the review process. Review action does not exempt requirements to meet the intent of the contract documents. Any changes will be made by change order. Items not included in the submittal or incorrectly selected shall be in accordance with the contract requirements.

END OF SECTION 16072
SECTION 16075 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The Electrical Contractor is responsible for the labeling of all electrical equipment for this project. The labels shall be made on one-eighth inch laminated Micarta and an engraving machine as stated below.

B. Labeling and Engraving: Any and all electrical control equipment shall be labeled with an engraved black Micarta with white core labels, 1/16" thick, shall be bolted on the interior and the exterior of branch panels (panel name and voltage) and the exterior of disconnect switches, motor controls, major J-boxes (power and auxiliary), push buttons, thermal switches, time switches and similar equipment. The labels shall have 1/4" high engraved letters, such as 1-1/2 HP FAN, PANEL - A. All main panel circuits shall be identified with Micarta labels. (RED MICARTA LABELS shall be used on emergency powered equipment.)

C. The phase of each feeder conductor shall be color coded at each end in panels and junction boxes. The feeder powers shall be attached to the bundle of cables with a tie-wrap.

D. Conduit shall be installed as diagramed on the plan. Any deviation shall be authorized in writing prior to rough-in.

E. A plastic label, as noted above with the name and address of the Engineer: Nielson Engineering, Inc., Pocatello, Idaho, Phone 208-232-2577 - the profession indicated - shall be bolted to the front of the Main Power Panel. The engraved letters in the name and address shall be 1/2" and 1/4" high, respectively.

F. Write with a felt tip pen that contains permanent ink, on the inside of each device box and on the back of every plate, the circuit to which the device is connected. Example: Circuit “A-1”.

G. Engraving device plates - see WIRING DEVICES.

END OF SECTION 16075
SECTION 16110 - CONDUIT RACEWAYS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Extent of raceway work is indicated by drawings and schedules.

B. Types of raceways in this section include the following:

1. Electrical Metallic Tubing (EMT).
2. Flexible Metal Conduit.
3. Intermediate Metal Conduit (IMC).
4. Liquid-Tight Flexible Metal Conduit.
5. Rigid Metal Conduit (RMC).
6. Rigid Non-Metallic Conduit. (below grade only w/RMC elbows)

C. Prohibited Raceway Materials:

1. Aluminum Conduit.
2. Electrical Non-Metallic Tubing (ENT).
3. Armored Cable Type AC (BX) Cable.
4. Metal-Clad Cable Type MC Cable.

D. Prohibited Fitting Materials:

1. Crimp-on, Tap-on, Indenter Type Fittings.
2. Cast Set-Screw Fittings for EMT.

1.2 QUALITY ASSURANCE

A. MANUFACTURERS: Firms regularly engaged in the manufacture of raceway systems of types and sizes required, whose products have been in satisfactory use in similar service for not less than three (3) years.

B. STANDARDS: Comply with applicable portions of NEMA standards pertaining to raceways. Comply with applicable portions of UL safety standards pertaining to electrical raceway systems; and provide products and components which have been UL-listed and labeled. Comply with NEC requirements as applicable to construction and installation of raceway systems.

C. MINIMUMS: Minimum, conduit sizes shall be as per NEC Tables 3A, 3B, and 3C or as shown on plans. Minimum home run size shall be 3/4". Electrical contractor shall not modify the wiring arrangement without prior approval from Engineer.

1.3 SUBMITTALS

A. Not required.
PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. GENERAL: Provide metal conduit, tubing and fittings or types, grades, sizes and weights (wall thicknesses) as indicated; with minimum trade size of 3/4".

B. Data/telephone conduit shall be installed as shown with 1-1/4" being the minimum size.

C. ELECTRICAL METALLIC TUBING (EMT): FS WW-C-563 and ANSI C80.3.

1. EMT FITTINGS: Provide and install set-screw type malleable steel fittings: connectors shall be insulated throat type, concrete tight where required by application. Install OZ Type B bushings on conduits 1-1/4" and larger.
2. Provide red EMT for fire alarm system (Allied “Fire Alarm E-Z Pull” or equivalent).
3. Provide blue EMT for data voice, video and Security System (Allied “Blue EMT E-Z Pull” or equivalent).

D. FLEXIBLE METAL CONDUIT: FS WW-C-566, of the following type:

1. Zinc-coated steel.
2. FLEXIBLE METAL CONDUIT FITTINGS: FS W-F-406, Type 1 Class 1, and Style A.

E. INTERMEDIATE METAL CONDUIT (IMC): RS 22-C-581.

1. INTERMEDIATE STEEL CONDUIT FITTINGS: Provide fully threaded malleable steel couplings; raintight and concrete tight where required by application. Provide double locknuts and metal bushings at conduit terminations, us OZ Type B bushing on conduits 1-1/4" and larger.

F. 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). Type UA and/or NMLT-B non-metallic.

1. LIQUID-TIGHT FLEXIBLE METAL CONDUIT FITTINGS: FS W-F-406, Type 1, Class 3, Style G and/or fittings to match the specified non-metallic conduit noted above.

G. RIGID METAL CONDUIT (RMC): FS WW-C-0581 and ANSI C80.1.

1. RIGID STEEL CONDUIT FITTINGS: 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). Type UA and/or NMLT-B non-metallic.

1. PVC EXTERNALLY COATED RIGID STEEL CONDUIT FITTINGS: 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). Type UA and/or NMLT-B non-metallic.

I. EXPANSION FITTING: OZ Type AX, or equivalent of suit application.

2.2 NON-METALLIC CONDUIT AND DUCTS (Below grade only)

A. GENERAL: Provide non-metallic conduit, ducts, and fittings of types, sizes and weights (wall thicknesses) as indicated shall not be installed inside the building, except it be encased in concrete and surfaces through a RMC elbow; with minimum trade size of 3/4". In this specification, it is not permitted above grade for any reason.

B. UNDERGROUND PVC PLASTIC UTILITIES DUCT: ANSI/NEMA TC 6, Type 1 for encased burial in concrete, Type II for direct burial.

1. PVC AND ABS PLASTIC UTILITIES DUCT FITTINGS: ANSI/NEMA TC9, match to duct type and material.

2. CONDUIT, TUBING, AND DUCT ACCESSORIES: Provide conduit, tubing and duct accessories of types, sizes, and materials, complying with manufacturer's published product information, which mate and match conduit and tubing.

C. SEALING BUSHINGS: Provide OZ Type FSK, or FSKA.

D. SPECIAL GROUND: To maintain the building ground continuity, a NEC size ground shall be installed in each non-metallic conduit run, where the system voltage is greater than 48-volts.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL RACEWAYS

A. Install electrical raceways where indicated; in accordance with manufacturer's written instructions, applicable requirements of NEC, NECA "Standard of Installation", and in accordance with the following.

B. FEEDERS UNDER 600 VOLTS: Install feeders to panels, motor control centers and individual equipment feeders rated 100 amps and greater, in rigid metal conduit (RMC), or intermediate metal conduit (IMC) where buried below grade, install in non-metallic conduit or duct. Feeder conduits 1-1/2” round and larger shall be encased in concrete as a part of the floor. Do not install conduit up in the floor. Install conduit just below the floor with the top of the conduit touching the bottom of the slab and the bottom of the conduit being covered with at least 1” of concrete.

C. FEEDERS OVER 600 VOLTS: All feeders over 600 volts shall be installed in RMC when installed inside of building. The conduit shall be supported in accordance with Section 16136.
D. Outside feeders below grade shall be installed in RMC and/or PVC conduit shrouded with a minimum of 3" cover of red concrete with a #3 rebar in opposite corners. The top of the duct bank shall be set 48-inches below finish grade.

E. BRANCH CIRCUITS, SIGNAL AND CONTROL CIRCUITS, AND INDIVIDUAL EQUIPMENT CIRCUITS RATED LESS THAN 100 AMPS: Install in electric metallic tubing (EMT); except in poured walls, floor slabs, below concrete slab-on-grade, or in earth fill. Conduits installed in before mentioned areas shall be non-metallic plastic duct. Encase non-metallic plastic duct 1-1/4” and larger in concrete.

F. Coordinate with other work, including metal and concrete deck work, as necessary to interface installation of electrical raceways and components.

G. **When non-metallic conduit is used it shall come to the surface in a RMC elbow or box.**

H. Install raceway in accordance with the following:
   1. Provide a minimum of 12” clearance from flues, steam and hot water piping, etc.
   2. Conceal raceways in finished walls, ceilings and floors (other than slab-on-grade). Where conduit is exposed in mechanical spaces, etc., install parallel with or at right angles to building or room structural lines.
   3. Where cutting raceway is necessary, remove all inside and outside burrs; make cuts smooth and square with raceway.
   4. **Flexible raceways shall not be concealed in construction and where installed the run shall be limited to 4 feet in length.**
   5. Comply with NEC requirements for installation of pull boxes in long runs.
   6. All raceways (metallic and non-metallic) shall terminate in a connection and/or bushing.

I. Division 15 shall install control conduit for Division 15 equipment.

J. Install fire alarm cable/conductors above grade in red fire alarm conduit (See 2.1-C(2)).

K. Install data, voice, video, and security cables above grade in blue conduit (See 2.1-C(3)).

3.2 NORMAL INSTALLATIONS

A. Cap open ends of conduits and protect other raceways as required against accumulation of dirt and debris. Pull a mandril and swab through all conduit before installing conductors. Install a 200 lb. nylon pull cord in each empty conduit run.

B. Replace all crushed, wrinkled or deformed raceway before installing conductors.

C. Provide rigid metal conduit (RMC) for all bends in buried conduit greater than 30 degrees. Provide a protective coating for RMC bend as specified herein.

D. Where raceways penetrate building or vault walls and floors below grade, install rigid metal conduit (RMC) for a minimum distance of 10 ft. on the exterior side of the floor or wall. Provide OZ, Type FSK or WSK sealing bushings (with external membrane clamps as applicable) for all conduit penetrations entering building or vaults below grade.
E. Install liquid-tight flexible conduit for connection of motors, transformers, and other electrical equipment where subject to movement and vibration.

F. Install five spare 3/4" conduit (capped) from each flush branch panelboard into accessible ceiling and floor space. Where the floor is not accessible run six conduits into accessible ceiling space. Run conduits the required distance necessary to reach accessible ceiling space.

G. Provide OZ expansion fittings on all conduits crossing building expansion joints, both in slab and suspended.

H. Complete installation of electrical raceways before starting installation of cables/conductors within raceways.

I. All conduit that penetrates the roof shall be flashed with a factory jack, see Section 16001/1.3.

3.3 GROUNDING

A. All metal conduit terminations shall be equipped with a grounding bushing.

B. To maintain the continuity of the building ground network, install a code size ground conductor in all non-metallic conduit.

3.4 FIRE PENETRATION SEALS

A. All penetrations through fire rated floors and walls shall be sealed to prevent the spread of smoke, fire, toxic gas or water through the penetration either before, during or after the fire. The fire rating of the penetration seal shall be at least that of the floor or wall into which it is installed so that the original fire rating of the floor or wall is maintained as required by Article 300-21 of the National Electrical Code. The sealant shall remain soft and pliable to allow for the removal and/or addition of cables without the necessity of drilling holes. It shall adhere to itself to allow any and all repairs to be made with the same material. It shall permit the vibration, expansion and/or contraction of raceways and/or cables going through the penetration without the seal cracking or crumbling.

B. When damming materials are to be left in place after the seal is complete, all such materials shall be non-flammable.

C. When sealant is injected into a penetration, the foam shall expand to surround all items within the penetration and maintain pressure against the walls of the penetration. The foam shall cure within five minutes and be fire resistant at that time. No heat shall be required to further expand the foam to block the passage of fire and smoke or water.

D. All wall or floor penetration opening shall be as small as possible.

E. The foam sealant shall meet all of the fire test and hose stream test requirements of ASTM E119-73 and shall be UL Classified as a Wall Opening Protective Device. The sealant shall be CHASE-FOAM CTC PR-585 Fire Resistant Foam Sealant from Chase Technology Corporation, Huntington Station, New York, 11746, or equals of 3m and T &B.
F. Escutcheon plates - when a conduit passes through a ceiling, wall and/or floor into a finished space, an escutcheon plate shall be installed on the conduit to cover the unfinished hole and sealant.

3.5 PROHIBITED PROCEDURES

A. Use of wooden plugs inserted in concrete or masonry units for mounting raceway, supports, boxes, cabinets, or other equipment.

B. Installation of raceway which has been crushed or deformed.

C. Use of torches for bending PVC.

D. Spray applied PVC cement.

E. Boring holes in truss members.

F. Notching of structural members.

G. Supporting raceway from ceiling system support wires.

H. Nail drive straps for supporting raceway.

3.6 EXCAVATION AND BACKFILL

A. Raceway installation below slab-on-grade, or below grade:
   1. The Electrical contractor is responsible for all excavation and backfill related to the electrical installation defined herein and/or as indicated on the plans.

B. UNDERGROUND RACEWAY AND CONDUIT:
   1. Bury underground raceway installed outside building 24 inches deep minimum.
   2. Wrap buried galvanized RMC and galvanized IMC conduit and fittings with vinyl tape where in contact with earth or concrete.
   3. Opening of finished surfaces asphalt concrete, grass, etc. shall be accomplished by first identifying the limits of the opening then cut within the limits preserving the undisturbed areas. Asphalt shall be cut with a wedging tool, concrete with a diamond saw and grass with a cutter.
   4. Excavation shall be accomplished with the proper equipment, protective care shall be taken to not disturb the adjacent surfaces and materials. This contractor is responsible and shall protect all material objects and things adjacent to the excavation.
   5. All materials not reinstalled in the installation shall be removed from the premise.
   6. Backfill the first six (6) inch layer over the installed subject (conduit, cable, etc.) shall be sand. Subsequent six (6) inch layers shall be loam soil. Each layer shall be compacted to a 90% standard proctor test before the next layer is applied. (Refer to Section 16110, Part 3 for conduits required to be encased in concrete).
COUNTY FAIRGROUNDS BUILDING  
CACHE COUNTY

7. For slab-on-grade construction, install runs of rigid plastic conduit (PVC) below slab. Install RMC (with protective coating) for raceways passing vertically through slabs on grade. Slope raceways as required to drain away from electrical enclosures and to avoid collection of moisture in raceway low points.

8. Apply protective coating to metallic raceways in direct contact with earth or fill of any type; consisting of spirally wrapped PVC tape (1/2" minimum overlap of scotch wrap tape or equal); or factory applied vinyl cladding (minimum thickness .020 inches). Completely wrap and tape all field joints.

9. Mark all buried conduits which do not require concrete encasement by placing yellow plastic marker tape (minimum 6" wide) along entire length of run 12" below final grade. Where multiple small lines are buried in a common trench and do not exceed an overall width of 16", install a single line marker.

10. Conduits encased in concrete shall be shrouded with a 3” of Red concrete. Install #3 rebar in opposite corners of the encasement except for two conduits or less where two #3 bars in opposite corners is acceptable.

D. RACEWAY INSTALLATION IN SUSPENDED SLABS:

1. Install conduit as close to the middle of concrete slab as practicable without disturbing reinforcement. Do not install conduits of diameter greater than 1-1/4" of the slab thickness. Space conduits not less than 3 diameters on center (except at stub up locations). Provide OZ expansion fittings at all expansion joints. All raceways shall be installed with concrete tight fittings.

2. Install RMC in all hazardous locations as defined by NEC. Provide suitable fittings, seal-offs, boxes, etc. to comply with requirements.

END OF SECTION 16110
SECTION 16120 - CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Extent of electrical conductor and electrical cable work is indicated by drawings and schedules.

B. Types of conductors and cables in this section include the following:

   1. Copper Conductors (600V)

C. Applications for conductors and cables required for project include:

   1. Feeders
   2. Branch Circuits

1.2 QUALITY ASSURANCE

A. Comply with NEC as applicable to construction and installation of electrical conductors and cable. Comply with UL standards and provide electrical conductors and cables which have been UL-listed and labeled.

B. Comply with applicable portions of NEMA/Insulated Cable Engineers Association standards pertaining to materials, construction and testing of conductors and cable.

C. Comply with applicable portions of ANSI/ASTM and IEEE standards pertaining to construction of conductors and cable.

D. Non-approved materials.

   1. AFC Cabling
   2. Non-metallic sheathed cable.
   3. Service entrance cable.

1.3 SUBMITTALS

A. FIELD TEST DATA: Submit test data in accordance with IEEE Standard 400-1980 showing ambient conditions, voltage levels, level durations, and conduction current for each step. Include effective insulation resistance in submittal.

PART 2 - PRODUCTS

2.1 COPPER CONDUCTORS (600V)

A. All conductors shall be copper with 90% conductivity.

B. Provide factory-fabricated conductors of sizes, ratings, materials, and types indicated for each service. Where not indicated provide.
C. Proper selection to comply with project's installation requirements and NEC standards. Provide conductors in accordance with the following:

1. Distribution and Panelboard Feeders; and other conductors, #2 AWG and larger shall be Copper; see drawings for size.
2. Conductors: All conductors shall be jacketed with THHN or XHHW insulation. Size all conductors in accordance with NEC; minimum size to be #12 AWG. Provide stranded conductors for #10 AWG and larger. Provide THHN insulated conductors (in dry areas) from outlets to fixtures, and in fixture channels.
3. Conductor ampacity shall comply when local codes have a derating factor because of ambient temperature.
4. Provide color and coding of conductors as follows:
   a. Conductors
      1) All conductors shall be stranded copper wire, #12 AWG & #14 AWG may be solid copper. Color code all 208 volt wiring using black for phase A, red for phase B, blue for phase C, white for neutral and green for equipment ground.
      2) Color code all 480 volt brown for phase A, orange (purple) for phase B, yellow for phase C, gray for neutral, and green for equipment ground. A green ground shall be pulled in every conduit - see Grounding.
   b. Motor Control
      1) Motor Feeders Black
      2) Hot or Stop Lead Red
      3) Start Lead Blue
      4) Common White
      5) Indicating Light Orange
      6) Interlock or Shunt Brown
      7) Ground Green
   c. Isolated Ground
      1) In all distribution feeders to panels having an isolated ground bar, install an insulated #8 green with orange stripe isolated ground conductor in that feeder conduit.
      2) In all branch circuits powering an IG receptacle, install #12 or insulated green with orange stripe isolated ground conductor. (See General Cable Co.)

2.2 AUXILIARY CABLES

A. The contractor shall provide and install a cable from each auxiliary system as noted below (before ordering this cable, check the specific auxiliary system 16700 - 16800 for exact cables). The cables shall be as noted in the specification for each specific system.

2.3 CONNECTING BLOCKS (Also see Section 16150)

A. Taps made to conductors in wireways, switchgear, J-Boxes, etc. larger than #10 shall be made with an insulated connector. The connector block shall be an alloy that is completely compatible with copper, aluminum alloy 6061-T6 conductive plating for low contact resistance, excellent anti-pull out ability and set-screw for suring in place. The block shall be insulated with a molded high dielectric plastisol that will not support combustion, abrasive and chemical resistant. All connections shall comply with rated for 600 volt 90°C and comply with NEC 100. Torque each lug to the recommendations of the manufacturer.
COUNTY FAIRGROUNDS BUILDING
CACHE COUNTY

B. The unit shall be Polaris Series IPL (in and out same side), other types are: Series IPL (double row), Series IT (in and out), Series IPLD (pass through), etc. The contractor shall decide which type of connection is best suited for installation.

PART 3 - EXECUTION

3.1 INSTALLATION

GENERAL: Install electrical conductors and cables as indicated, in compliance with manufacturer’s written instructions, applicable requirements of NEC and NECA’s "Standards of Installation", and in accordance with recognized industry practices.

A. Provide #10 AWG conductor for all three and four wire fluorescent circuit home runs.

B. Conductor size noted in panels is for the home-run. The conductor may be changed to code size after the first apparatus.

C. Parking Lot conductors shall be installed of the size noted until a change is indicated. Minimum size #10.

D. "G" in the Conduit symbol denotes a green ground (#12 for branch circuits, #10 interconnecting outside flood lights and all parking lot poles) which shall be installed in the conduit with other conductors. It shall connect with an insulated ground bar in the panel.

E. Coordinate installation work with electrical raceway and equipment installation work, as necessary for proper interface.

F. Use pulling compound or lubricant, where necessary; compounds must not deteriorate conductor or insulation.

G. Keep conductor splices to minimum in a J-box.

H. Install splices and tapes which have mechanical strength and insulation rating equivalent- or-better than conductor.

I. Use splice and tap connectors which are compatible with conductor material.

J. The conductor ends shall be stripped at the ends to comply with the following chart:

<table>
<thead>
<tr>
<th>CONNECTOR SIZE</th>
<th>LENGTH (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>2</td>
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<tr>
<td>350</td>
<td>1.75</td>
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<tr>
<td>1/0</td>
<td>1.25</td>
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<tr>
<td>#4</td>
<td>0.875</td>
</tr>
</tbody>
</table>
2. All conductor connections on lugs, breakers, connection blocks, etc. of the set-screw type shall be set with a torque wrench in strict accordance with industry standards as recommended for each conductor size.

3. Lug Torque Chart

<table>
<thead>
<tr>
<th>CONN SIZE</th>
<th>500</th>
<th>350</th>
<th>250</th>
<th>3/0</th>
<th>1/0</th>
<th>#4</th>
</tr>
</thead>
<tbody>
<tr>
<td>AWG/MCM WIRE SIZE</td>
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<td>35</td>
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</tbody>
</table>

K. Vertical Support: Conductors rising vertically shall be supported with conduit kellem grips or equal, in accordance with NEC section 300-19.

<table>
<thead>
<tr>
<th>Cable Vertical Support Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conductor Size</td>
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<tr>
<td>12 - 1/0</td>
</tr>
<tr>
<td>2/0 - 4/0</td>
</tr>
<tr>
<td>4/0 - 350 KCM</td>
</tr>
<tr>
<td>500 KCM</td>
</tr>
</tbody>
</table>

3.2 AUXILIARY SYSTEMS

A. Telephone: From each telephone outlet shown on the plans, install a telephone cable. One end of the cable shall terminate in the telephone jack and the other shall end in an 8-ft service loop at the telephone board. Numerically, identify each cable at both ends.
B. Voice/Data: From each voice/data outlet shown on the plans, install a voice/data cable. The cable shall run from the indicated outlets to the telephone/computer board - see schedule on the plans.

C. The cables shall terminate in the indicated voice/data jack outlet shown on the plans. The other end shall terminate as an eight (8) foot service loop at the telephone/data board. Each cable shall be numerically identified on each end.

3.3 FIELD QUALITY CONTROL

A. Prior to energization, test cable and wire for continuity of circuitry, and also for short circuits. Correct malfunctions when detected.

B. Check and prove the proper phase rotation of all rotating equipment powered by this network.

C. Subsequent to wire and cable connections, energize circuitry and demonstrate functioning in accordance with requirements. (SEE SECTION ON COMPLETION AND TESTING)

END OF SECTION 16120
SECTION 16130 - BOXES, PULL BOXES, AND CONDUIT BODIES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Extent of electrical box and electrical fitting work is indicated by drawings and schedules.

B. Types of electrical boxes and fittings in this section include the following:

1. Outlet boxes
2. Junction boxes
3. Pull boxes
4. Floor boxes
5. Ground boxes
6. Conduit bodies
7. Bushings
8. Locknuts
9. Knockout closures
10. Miscellaneous boxes and fittings

1.2 QUALITY ASSURANCE

A. Comply with NEC as applicable to construction and installation of electrical boxes and fittings. Comply with ANSI C 134.1 (NEMA Standards Pub. No. OS 1) as applicable to sheet-steel outlet boxes, device boxes, covers and box supports. Provide electrical boxes and fittings which have been UL-listed and labeled.

1.3 SUBMITTALS

A. None required.

PART 2 - PRODUCTS

2.1 FABRICATED MATERIALS

A. INTERIOR OUTLET BOXES: Provide one piece, galvanized flat rolled sheet steel interior outlet wiring boxes, of types, shapes and sizes, including box depths, to suit each respective location and installation; construct with stamped knockouts in back and sides, and with threaded screw holes with corrosion-resistant screws for securing box covers and wiring devices; standard box shall be 4” square x 2-1/8” deep, (Raco 231) with 3/4” knock outs and tile or masonry/type box extensions (Raco 843).

B. If the structure will not allow a 4 square box use a 3” deep single gang unit (Raco 695).

C. In spaces with restricted width, like between a door frame and window jam, use partition boxes (Raco 426).
D. INTERIOR OUTLET BOX ACCESSORIES: Provide outlet box accessories as required for each installation, including mounting brackets, hangers, masonry extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used and fulfilling requirements of individual wiring applications. See the details on the plans.

E. WEATHERPROOF OUTLET BOXES: Provide corrosion-resistant cast-metal weatherproof outlet wiring boxes, of types, shapes and sizes (including depth) required, with threaded conduit ends, cast-metal face application, with face plate gaskets and corrosion-resistant fasteners.

F. JUNCTION AND PULL BOXES: Provide code-gage sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws and washers. J-box larger than 8 x 8 x 6 shall have a hinged cover.

G. CONDULET BODIES (FITTINGS): Provide galvanized cast-metal conduit bodies, of types, shapes and sizes to suit respective locations and installation, construct with threaded-conduit-entrance ends, removable covers, and corrosion-resistant screws.

H. BUSHINGS, KNOCKOUT CLOSURES AND LOCKNUTS: Provide corrosion-resistant punched-steel box knockout closures, conduit locknuts and malleable iron conduit bushings and offset connectors, or types and sizes to suit respective uses and installation.

2.2 FLOOR BOXES

A. All floor boxes, unless otherwise indicated, shall be T & B #664/(2) 664-RP/664CST GRY or equals of Hubbell (from the contract documents, confirm floor covering where the box is installed, and determine the floor covering (carpet or tile) select the proper box cover). See plans and Section 16140 for devices to be installed.

2.3 GROUND BOXES

A. All ground boxes shall be mounted to be flush with the finished grade. (See architectural plans)

B. All J-boxes installed outside where access is needed shall be a composition type capable of withstanding the elements for an indefinite period of time. The boxes shall be rated for no less than 5,000 - lbs over a 10" x 10" area and be designed and tested to temperatures of 50 degrees F. The material compressive strength shall be no less than 11,000 psi. Provide a locking cover (Label electrical with bolt and locking mechanism) shall have a minimum coefficient of friction of 0.5. The boxes shall be stackable for extra depth if needed. The bottoms of the boxes are open and shall have a 6" layer of pea gravel in the bottom. The unit shall be of the size noted on the plans.

2.4 FITTINGS

A. The contractor shall provide all steel metallic connectors, coupling, etc, a needed on this project.
B. When installing non-metallic sheathed cable, all connections to boxes, cabinets, etc., shall be made with screw steel fittings with a locknut connection to the box.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Interface with other work.

B. Coordinate location of outlet for water cooler with Division 15.

C. Coordinate location of outlets adjacent to or in millwork with Division 06 before rough-in. Refer conflicts to Architect and locate outlet under his direction.

D. Coordinate with Division 15 for installation of exposed raceway in mechanical equipment areas. Exact separation of responsibility is shown on Drawings.

E. Mount switch boxes with long dimension vertical.

F. **Mount receptacle boxes with long dimension vertical.**

G. Boxes shall be accessible and installed with approved cover.

H. Do not locate device boxes which are on opposite sides of framed walls in the same stud space. In other wall construction, do not install boxes back to back. See Detail 5/ED-101.

I. Locate boxes so outlets are not obstructed by pipes, ducts, or other items.

J. Install outlets flush with finished surface and level and plumb.

K. Boxes for switches shall generally be located within 6 inches of door jamb.

L. Properly center single outlets in each room. Where two or more outlets occur, space them uniformly and in straight lines with each other.

M. Support switch boxes larger than two-gang with side brackets and steel bar hangers in framed walls.

N. HVAC Instrumentation and Control System:

   1. Mount remote sensor outlet boxes with long dimension vertical.
   2. Mount thermostat outlet boxes with long dimension horizontal.

O. Install electrical boxes and fittings where indicated, complying with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

P. Minimum height of wall receptacles shall be 18". With the box arranged for horizontal mounting of the receptacles (ground slot at the bottom).
Q. Coordinate installation of electrical boxes and fittings with wire/cable and raceway installation work.

R. Provide coverplates for all boxes. See Section 16140, Wiring Devices.

S. Provide weatherproof outlets for interior and exterior locations exposed to weather or moisture.

T. Provide knockout closures or cap unused knockout holes where blanks have been removed.

U. Install boxes and conduit bodies to ensure ready accessibility of electrical wiring. Install recessed boxes with face of box or ring flush with adjacent surface so the device mounting flange sets on the box mounting plate. This will cause the device and coverplate surfaces to match.

V. Fasten boxes rigidly to substrates or structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry. Use bar hangers for stud construction. Use of nails for securing boxes is prohibited. Set boxes on opposite sides of common wall with minimum 10" of conduit between them.

W. Provide electrical connections for installed boxes.

END OF SECTION 16130
SECTION 16140 - WIRING DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The extent of wiring device work is indicated by drawings and schedules. Wiring devices are defined as a unit of an electrical system that carries or controls electric energy as its principal function.

B. Types of electrical wiring devices in this section include the following:

1. Switches
2. Receptacles
3. Cord caps and connectors
4. Wiring device accessories

1.2 QUALITY ASSURANCE

A. Comply with NEC and NEMA standards as applicable for construction and installation of electrical wiring devices. Provide electrical wiring devices which have been UL listed and labeled.

1.3 SUBMITTALS

A. PRODUCT DATA: Submit manufacturer's data on electrical wiring devices.

PART 2 - PRODUCTS

2.1 FABRICATED WIRING DEVICES

A. GENERAL: Provide factory-fabricated wiring devices, in types, and electrical ratings for applications indicated and complying with NEMA Std. Pub. No. WD 1. The devices shall be white with white coverplates.

B. Provide wiring devices (of proper voltage rating) as follows:

<table>
<thead>
<tr>
<th>SWITCHES</th>
<th>(20A Continuous Rating)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MFRGR.</td>
<td>1-Pole</td>
</tr>
<tr>
<td>Hubbell</td>
<td>DS120W</td>
</tr>
<tr>
<td>P&amp;S</td>
<td>2621W</td>
</tr>
<tr>
<td>Leviton</td>
<td>5621-2W</td>
</tr>
<tr>
<td>Eagle</td>
<td>7622W-Box</td>
</tr>
<tr>
<td>Bryant</td>
<td>9901W</td>
</tr>
</tbody>
</table>
C. Special devices as indicated on the plans, complete with matching coverplates shall be provided and installed where indicated.

D. All weatherproof covers on receptacles (GFI) and/or switches shall be mounted on a recessed box. Cover shall be made of cast aluminum such as Hubbell WP26EH. Equals of T&B and TayMac are acceptable. GFI receptacle shall be weather resistant as indicated in schedule above.

E. Provide devices in colors selected by Architect.

F. Supply tamper-resistant devices per NEC and as noted on plan.

2.2 CORDS CAPS AND CONNECTORS

A. Provide 3-wire grounding, cap plugs, and connectors of ampere and voltage rating required, for final equipment connection, and as indicated otherwise on drawings. Provide products of one of the following manufactures:

1. Arrow Hart
2. General Electric
3. Hubbell
4. Leviton
5. Pass and Seymour
6. Bryant 7

2.3 WIRING DEVICE ACCESSORIES

A. WALL PLATES: Provide and install high impact, smooth, white nylon coverplates for all wiring devices. Provide galvanized steel plates in unfinished or kitchen areas. Engrave all receptacle plates other than those serving 120 volt, single phase devices. State voltage and amperage characteristics. Example: "208V, 30A".

B. All switch banks shall have each switch identified as to its function with 1/8" thick laminated micarta engraved adhesive plate.

C. Weatherproof coverplates shall be Arlington DSHB1BRC. Equals of T & B and TayMac are acceptable.
D. Emergency power coverplate shall be "RED", engrave "Emergency Power" on coverplate.

PART 3 - EXECUTION

3.1 GENERAL

A. Install wiring devices as indicated, in compliance with manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation", and in accordance with recognized industry practices to fulfill project requirements.

B. Coordinate with other trades (including painting), the installation of electrical boxes and wiring. Install devices in boxes such that front of device is flush and square with coverplate. Drawings are small scale and, unless dimensioned, indicate approximate locations only of outlets, devices, equipment, etc. Locate outlets and apparatus symmetrically on floors, walls and ceilings where not dimensioned and coordinated with other work. Verify all dimensioned items on job site. Consult architectural cabinet, millwork, and equipment shop drawings prior to rough-in of electrical work.

C. Receptacles: **The receptacles shall be mounted vertically** with the neutral terminal or slot at the left side.

D. Install devices only in electrical boxes which are clean; free from excess building materials, dirt, and debris. Mark each box and the back of each device plate, with felt tip marker, indicating the circuit or port to which the device is connected. Example: "CKT A-1".

E. Install blank plates on all boxes without devices.

F. Delay installation of wiring devices until wiring work is completed. Delay installation of wall plates until after painting work is completed.

G. Do not Edison or share neutral conductors between phases.

3.2 PROTECTION OF WALL PLATES AND RECEPTACLES

A. At time of substantial completion, replace those items which have been damaged, including those stained, burned and scored.

3.3 GROUNDING

A. Provide electrical continuous, tight grounding connections for wiring devices, unless otherwise indicated.

3.4 TESTING

A. Prior to energizing circuitry, test with a hand test device that proves electrical connections: continuity, proper polarity, grounding, neutral connection, etc. Any irregularities shall be corrected.

END OF SECTION 16140
SECTION 16145 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The Contractor shall provide and install the lighting controls as noted, which shall include the controls, accessories, boxes, etc., to make the installation complete and operable.

1.2 MOTION DETECTORS

A. The contractor shall provide and install adjustable timer (6-15 min.) motion detectors as noted on the plans. The detectors shall be complete with sensors, relays, (or power pack) enclosures, etc. for a complete installation.

1. The small room wall detectors shall be of PIR technology. The unit shall cover a semi-circular area of 35-ft and shall be mounted 48-inches A.F.F. It shall be Watt Stopper WS-120/277 for 120 or 277-volts.

2. The ultrasonic detector shown in corridors is for controlling the total corridor light fixtures. It shall have a 10-ft. narrow beam for a range of 45-ft. on either side of the center line or a range of 90ft - see plan for layout. The unit shall be ceiling mounted spaced down to level with the bottom of any obstruction. It shall be Watt Stopper W-2255 (direction oriented) with power pack. A power pack can serve up to 3 sensors.

3. A detector requires a power pack for power control. The contractor shall provide and install these components as a part of the contract. The power pack unit shall be Watt Stopper C120E-P or C277E-P (confirm voltage).

4. In lavatories, mount on the ceiling an advanced ultrasonic sensor that is omni-directional, Doppler technology. The unit shall control a power pack (double contact) that will control the lights and the exhaust fan. The unit shall be a Watt Stopper WT1100 w/Power Pack C120E-P or C277E-P for 120 and 277-volts, respectively.

5. Provide and install “power packs and slave relays” as needed, for each sensor as required. The power pack shall be installed in a J-box located in an accessible location. Note the final location of the power pack on the plans. The power packs shall be C120E-P and C277E-P for 120 and 277-volts, respectively.

B. The detector shall have been tested and completed 60,000 successful operations.

C. Watt Stopper, Hubbell, Tork, or Sensor Switch are approved equals provided they meet the specifications and functions of the named units criteria. If the substituted units do not perform all the functions, the contractor shall provide the named and/or specified equipment.

D. nLight devices for function rooms, kitchen and exhibit hall are specified on Sheets E-201 and E202.

E. Submission: The contractor shall coordinate exact sensor location with manufacturer by submitting to the manufacturer a layout of the sensors for his review and evaluation. After the manufacturer has approved and endorsed the submitted plan, it shall be issued to the engineer as a shop drawing. The manufacturer shall provide the sensors as needed to perform the function and intents of the design.
1.3 PHOTO ELECTRIC RELAYS

A. The contractor shall provide and install photo switches/relays as noted on the plans. The photo switch shall be located at the indicated point and/or a location that will read daylight and wired into the system so that it will control the operation wherein it is placed.

B. The photo-switch/relay shall be such as Tork No. K4223C, with equals of Intermatic, Paragon as being acceptable.

1.4 TIME SWITCHES

A. The contractor shall provide and install a time-controlled switch of the type noted on the plans. The switches shall have two 30A switches for operation with a resistance or inductive load. The clocks shall operate on 120V AC with a 24-hour over-ride on power failure. The switches shall be as follows (with Tork, Paragon, and Intermatic as an acceptable equal):

1. 24-hour timer shall be Tork No. 1101NC
2. Astronomical timer shall be Tork No. DGLC
3. Elapse timer shall be Intermatic No. FF60M

1.5 LIGHTING CONTACTORS

A. The contractor shall provide and install multi-pole lighting contactors as shown on the plans. The scheduler may indicate more than the 4-pole, 30A, specified herein. If that be the case, provide the number of poles specified. The contactors shall be mechanically held 120-Volt coils such as Square “D” No. 8903 LXG60 V02. Refer to the schedule on the plans.

END OF SECTION 16145
SECTION 16150 - ELECTRICAL WIRING CONNECTIONS

PART 1 – GENERAL

The contractor shall make all electrical connections relating to the power, lighting and auxiliary systems for this project. Each connection shall be made in such a manner that it will not generate heat and destroy the connecting and/or the insulation on the conductor. All connections shall be made in a skilled craftsmanlike manner.

1.1 DESCRIPTION OF WORK (STANDARD CONNECTIONS)

A. All connections shall be in compliance with the 75° NEC ratings.

B. The conductors being connected shall be cut of sufficient length to conveniently make a splice - minimum 6-inches.

C. Conductors No. 8 and smaller can be connected with a spring wire connector after the conductors have been mechanically twisted two (2) turns.

D. Conductors No. 6 and larger shall be connected with pressure type terminal lugs of a type hereafter noted.

E. All connections made shall be set in compliance with the lug torque chart in Section 16120.

F. All conductor connections No. 8 and smaller made below a point 24” above grade outside the building shall be made with a non-hardening sealant connector.

G. All conductor connections No. 6 and larger shall be made with water tight connectors.

1.2 PRODUCT DATA

A. Conductors No. 8 and Smaller: Free spring wire connectors made from flame retardant thermo plastic rated at 105° c (221° f), UL standard 486, CSA LR6541. Cu/Cy, 600 Volt. Intgr. TSB, NSI.

B. Conductors No. 8 and smaller outside building (ground j-box, pole base, etc.) water tight steel spring connectors with water-proof non-hardening sealant, same rating as “A”.

C. Conductors No. 8 and larger (dry locations): Insulated copper rated connectors with Allen wrench set-screw, such as NSI “IT” Series (size to conductors)

D. Multiple conductor connections No. 8 and larger (dry locations): NSI Series IPL, IPLD, etc.

E. Insulated terminal strips up to 30 Amp, 600 V shall be a double terminal block such as NSI Series “TB”, with appropriate mounting hardware.

F. Terminal blocks (Size to conductors) such as Square “D” No. CBA363106.

PART 2 - EXECUTION:

2.1 GENERAL: All connectors shall be secure in place making a tight electrical connection.
2.2 FIXED EQUIPMENT: Terminal strips, terminal blocks shall be firmly secured in place.

END OF SECTION 16150
SECTION 16215 - ELECTRICAL POWER MONITORING AND CONTROL

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The extent of this section is to provide and install special power monitoring as a part of the main panel. Incorporated in the main panel shall be a unit that reads and retains the electrical functions of the system, namely a Power Logic Panel, which shall be installed in conjunction with, and a part of, the main switchboard and/or power distribution systems, which will relate to the building operation for power analysis and service improvement.

1.2 QUALITY ASSURANCE

A. This equipment shall meet all of the NEC, NEMA, ANSI, IEEE, etc. standards that relate to this type of equipment.

1.3 SUBMITTALS

A. The manufacturers detailed data shall be submitted for evaluation and approval prior to purchasing the equipment. Only stamped and signed submittal sheets will be used in ordering the equipment.

PART 2 - PRODUCTS

2.1 POWER LOGIC PANEL

A. The Contractor shall provide and install a Power Logic panel as indicated on the plans. The panel shall be connected into the service feeder and set-up to perform all of the functions listed below. Mount the unit in the main disconnect section in a manufactured enclosure, unless otherwise noted on the plans. Features to be accomplished are:

1. Full Instrumentation
2. RS-485 Comm Port
3. Front Panel Optical Comm Port
4. 0.2% Accuracy Class
5. Alarm/Relay Functions
6. On-board Data Logging
7. Downloadable Firmware
8. Date/Time for Each Min/Max
9. Waveform Capture
10. 12-Cycle Event Capture

B. The unit shall be as manufactured by Square “D” Company. The equipment shall be Powerlogic PMB00 Series.

C. The installation shall be in strict accordance with the manufacturers recommendations and shall be tested and made operative when the project is complete.
PART 3 - EXECUTION

3.1 GENERAL

A. The components defined in this section shall be installed in strict accordance with the manufacturers recommendations and applicable sections of this specifications.

B. The power logic unit shall be installed in the main panel ahead of the distribution section and shall read the characteristics of the service power. All components required to make the unit operate shall be installed in their proper location and shall be electrically protected.

C. When the installation is completed on all items in this section of the specifications, the units shall be tested and information related thereto given to the owner's representative, who will also be schooled in the operation.

END OF SECTION 16215
SECTION 16289 - SURGE PROTECTION DEVICE

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

   A. The contractor shall provide and install a 120 KA surge suppression device in main distribution panel (MDP). The unit shall be incorporated in the panel.

END OF SECTION 16289
SECTION 16410 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Extent of motor and circuit disconnect switch and/or circuit breaker is indicated on the plans and schedules. Work includes complete installation and electrical connections.

1.2 QUALITY ASSURANCE

A. Provide motor and circuit disconnect switches, and/or circuit breaker (as noted), which have been UL listed and labeled. Comply with applicable requirements of NEMA Standards Pub. No. KS 1, and NEC.

1.3 SUBMITTALS

A. PRODUCT DATA: Submit manufacturer's data including specification, installation instructions and general recommendations, for each type of motor and circuit disconnect switch required.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. MANUFACTURER: Subjects to compliance with requirements, provide products of one of the following (for each type of switch):

   1. Square D Company
   2. General Electric Co.
   3. Eaton

2.2 FABRICATED SWITCHES

A. GENERAL

   1. Provide heavy duty type disconnect and safety switches as indicated herein.
      a. Heavy duty switches on 240 and/or 600 volt rated circuits.
      b. HP rated switches on all motor circuits.

B. HEAVY DUTY SWITCHES

   1. Provide heavy-duty type, sheet-steel enclosed switches, fusible or non-fusible as indicated of types, sizes and electrical characteristics indicated; rated 240 and/or 600 volts, 60 hertz; incorporating spring assisted, quick-make, quick-break switches which are so constructed that switch blades are visible in OFF position with door open. Provide single phase or three phase with solid neutral as required by applications. Equip with an interlocked operating handle which is capable of being padlocked in OFF position. Provide NEMA 1 or NEMA 3R as required by application, unless noted. Provide fusible switches with Class R rejection fuse clip kits.
C. FUSES

1. Where indicated, provide fuses for switches, as required of classes, types and ratings needed to fulfill electrical requirements for services indicated. Provide spare fuses amounting to one spare fuse for each 10 installed but not less than three of any one type and size. See Section 16491 Overcurrent Protective Devices for fuse types.

D. CIRCUIT BREAKERS

1. Provide and install circuit breakers of the size noted on the plans. They shall be installed in a NEMA 1 enclosure unless otherwise noted.

PART 3 - EXECUTION

3.1 INSTALLATION OF MOTOR AND CIRCUIT DISCONNECT SWITCHES

A. Install motor and circuit disconnect switches where indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation" and in accordance with recognized industry practices to ensure that products fulfill requirement.

B. Coordinate motor and circuit disconnect switch installation work with electrical raceway and cable work, as necessary for proper interface.

C. Install disconnect switches with motor drive appliances, and motors and controllers within sight of controller position.

END OF SECTION 16410
SECTION 16420 - ENCLOSED CONTROLLERS AND STARTERS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Extent of motor starter work is indicated by drawings and schedules.

B. Types of motor starter in this section include the following:

1. AC Fraction horsepower Manual Starters
2. AC Line Voltage Manual Starters
3. AC Non-Reversing Magnetic Starters
4. AC Combination Non-Reversing Magnetic Starters

1.2 QUALITY ASSURANCE

A. Comply with NEC and NEMA Standards as applicable to wiring methods, construction and installation of motor starters. Comply with applicable requirements of UL 508, "Electric Industrial Control Equipment", pertaining to electrical motor starters. Provide units which have been UL-listed and labeled.

1.3 SUBMITTALS

A. PRODUCT DATA: Submit dimensioned drawings of motor starters showing accurately scaled equipment layouts.

B. MOTOR VOLTAGE/CURRENT REPORT: After installation is complete, including water and air balancing, measure voltage (L-L and L-N) and full load current of each phase of each motor. Submit report showing field readings of voltage and amperage and thermal heater size installed for each motor.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Subject to compliance with requirements, provide products of one of the following (for each type and rating of motor starter):

1. Square D Co.
2. General Electric Co.
3. Allen-Bradley Co. 1

2.2 MAINTENANCE STOCK, FUSES

A. For types and ratings required, furnish additional fuses, amounting to one unit for every 10 installed units, but not more than 5 units of each type, for both power and control circuit fuses.
2.3 MOTOR STARTERS

A. GENERAL: Except as otherwise indicated, provide motor starters and ancillary components; of types, sizes, ratings and electrical characteristics indicated which comply with manufacturer's standard materials, design and construction in accordance with published information, and as required for complete installations.

B. THERMAL OVERLOAD UNITS: Provide thermal overload units, sized in accordance with manufacturer's recommendations for full load current of motor controlled. Provide thermal heater units, sized to actual running full load current if actual full load current is less than 90 percent of motor nameplate full load current. Size heater for mechanical equipment after air and water balancing have been completed. Spare parts: Provide a spare set of each type and/or size.

C. AC FRACTIONAL HP MANUAL STARTERS (EQUAL TO SQUARE D CLASS 2510): Provide manual, single-phase, 1 and 2 pole, 300 volt AC max, fractional HP motor starters, of types, ratings and electrical characteristics indicated; equip with one piece thermal overload relay with field adjustment capability of plus or minus 10 percent of nominal overload heater rating; for protection of AC motors of 1 HP and less. (For manually controlled motors in excess of 1 HP, see Line Voltage Manual Starters specified herein.) Provide starter with quick-make, quick-break trip free toggle mechanisms, green pilot lights, and with lock-off toggle operated handle. Mount surface units in NEMA 1 enclosures, unless noted otherwise. Provide flush mounted units with coverplate to match wiring device coverplates.

D. AC LINE VOLTAGE MANUAL STARTERS (EQUAL TO SQUARE D CLASS 2510): Provide line voltage manual starters, of types, ratings and electrical characteristics indicated; 2 or 3 pole, 600 volt AC max; equip with pushbutton operator, low voltage protection feature, and green pilot light. Provide starters with trip free mechanism such that contacts will open under load and remain open until thermal element has cooled, and unit is reset. Mount surface units in NEMA 1 enclosure, unless noted otherwise. Provide overlapping trim for flush mounted units.

E. AC NON-REVERSING MAGNETIC STARTERS (EQUAL TO SQUARE D CLASS 8536): Provide line voltage magnetic starters (nothing smaller than size 1 - typical all arrangements), to types, ratings and electrical characteristics indicated; 2 or 3 pole, 600 volt max, 120 volt control voltage with solid state current sensing protection with under voltage trip in all phases. Equip units with holding contact, 2 normally open, and 2 normally closed auxiliary contacts, unless noted otherwise. Provide fused control transformer in each starter. Mount hand-off-auto switch, red pilot light, and reset button in face of enclosure. Provide NEMA 1 enclosure unless noted otherwise. Equip all spare starters complete with items as specified herein.

F. CONTROL CONTACOR (EQUAL TO SQUARE D CLASS 8903 TYPE PB): Provide line voltage Contactor of the size indicated on the plans, to types, ratings and electrical characteristics indicated; 2 or 3 pole, 600 volt max, 120 volt control voltage or as noted. Equip units with holding contact, 1 normally open, and 1 normally closed auxiliary contacts, unless noted otherwise. Provide fuse control transformer in each Contactor. Mount a red pilot light, in face of enclosure. Provide NEMA 1 enclosure unless noted otherwise.
SOLID STATE OVERLOAD RELAY (Include as a part of all magnetic starters)

A. The overload relay shall be a solid state current sensing device that is ambient insensitive. The overload relay shall incorporate phase unbalance, phase loss and overload protection. The overload relay shall have a 3:1 current adjustment range. A visible trip indication and a trip test function shall be included. An LED shall indicate power to the device and there shall be a lockable tamper guard to protect the dial adjustment. The device shall be a Square D Class 9065 or approved equal.

B. AC COMBINATION NON-REVERSING BREAKER AND MAGNETIC STARTERS (EQUAL TO SQUARE D CLASS 8538): Provide line voltage combination starters, of types, ratings and electrical characteristics and indicated for 8536; 2 or 3 pole, 600 volts max with non-reversing magnetic starters with solid state current sensing overload protection, as specified herein; in common cubicle or enclosure with motor circuit protector. (To include Solid State Overload Relay).

C. Provide instantaneous trip circuit breaker as indicated and adjust to comply with manufacturer's recommendations. Provide combination starters for individual mounting, or for group mounting in motor control center as indicated. Provide NEMA 1 enclosures unless otherwise indicated.

D. AC COMBINATION NON-REVERSING FUSED DISCONNECT AND MAGNETIC STARTERS (EQUAL TO SQUARE D CLASS 8539): Provide line voltage combination starters, of types, ratings, and electrical characteristics; 2 or 3 pole, 600 volt maximum with non-reversing magnetic starters as specified herein; in common cubicle or enclosure with fusible disconnect switch. Provide quick-make, quick-break, visible blade disconnect switch. Provide 2, 3, and 4; and visible blade, automatic circuit interrupters with push-to-trip feature and separate fuse clips for larger NEMA sizes. Fuse all starters with dual-element (time-delay) fuses equal to Bussman FRN/FRS. Provide combination starters for individual mounting, or for group mounting in motor control centers as indicated. Provide NEMA 1 enclosures unless otherwise indicated. (To include Solid State Overload Relay).

PART 3 - EXECUTION

3.1 INSTALLATION OF MOTOR STARTERS

A. Install motor starters as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standards of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

B. Install fuses in fusible disconnects, if any.

3.2 ADJUST AND CLEAN

A. Inspect operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.

B. Touch-up scratched or marred surfaces to match original finish.

C. Each motor starter shall be equipped with lock out capabilities.
3.3 FIELD QUALITY CONTROL

A. Subsequent to wire/cable hook-up, energize motor starters and demonstrate functioning of equipment in accordance with requirements.

END OF SECTION 16420
SECTION 16430 - OVERCURRENT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Extent of overcurrent protective device work is indicated by drawings and schedules. Overcurrent protective devices specified herein are for installation as individual components in separate enclosures; and for installation as integral components of switchboards and panelboards. See Section 16426, Switchgear and Switchboards, and Section 16470, Panelboards.

B. Types of overcurrent protective devices in this section include the following for operation at 600 volts and above:
   1. Molded case circuit breakers
   2. Power circuit breakers
   3. Fusible switches
   4. Molded case systems breakers
   5. Phase failure

C. Refer to other Division-16 sections for cable/wire and connector work required in conjunction with overcurrent protective devices.

1.2 QUALITY ASSURANCE

A. Comply with NEC requirements and NEMA and ANSI standards as applicable to construction and installation of overcurrent protective devices.

1.3 SUBMITTALS

A. PRODUCT DATA: Submit manufacturer's data on overcurrent protective devices, including catalog cuts, time-current trip characteristic curves, and mounting requirements.

B. SHOP DRAWINGS: Submit layout drawings of overcurrent protective devices, with layout of circuit breakers, including special relationships to proximate equipment.

C. MAINTENANCE STOCK, FUSES: For types and ratings required, furnish additional fuses, amounting to one unit for every 5 installed units, but not less than two units of each size and type.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER’S (LOW VOLTAGE)

A. Subject to compliance with requirements, provide products of one of the following (main and branch manufacturer must be same as panelboard and/or switchboard manufacturer):

   1. Circuit Breakers and Fusible Switches
      a. Square “D” Co.
b. General Electric Co.
c. Westinghouse Electric Corp.

2.2 MOLDED CASE CIRCUIT BREAKERS

A. Provided factory-assembled, molded case circuit breakers for power distribution panelboards and switchboards; and for individual mounting, as indicated. Provide breakers and amperage, voltage and RMS interrupting rating shown, with permanent thermal trip and adjustable instantaneous magnetic trip in each pole. Construct breakers for mounting and operating in any physical position and in an ambient temperature of 40 degrees C. Provide with mechanical screw type removable connector lugs, AL/CU rated.

B. All breakers in the main distribution panel shall have sufficient interrupting capacity to safely interrupt the available short circuit current from the transformer bank. Circuit breakers shall be Square "D", Type FH, KH, LH, MH, or as noted on the plans.

C. All breakers specified with motor starters shall be Square "D" Mag-Guard.

2.3 FUSIBLE SWITCHES

A. Provide factory-assembled fusible switch units for power distribution panelboards and switchboards, and for individual mounting as indicated. Provide switch units of amperage, voltage, and RMS interrupting rating as shown, with quick-make, quick-break mechanisms, visible blades and dual horsepower ratings. Equip with lockable handles with on-off indication. Interlock switch covers with handles to prevent opening in "ON" position. Provide switch with Class R rejection fuse clip kits.

B. Acceptable Manufacturer

1. Subject to compliance with requirements, provide ground-fault sensing and relaying equipment of one of the following (manufacturer must be same as panelboard and/or switchboard manufacturer):
   a. Square D Co.
   b. General Electric Co.

2.4 PHASE FAILURE EQUIPMENT

A. Provide and install single phase reverse phase relay (Square “D” PR 101-PLR) that will tie to the main breaker in MDP to open on abnormal service power. Provide a 120 volt source of power to operate the equipment.

B. Ground-Fault Relay

1. Provide solid-state ground-fault relay, which requires no external source of electrical power, drawing energy to operate GFP system directly from output of current sensor. Construct with adjustable pick-up current sensitivity for GF currents from 200 to 1200 amperes, with calibrated dial to show pick-up point settings. Provide factory-set time delay of 0.5 seconds and protection which precludes tampering with setting after installation.
C. Current Sensors

1. Provide zero sequence current sensors for overcurrent protective devices; inputs compatible with relay. Construct sensor frame so it can be opened to prevent removal or installation around conductors without disturbing conductors. Provide test winding in sensor for testing operation of GFP unit including sensor pick-up relay, and circuit protection device operation.

D. Monitor Panel

1. Provide monitor panel capable of indicating relay operation, and provide means for testing system with or without interruption of service. Construct so GF system cannot be left in an inactive or OFF state. Provide indicator lamps and TEST and RESET control switches.

E. Acceptable Manufacturer

1. Subject to compliance with requirements, provide ground-fault sensing and relaying equipment of one of the following:
   a. Square “D” Co.
   b. General Electric Co.
   c. Eaton

PART 3 - EXECUTION

3.1 INSTALLATION OF OVERCURRENT PROTECTIVE DEVICES

A. Install overcurrent protective devices as indicated, in accordance with the manufacturer's written instructions and with recognized industry practices to ensure that protective devices comply with requirements. Comply with NEC and NEMA standards for installation of overcurrent protective devices.

B. Coordinate with other work as necessary to interface installation of overcurrent protective devices with other work.

C. Set field-adjustable circuit breakers for trip settings as indicated, subsequent to installation of devices.

D. Install fuses in overcurrent protective devices.

E. Field test all ground fault protective devices for proper operation; test to be performed by representative of the manufacturer. Include verification of complete time current trip characteristics.

3.2 FIELD QUALITY CONTROL

A. Prior to energization of overcurrent protective devices, test devices for continuity of circuitry and for short-circuits. Correct malfunctioning units, and then demonstrate compliance with requirements.
3.3 PHASE FAILURE EQUIPMENT

A. The contractor shall have the factory representative field test the phase failure equipment by assimilating a phase failure, reversing condition to test this equipment. If it does not operate correctly, make appropriate repairs. Condition of operation shall be reported in writing to the architect in triplicate.

END OF SECTION 16430
SECTION 16441 - ELECTRICAL SERVICE AND DISTRIBUTION SWITCHBOARDS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The extent of this work is to provide, install and connect a main service disconnect and distribution switchboard as indicated on the drawings.

B. Furnish distribution sections shall be mounted on a concrete curb and tied together as if it were factory installed as a single unit. The total unit shall be anchored to the pad at each corner - see Section 16072.

1.2 QUALITY ASSURANCE

A. Provide units which have been UL listed and labeled. Comply with NEC as applicable to installation of panelboards, cabinets, and cutout boxes. Comply with NEC pertaining to installation of wiring and equipment in hazardous locations. Comply with NEMA Stds. Pub. No. 250, “Enclosures for Electrical Equipment (1000 volt maximum)”. Pub. No. 1 “Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less”, braced for 100,000A SCA.

1.3 SUBMITTALS

A. PRODUCT DATA: Submit manufacturer data including specifications, installation instructions and general recommendations, for each type of panelboard required.

B. SHOP DRAWINGS: Submit dimensioned drawings of main service disconnect and distribution switchboard with accurately scaled layouts of enclosures and required individual switchgear, including, but not necessarily limited to, circuit breakers, fusible switches, fuses, ground-fault circuit interrupters, and accessories.

PART 2 - PRODUCTS

2.1 METER SECTION

A. The contractor shall provide and install a meter base and/or section as shown on the plans. These sections shall be sized to the service conditions.

B. The serving utility has definite requirements for meter section to monitor to power used in this building. The contractor shall provide and install the utility required EUSERC meter equipment. The contractor shall contact the utility company and confirm the units indicated on the plans. The contractor has the responsibility and shall provide the required equipment regardless of what is shown on the plans.
2.2 MAIN DISCONNECT AND SWITCHBOARD (EUSERC APPROVED)

A. SWITCHBOARD: Floor standing, dead front, dead rear, with all bussing and equipment accessible from the front, constructed in accordance with the feeder diagram and approved shop drawings. Each section of the switchboard shall bear the Underwriters’ label and manufacturer’s label and shall comply with all applicable codes and ordinances. Provide black and white bakelite nameplates identifying each function and each circuit breaker in the switchboard.

B. WHERE SPACES ARE INDICATED, BUSSES: Extended full length and complete with mounting holes and/or hardware for the installation of future equipment.

C. Pull section if specified shall be constructed like unto the distribution panel as to height, color, and finish.

2.3 DISTRIBUTION PANEL

A. ALL CIRCUIT BREAKERS, SWITCHES, AND OTHER INTERIOR EQUIPMENT: Mounted to the framework and no equipment mounted to the front plates except as allowed by applicable codes and defined detailed on the plans and/or in the schedule.

B. Design of all current carrying devices or parts of the switchboard shall conform to the latest standards specified in the related section of IEEE standards except as these characteristics may be modified herein.

C. All control and secondary wiring insulated for the voltage indicated in the schedule. All primary connection uninsulated except for special installation where insulation is specified, or unless insulation is required to make the equipment comply with the required dielectric test.

D. Standard test for all switching and control apparatus system 61 to 600 volts; 1500 volts for 1 minute; where the standards on devices used on this equipment call for a lower test voltage, such devices may be disconnected during the test. Voltage tests made in accordance with ASA Standard C68.1.

E. Switchboard sections constructed of a code gauge steel to the dimensions indicated in the schedule or on the plans. Holes, supports, studs, and openings standardized to enable interchange or interior and front cover units. Sections fabricated with right angle corners and plumb edges and surfaces.

F. This panel is designed for installation in a certain space, the indicated physical dimensions are critical and must be strictly followed.

G. Enclosures, parkerized or bonderized as a unit after all welding has been completed, then painted with a rust-resisting prime coat of paint. Back of the enclosure and the interior finished with a coat of light grey baked enamel and the front, top, and exposed sides shall be finished with a scratch-resistant silver-grey hammertone finish.

H. Wiring gutters extend the full depth of the switchboard front - front to back.

I. Bus bars, connection bars, and wiring on the back of the switchboard arranged so that maximum accessibility is provided for cable connections.
J. Consideration given to the arrangement of cables so they may be connected to the switchboard in an orderly manner. Electrical clearance between parts of opposite polarity and between live parts and ground shall conform to the National Electric Code.

K. Each distribution section bussed for the full connected load of the section. Bussing in all sections shall extend to all spare circuit breaker spaces, the busses drilled, taped and with straps or other mounting accessories.

L. BUS BARS: Tin, aluminum or tinned copper, meeting cross sectional area of UL Standard 891 for temperature rise. The through bus shall be 100% rated, neutral bus 100% rated, provided with CU/AL lugs. Ground bus sized to UL 891.

M. AMPERE RATINGS: The switchgear shall be the rating indicated on the plans and in accordance with the latest applicable standards of IEEE and NEMA.

N. BUS BRACING SUPPORTS: The bus work shall be braced to meet the short-circuit rating indicated on the plans. Cables shall not be used in lieu of bus bars, riser busses, connection busses or bus jumpers. All bars, riser busses, connecting busses, and bus jumpers adequately supported. Bus bars of a length greater than 15” but less than 30” shall be supported with not less than one intermediate insulated support (Underwriter approved) unless the bar is taped with one layer of friction tape, half lapped, and the entire taping thoroughly varnished with approved insulating varnish. Bus bars of a length greater than 30” shall not have less than two insulated supports; sufficient supports shall be provided so that the distance between supports shall not exceed the width of the switchboard section in which they are used. Bus bars shall extend through all spare circuit breaker spaces in switchboards.

O. GROUND BUS: A ground bus shall extend throughout the length of the switchboard assembly. Each housing of the assembly shall be grounded directly to this bus.

P. If the panel is shown as an outside installation, it shall be NEMA 3R with hinged locking doors.

2.4 ACCEPTABLE MANUFACTURER

A. Subject to compliance with requirements, provide ground-fault sensing and relaying equipment of one of the following:

1. General Electric Co.
2. Square D Co.

PART 3 - EXECUTION

3.1 GENERAL

A. Torque tighten all bolted connections of bus bars in all switchboards. All torque settings shall conform to NEMA, code and industry standards.

B. Rigidly secure and bolt switchboards to the building construction in an approved manner to resist seismic stress. Secure from the switchboard manufacturer all necessary calculations and drawings required to meet seismic conditions and be responsible for obtaining written approval of installation from proper authorities.
C. Provide approved attachments for padlocking each circuit breaker or fused switch in the OFF position.

D. The conduits connected to the switchboard shall be mounted in an approved place, the holes shall be carefully cut and secured in place with lock-nuts and bushings.

E. Cable connections to the main and distribution circuit breakers shall be installed in proper size lugs and torqued in place as per the manufacturer’s recommendation.

3.2 IDENTIFICATION

A. Main and distribution circuit breakers shall be labeled in accordance with the label specifications, name of Engineer and Contractor. Also install a label with the Electrical contractor and Engineer’s name to be mounted on the main disconnect. See Section 16075, Labeling.

END OF SECTION 16441
SECTION 16442 - PANELBOARDS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Extent of panelboard and enclosure work, is indicted by drawings and schedules.

B. Types of panelboards and enclosures in this section include lighting and appliance panelboards, and power distribution panelboards.

1.2 QUALITY ASSURANCE

A. Provide units which have been UL listed and labeled. Comply with NEC as applicable to installation of panelboards, cabinets, and cutout boxes. Comply with NEC pertaining to installation of wiring and equipment in hazardous locations. Comply with NEMA Stds. Pub. No. 250, "Enclosures for Electrical Equipment (1000 volt maximum)". Pub. No. 1, "Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less".

1.3 SUBMITTALS

A. PRODUCT DATA

1. Submit manufacturer data including specifications, installation instructions and general recommendations, for each type of panelboard required.

B. SHOP DRAWINGS

1. Submit dimensioned drawings of panelboards and enclosures showing accurately scaled layouts of enclosures and required individual panelboard devices, including, but not necessarily limited to, circuit breakers, fusible switches, fuses, ground-fault circuit interrupters, and accessories.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products of one Square “D” Company - NQOD or NF Type.

B. Approved Manufacturers

1. Square “D” Company
2. General Electric Company
3. Eaton
2.2 PANELBOARDS

A. GENERAL

1. Except as otherwise indicated, provide panelboards, enclosures and auxiliary components, of types, sizes, and ratings indicated. Equip with number of unit panelboard devices as required for complete installation. Fully equip “spaces” with hardware to receive breaker or switch of size indicated.

2.3 LIGHTING AND APPLIANCE PANELBOARDS

A. Provide dead-front safety type lighting ans appliance panelboards as indicated, with switching and protective devices in quantities, ratings, types and arrangement shown, provide bolt-on thermal magnetic type branch breakers. Where multiple breakers are indicated, provide with common trip handle. Equip with aluminum bus bars full-sized neutral bus, ground bus and isolated ground bar when indicated.

2.4 PANELBOARD ENCLOSURES

A. Provide galvanized sheet steel cabinet type enclosures, in sizes and NEMA types as indicated, code-gauge minimum 16-gauge thickness. Provide fronts with adjustable indicating trim clamps, and doors with flush locks and keys, all panelboard enclosures keyed alike, with concealed door hinges and door swings as indicated. Equip with interior circuit-directory frame, and card with clear plastic covering. Provide baked gray enamel finish over a rust inhibitor. Provide enclosures fabricated by same manufacturer as overcurrent devices contained therein. Bolt engraved Formica labels indicating panel name and voltage on the interior and exterior of panelboards.

2.5 FINISH

A. Coat interior and exterior of surface with manufacturer’s standard color; baked on enamel finish.

2.6 IDENTIFICATION

A. Provide 1/16” thick black Formica labels with 1/4” high lettering on the interior and exterior of each panelboard; include panelboard name and voltage - see Section 16075.

2.7 BRANCH CIRCUIT BREAKERS

A. Provide and install branch circuit breakers of the size, type and amperage indicated, mounted in the position noted in the panel schedule.

B. The circuit breakers shall be as defined by NEMA as a device designed to carry electric current through a set of contacts and by automatic means open the contacts, interrupting the flow of current when the flow of current exceeds the labeled rating or on a high instantaneous inrush of current. The tripped breaker shall flag the interruption of the flow of current and be capable of being reset when returned to normal operating temperature. The breaker shall be a molded case unit that will open on an overload and/or short-circuit condition.
C. The unit shall be constructed as molded case units having a single handle operator for one, two or three pole units. For multiple pole units, and overload on any pole shall cause all terminals to open.

PART 3 - EXECUTION

3.1 GENERAL

A. Install panelboards and enclosures where indicated, in accordance with manufacturer’s written instructions, applicable requirements of NEC and NECA’s “Standard of Installation”, in compliance with recognized industry practices to ensure products fulfill requirements.

B. Position the breakers in the panel to match the schedule on the plans.

C. Coordinate installation of panelboards and enclosures with cable and raceway installation work. Anchor enclosure firmly to walls and structural surfaces, ensuring they are permanently and mechanically secure. Arrange conductors neatly within enclosure, and secure with suitable nylon ties.

D. Fill out panelboard’s circuit directory card upon completion of installation work. Utilize actual final building room numbers, not architectural numbers used on drawings. Identify individual lighting circuits and individual receptacle circuits by room served. Include room number with equipment circuit designations. All directories to be typewritten.

END OF SECTION 16442
SECTION 16511 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Extent of interior and exterior luminaire work is indicated by drawings and schedules.

B. The contractor shall provide the quantity of luminaires indicated on the plans. The drawn length (in standard increments) of the luminaire determines the quantity and the catalog number identifies the model or type. The catalog numbers have been carefully prepared to define the luminaire type, but may not be completely accurate. At least four (4) days prior to bidding each manufacturer shall compare the catalog numbers shown with the description and requirements on the drawings and shall notify the Architect/Engineer of any discrepancies. Specifically included in the evaluation shall be the verifying of proper mounting kits or accessories to facilitate installation of the luminaire as shown at each location on the plans. No allowance or redress will be allowed for discrepancies that were not addressed to the indicated authorities for clarification prior to bidding. Reporting of ambiguities is the responsibility of the bidder.

C. On all pendant mounted luminaires, provide a second set of pendants, of a different length, as directed by the Architect/Engineer, to be used at their discretion, provide and install at no additional charge to the project.

D. Types of light sources within the luminaires include the following:
   
   1. LED

1.2 QUALITY ASSURANCE

A. Comply with NEC (Article 410), NEMA and ANSI 132.1 as applicable to installation and construction of luminaires. Provide UL listed and labeled luminaires for installation on this project.

1.3 SUBMITTALS

A. PRODUCT DATA: Submit manufacturer’s data on interior and exterior building luminaires. Submit the manufacturer’s data on ballasts supplied with luminaires.

B. SHOP DRAWINGS: Submit dimensioned drawings of luminaires and supplied ballasts. Submit luminaire shop drawings with ballasts in booklet form with separate sheet for each luminaire, assembled in "type" alphabetical order, with proposed luminaire/accessories clearly indicated on each sheet.
PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products of one of the following (for each luminaire):

1. LED
   a. LM-80 compliant

2.2 INTERIOR LUMINAIRES

A. GENERAL: Provide luminaires, of sizes, types and ratings indicated. Luminaire shall be complete with, but not necessarily limited to, housings, lamps, lamp holders, reflectors, ballasts, starters and wiring. Label each luminaire with manufacturer's name and catalog number. Provide all enclosed luminaires with positive latch mechanisms; spring tension clips not acceptable. Provide all exterior luminaires with damp or wet location label as required by application.

B. SUPPORT REQUIREMENTS: Provide all pendant and stem mounted luminaires with flexible ball joint hangers at all points of support. Equipment hooks used to hang luminaires shall be supplied with safety latches. Provide all detachable luminaire parts, luminous ceiling accessories, louvers, diffusers, lenses, and reflectors with locking catches, screws, safety chain or safety cable.

C. Each hanger point shall be capable of supporting four times the luminaire weight. Backing supports shall be installed above (or behind) sheetrock, plaster and similar ceiling and wall materials. All surface mounted ceiling luminaires shall be supported from a structural channel. See plans for additional details.

2.3 LAMPS

A. MANUFACTURES’ REQUIREMENTS: Comply with manufacturer's written recommendations for all lamp/driver combinations.

B. OUTDOOR LUMINAIRES: Equip outdoor luminaires with low temperature starting drivers.

C. EMERGENCY BATTERIES: Provide and install batteries for luminaires indicated on the plans. The battery ballast shall be factory installed. The following also applies:

1. The ballast shall be able to operate lamps at approximately 20 percent output for 90 minutes minimum.
2. Ballast shall be long life cadmium type. Ballast shall be capable of full recharge in 24 hours.
3. Battery shall be complete with charging indicator light and test switch.
4. Note: Size battery to number of lamps.

D. LED: 5 year warranty; lamps (4000-4500k)
COUNTY FAIRGROUNDS BUILDING  
CACHE COUNTY

E. DIFFUSERS: Where plastic diffusers are specified, provide 100 percent virgin acrylic compound; minimum thickness, .125 inches.

PART 3 - EXECUTION

3.1 INSTALLATION OF LUMINAIRES

A. Install luminaires at locations and heights indicated, in accordance with luminaire manufacturer's written instructions, applicable requirements of NEC (Article 410), NECA's "Standard of Installation", NEMA standards, and with recognized industry practices to ensure that luminaires fulfill requirements.

B. Coordinate with other work as appropriate to properly interface installation of luminaires. Consult architectural reflected ceiling plan for exact location of all luminaires.

C. Provide all necessary supports, brackets, and miscellaneous equipment for mounting of luminaires. Support all ceiling mounted luminaires from the building structure; independent of the ceiling system, unless noted. Support each recessed luminaire from the building structure with #12 ga. steel wire attached to each luminaire corner (in addition to supports normally provided for attachment to the ceiling system). Provide backing supports above (or behind) sheetrock, plaster and similar ceiling and wall materials. Support ceiling mounted outlet boxes independent of the raceway system, and capable of supporting 200 pounds. See plans for additional details.

D. Install LED emergency battery inside luminaire driver channel with charging indicator light and test switch mounted on fixture end, or visible and accessible through lens. Wire so luminaire can be tested with lights on and lamps in normal mode are switched off with other lighting in area. Connect emergency battery to unswitched conductor.

E. Clean luminaires of dirt and debris upon completion of installation.

F. Protect installed luminaires from damage during remainder of construction period. Repair all nicks and scratches to appearance of original finish. If repair is not possible, replace damaged portion of luminaire.

3.2 FIELD QUALITY CONTROL

A. Upon complete installation of luminaires, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning luminaires on site, then reset to demonstrate compliance; otherwise remove and replace with new luminaires, and proceed with retesting.

B. At the time of Substantial Completion, replace lamps in interior luminaires which are observed to be noticeably dimmed after the Contractor's use and testing, as judged by Architect/Engineer. In addition, furnish replacement lamps amounting to 15 percent (but not less than one lamp) of each type and size used (Max. 48 of any one type). Deliver replacement stock with letter of transmittal as directed to Owner's storage space.

C. Provide tight equipment grounding connections for each luminaire.

END OF SECTION 16511
SECTION 16521 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The contractor shall provide and install luminaires as noted on the plans and located as indicated.

B. The exterior luminaires being provided for this project shall be submitted for approval with those on Section 16511.

C. The conduit/conductor installation shall comply with the specification relating to the respective section, but the conductor size shall be taken from the plans and shall comply therewith.

D. When the installation is complete, the luminaire must be clean and the area free of debris.

END OF SECTION 16521
PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The Auxiliary Systems of this specification are sections that have numbers greater than 16700. This specification will include the Auxiliary Sections that are relative to this project. (See Section 16001-1 for listing).

B. Each system mentioned herein is a complete system. Each network is a new system, an extension of an existing and/or a new system that incorporates an existing system into the new. Whatever the condition, the contractor shall provide all the equipment, materials, labor, etc. for a complete and operable network. Each system is specified to perform a definite function. The function and operation of a system is the final objective and whatever the requirement to accomplish that objective shall be included. If for any reason the specifications do not complete the network, the bidder and/or manufacturer’s representative shall call the deficiencies to the attention of the engineer by facsimile five (5) days prior to the bid date, so they can be included in an addendum. Failure to submit this information to the attention of the engineer does not relieve the bidder from supplying and installing the equipment needed for a complete and operable system.

C. Walk through the system when the project is complete and each auxiliary system shall be tested and set into operation.

D. The contractor, the owner's and manufacturer's representative shall test each component of each system, except for the Fire Alarm System where the local fire chief shall also witness the test, for normal operation. When the test is complete, the outcome of the test shall be reported in writing to the architect and engineer that the system meets all the conditions and functions of the specifications for normal operation. Each person in the test party shall place his signature on the report.

E. Example: In the case of the Fire Detection and Alarm System, the people mentioned above plus the local Fire Marshall (or his representative) shall check out the Fire Alarm System. Each component (break glass station, heat detector, ionization detector, alarms, etc.) shall be tested individually to prove their function in the total system. Any and all defective components shall be repaired and/or replaced.

F. Each of the other auxiliary systems, one by one (sound, F.A., telephone, data, etc.) shall be tested and written reports made on the results of the test, as stated above with copies sent to the engineer and placed in each maintenance manual.

G. Return visits for sound and telephone systems: One, six, and eleven months after the system has been accepted by the owner, the factory representative shall return to the project and check-out the system to determine the condition of operation, answer any questions of the operator and/or administrator, make repairs, etc., to determine if the system is operating to its full potential.

H. The factory representative shall review with the operator and administrator on their use of the equipment making sure the equipment is used to the ultimate.
I. As heretofore mentioned in this specification each auxiliary system carries a one year warranty from the date of acceptance by the owner.

END OF SECTION 16700 - 16800
SECTION 16714 - DATA SYSTEM CONDUIT

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Install blue conduit as required, 1-1/4” minimum size, for the installation of a data network system as per the drawings. The equipment shall be by others. Coordinate rough-in with the equipment supplier.

B. Where computer conduit is indicated for cabinet mounting, refer to the detail on the drawings. EMT conduit, boxes, fitting, etc. shall be fabricated and installed in the cabinet. The height shall be below the counter top and the plugs made accessible through holes in the counter top.

C. The owner shall provide and install the active switch components of the data network system.

END OF SECTION 16714
SECTION 16715 – DATA EQUIPMENT AND CABLING SYSTEM

PART 1- GENERAL

1.1 SCOPE

A. The contractor shall furnish and install all materials for a complete, functional data and voice communications system in accordance with this specification and the contract drawing. Contractor shall be responsible for providing a complete, functional system including necessary components, whether included in this specification or not.

B. The installation shall include cable (twisted-pair copper), interconnect-patching equipment connectors, jumpers, and telecommunications outlets.

C. In addition to material and equipment, Contractors shall provide labor and any incidental material required for installation. All copper station cables shall be terminated on patch panels at distribution frames and on data communication outlets at the workstation end.

D. The owner, upon completion of the project, shall furnish all active Network and VoIP equipment. The owner is also responsible to patch all connections both in the closet and at the work station.

E. Upon completion of installation, Contractors shall test ALL copper and record the test results, as specified in this section.

F. The work performed under this specification shall be of good quality and performed in a workmanlike manner. In this context “good quality” means the work shall meet industry technical standards and quality of appearance. The owner reserves the right to reject all or a portion of the work performed, either on technical or aesthetic grounds.

G. All Cable pathways to be installed by division contractors when indicated on the drawings and/or in this specification.

1.2 RELATED DOCUMENT

A. Regulatory References

The following industry standards are the basis for the structured cabling system described in this document.

1. ANSI/TIA
   • ANSI/TIA-568-C.0 – Generic Telecommunications Cabling for Customer Premises or most recent revision at the time of installation.
   • ANSI/TIA-568-C.1 – Commercial Building Telecommunications Cabling Standards or most recent revision at the time of installation.
   • ANSI/TIA-568-C.2 – Balance Twisted Pair Communications and Components Standards or most recent revision at the time of installation.
   • ANSI/TIA-568-C.3 – Fiber Optic Cable System Components Standards or most recent revision at the time of installation.
   • TIA-569-B – Commercial Building Standard for Telecom Pathways and Spaces or most recent revision at the time of installation.
• **ANSI/TIA-606-A** – Administration Standard for the Telecommunications Infrastructure of Commercial Buildings or most recent revision at the time of installation.
• **ANSI-J-STD-607-A** – Commercial Building Grounding/Bonding Requirements or most recent revision at the time of installation.
• **ANSI/TIA 1152** – Testing of Copper Links

2. National Electric Codes
   • National Electrical Safety Code (NESC) (IEEE C 2)
   • National Electrical Code (NEC) (NFPA 70)

3. ISO/IEC
   • ISO 11801 - Generic Cabling for Customer Premises.

4. OSHA Standards and Regulations – All Applicable.

5. Local Codes and Standards – All Applicable.

If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.

This document does not replace any code, either partially or wholly. The contractor must be aware of local codes that may impact this project.

B. Quality Assurance

1. The Following Certified Installation Contractors are approved for the work of this section.
   a. SystemTech

2. The Contractor MUST possess a valid Idaho State Contractor’s License. The contractor shall have an RCDD (Registered Communications Distribution Designer) on staff, full time, to oversee bid and installation procedures. As well as a BICSI certified Installer II and/or a BICSI Technician on staff and on the project full time. Man power used on projects that consists of employees from a staffing service or temp agency is not acceptable.

3. The Contractor shall be completely familiar with the TIA/EIA standards for telecommunications raceway/pathway infrastructure systems and with the telecommunications design practices as defined in the BICSI Telecommunications Distribution Methods Manual.

4. The Contractor shall have worked satisfactorily for a minimum of five years on systems of this type and size within a fifty mile radius of the center of Area of Operations Building. The Contractor shall have Idaho based service personnel, factory trained to service the equipment proposed with a normal response to service calls (not to exceed two hours for major systems failures) on the same day.
5. Hubbell Warranty shall provide a complete system warranty to guarantee end-to-end high performance cabling systems that meet application requirements. The guarantee shall include cable and connectivity components and have one point of contact for all cabling system issues. The system shall be warranted for a period of 20 years. The manufacturer of the telecommunications equipment, devices and cable shall warranty the entire telecommunications structured cable system to be in compliance with applicable codes and standards and to be free from defects in materials and workmanship. The warranty shall apply to all passive structured cabling system components and shall cover failure of the system to support applications in accordance with the performance levels stipulated in the referenced TIA/EIA standards. This warranty shall extend for a period of at least 20 years from the date of final field-testing and acceptance of the system and shall cover the full cost of all repairs and all replacement for the entire system.

6. Upon successful completion of the installation and subsequent inspection by the manufacturer’s project manager the manufacturer of the telecommunications equipment devices and cable shall register the telecommunications structured cable system installation and shall furnish a numbered registration certificate to the owner.

C. Governing Codes and Conflicts

1. If the requirements of this section or the Project Drawings exceed those of the governing codes and regulations, then the requirements of this section and the Drawing shall govern. However, nothing in this section or the Drawings shall be construed to permit work not conforming to all governing codes and regulations.

D. Submittals

1. Prior to installation of any equipment, the Contractor shall provide the Engineer and/or the Owner with copies of submittals and drawings for approval. Submittals shall include a list of equipment with model numbers, quantities, catalog information, cut sheets and equipment specification sheets. Drawings shall include floor plans with equipment and wire locations, and room numbers. No Equipment shall be purchased for the project until shop drawings have been reviewed and approved by the Engineer and/or the owner No Exceptions Taken.

2. Submit product data sheets as a complete set within thirty (30) days of award of contract. For initial submission and for re-submission required for approval submit (8) copies of each item. The Engineer will not return copies. Make reproductions as required for your use and distribution to subcontractors.

3. Provide catalog cut sheets and information for the following (Product Data).
   a. Cabling plant.
   b. Outlets, jacks, faceplates and connectors.
   c. Patch panels required for all terminations both phone and data.
   d. Enclosures, racks, horizontal and vertical cable management.

E. Project Record Drawings

1. As-built drawings are the final set of drawings produced at the completion of the construction project. They include all the changes that have been made to the original construction drawings, including notes, modifications, and any other information that the builder decides should be included. The drawings shall be produced using computer-aided design (CAD) software. An 11X17 laminated or framed copy of the As-Built shall be posted on site within the IDF.
PART 2 – PRODUCTS

2.1 GENERAL

A. All products shall be new and brought to the job site in original manufacturer’s packaging.

B. Electrical components shall bear the Underwriter’s Laboratories label. All communications cable shall bear the manufacturer’s label in accordance with NEC 800 based on flammability testing as follows.

1. CMR Riser-rated Communication Cable.
2. CMP Plenum-rated Communications Cable.

2.2 HORIZONTAL DISTRIBUTION SUB-SYSTEM

A. Work Area Outlets

1. Use Hubbell Single Gang, Four Port Faceplates that shall be white in color (for A, B and L type drops). All Voice cable shall be white in color with white phone icons and installed in top of the outlets. All Data cable shall be blue in color with blue icons and installed in the bottom of each outlet. The typical telecommunication work area outlets are as follows.
   1. An “A” Drop: A single gang one port face plate with (1) Hubbell Jack, and (1) data.
   2. “B” Drop: A single gang two port face plate with (2) Hubbell Jacks, (1) voice and (1) data.
   3. “L” Drop: Data Only work area outlet (L-X where X represents the cable count in that outlet) Consists of a single gang plate with 1-4 ports and/or a double gang faceplate with 6-8 ports.
2. Wireless Access Points: An L2 or two data lines are to be used for wireless access point locations. Conduits for wireless access points shall be installed in the ceiling. Each of these locations is to have enough service loops on the access point end to get the cable below ceiling. These access point locations shall be numbered and terminated according to the other locations within each classroom or location. Labels shall be produced with a labeling machine producing white text on black adhesive Mylar tape labels and are to be placed on T-bar ceiling grid for easy identification.
   a. Approved Manufacturer: Hubbell #1FP14W
   b. Approved Manufacturer: Hubbell #HXJ6
   c. Approved Manufacturer: Hubbell (Blank)

B. Miscellaneous area outlets may include but not be limited to Fire Alarm Emergency Dialers, Elevators (including stage lifts), Environmental Controls, Access Control Card Readers, Intercom Systems and Premise Alarm Systems. REFERENCE PLANS FOR EXACT LOCATIONS, TYPES AND CABLE COUNT.

1. One (1) 4 Pair Cat 6 Data line to be pulled for each Environmental Control, refer to plans for exact locations.
2. Two (2) 4 Pair Cat 6 Data lines to be pulled for each Fire Alarm Emergency Dialers, refer to plans for exact locations.
C. Horizontal Station Cabling:

1. Horizontal station cable shall be Category 6e unshielded four pair copper cable, 23 AWG UTP, UL/NEC CMR or CMP, plenum rated with a PVC jacket as required for the application. All cables shall conform to the requirements for communications circuits defined by the National Electrical Code Article 800. Any pathways on the ground level, in or under the slab or any other potentially wet locations shall use the appropriate OSP cable listed below.
   a. Approved Manufacturer: Mohawk #M57413 (voice cables white)
   b. Approved Manufacturer: Mohawk #M57414 (data cables blue)
   c. Approved Manufacturer: Mohawk #58772 (slab on grade runs)

D. CCTV Surveillance Camera Cabling

1. CCTV Surveillance Camera Cabling should be designed to cover strategic locations and sensitive areas of the school for comprehensive surveillance and monitoring. All cables shall be Mohawk Cat 6 UTP and green in color. All runs shall be home run to the nearest IT Network closet as indicated on drawings. No wiring shall be left exposed and accessible to tampering. Use a 1 ¼” conduit and junction boxes shall be used as a secure pathway from the cable tray to close proximity of camera locations indicated on drawings.
   2. The cable for each camera location shall have a 15’ service loop and be terminated using the L1 standard with a Hubbell Cat 6 jack on the end. All cables shall be tested, recorded and held to the same standard as all other network cabling.
   3. Cables shall be landed within the Network Data Rack. Cables shall be terminated using Hubbell green Cat 6 jacks using the (B) standard that will be landed into a 24 port or 48 port MAX Patch Panel. Black Hubbell blanks to be used on any open unused port. Camera patch panels shall be mounted 3RU below the lowest installed device to keep separate from all other network cables.
   4. A green 7’ Hubbell Cat 6 patch cable shall be provided for each camera cable run. Each run shall be identified with descriptive labels on both ends.
      a. Approved Manufacturer: Mohawk #57416 (Green Cable)
      b. Approved Manufacturer: Hubbell #HXJ6GN (Green Cat 6 Jacks)
      c. Approved Manufacturer: Hubbell #HC6GN07 (Green Cat 6, 7’ patch cable)

E. IP Intercom Cabling

1. IP Intercom Cabling shall be Mohawk Cat 6 UTP and yellow in color. All runs shall be home run to the nearest IT Network closet as indicated on drawings. No wiring shall be left exposed and accessible to tampering. Use a 1 ¼” conduit and junction boxes shall be used as a secure pathway from the cable tray IP clock/speaker locations indicated on drawings.
   2. The cable for each IP clock/speaker location shall be terminated using the L1 standard with a Hubbell Cat 6 jack on the end. All cables shall be tested, recorded and held to the same standard as all other network cabling.
   3. Cables shall be landed within the Network Data Rack. Cables shall be terminated using Hubbell yellow Cat 6 jacks using the (B) standard that will be landed into a 24 port or 48 port MAX Patch Panel. Black Hubbell blanks to be used on any open unused port. IP clock/speaker patch panels shall be mounted adjacent to camera cables to keep separate from all other network cables.
COUNTY FAIRGROUNDS BUILDING
CACHE COUNTY

4. A yellow 7’ Hubbell Cat 6 patch cable shall be provided for each IP clock/speaker cable run. Each run shall be identified with descriptive labels on both ends.
   a. Approved Manufacturer: Mohawk #57415 Yellow Cable)
   b. Approved Manufacturer: Hubbell #HXJ6Y (Yellow Cat 6 Jacks)
   c. Approved Manufacturer: Hubbell #HC6W07 (Yellow Cat 6, 7’ patch cable)

2.3 HORIZONTAL CROSS-CONNECT TERMINATION HARDWARE

A. Horizontal Cross-Connections

1. All four pair Category 6e cabling shall be terminated onto Hubbell Patch Panels 24 and/or 48 port patch panels only. One station cable per port plus 25% unused ports available for future growth within every Data/Voice rack. Provide Hubbell horizontal cable management on the backside of each patch panel installed.

2. The horizontal cross-connect for Data circuits shall consist of patch cords from the rack mounted patch panels to the network equipment as well as each work station. Provide (2) patch cables for each horizontal Data cable installed.
   a. Approved manufacturer: Hubbell #HC6BXX

3. The horizontal cross-connect for Voice circuits shall consist of patch cords from the rack mounted patch panels to the network equipment as well as each work station. Provide (2) patch cables for each horizontal Voice cable installed.
   a. Approved manufacturer: Hubbell #HC6WXX.

2.4 CABLE MANAGEMENT

A. Distribution Rings

1. All Cables routed on back boards shall be supported using die-cast aluminum distribution rings “D-Rings”. Rings shall be located within 12” of entering or exiting conduit, 6” prior to any radius bends and at least 2’ on center. Metal Distribution Rings keep all low voltage cables & wires neat & well-organized, featuring rounded edges that will prevent damage to the wire & cable, allowing for an easier “pull”.
   a. Approved manufacturer: Allen Tel GB13A, GB13B and GB13C.

B. Cable Management ties

1. Bundle all communications cables together with Hook & Loop-type tie wraps only.
   a. Approved manufacturer: Panduit HLT, HLS, HLM and TAK-TAPE series cable ties.

2.5 COMMUNICATIONS CLOSETS CONFIGURATION

The MDF (Main Distribution Frame) shall always be recognized and labeled as “Closet A” no matter the actual location.

A. Communication Backboard

1. Data/Voice terminal backboards shall be 3/4” thick plywood painted with two (2) coats of White, fire retardant paint, APA exterior grade Douglas Fir A-C and fire retardant with flame spread rating not more than 25 when tested according to ASTM E-84. Refer to drawing for locations, quantities and mounting arrangement.
B. Equipment Racks

1. Equipment Rack(s) *MDF*: In areas where floor-mounted rack is shown, provide PANDUIT 19" wide x 7'-0" Equipment Rack with vertical wire management on both sides. Provide PANDUIT wire spool for each vertical wire management and PANDUIT patch runner dual hinged doors for the front and rear of each rack with the number of vertical rack sections as required to accommodate all switches, patch panels and managers to a maximum of 70% rack capacity. Provide HUBBELL Horizontal cable management for the front side of the rack for patch cable management. All Equipment Rack(s) shall have ladder rack bracing in a minimum of two directions to ensure stability and bonded (as per section 3.6.A.5).
   a. Approved manufacturer: PANDUIT P/N CMR19X84 (Rack)
   b. Approved manufacturer: PANDUIT P/N PRV6 (Vertical wire management)
   c. Approved manufacturer: PANDUIT P/N PRSP5 (Wire spool)
   d. Approved manufacturer: PANDUIT P/N PRD6 (Patch runner dual hinged door)
   e. Approved manufacturer: HUBBELL HC219CE3N (Horizontal cable management)
   f. Approved manufacturer: HUBBELL HLS1012B (Ladder rack)
   g. Approved manufacturer: HUBBELL #HP624 (Cat 6, 24 port patch panel)
   h. Approved manufacturer: HUBBELL #HP648 (Cat 6, 24 port patch panel)
   i. Approved manufacturer: SIEMON P/N WM-BK (Rear cable management)

2. Wall mounted cabinet (HUBBELL REBOX #RE4X – See Detail 11/ED.02) *IDF*
   a. Include equipment shown in detail.
   b. Set a second wall mounted cabinet (adjacent to cabinet shown on plan) to achieve spare capacity referenced in 2.5 (BX1) if required. Each cabinet shall have a fiber cable to MDF.

2.1 BACKBONE CABLING

Backbone cables shall be installed separately from horizontal distribution cables. Where backbone cables and distribution cables are installed in a cable tray, backbone cables shall be installed first and bundled separately from the horizontal distribution cables.

A. Copper Backbone

1. Voice copper backbone cabling consists of 25 pair category 5e, solid copper 24 AWG, UTP plenum cable installed from telephone board to IDF-V. This backbone will be utilized for voice telecommunications service only. Termination of the 25 pair shall patch down on a 24 port patch panel with one pair per port. The last pairs of the 25 pair cable may be rolled back and tied out of the way.
   a. Approved Manufacturer: Mohawk M58142

2. Non-Plenum wet location 25 pair Category 5e, copper backbone cabling shall be used for all underground, pathways.
   a. Approved Manufacturer: Mohawk M58783
COUNTY FAIRGROUNDS BUILDING  
CACHE COUNTY

B. Optical Fiber

1. Optical Fiber Cable: Data communications backbone shall be installed from the new high school MDF to existing MDF in middle school, IDF-A (Auditorium), and IDF-V (Vo-Ag). There is to be a minimum of a 6 count that consists of CORNING 50/125 µm laser optimized, OM3 Plenum Armored Fiber. Any backbone that must be routed under slab is to be installed using non-plenum OSP cabling.
   a. Approved Manufacturer: Corning 012T88-33180-A3

2. Rack mounted Fiber Optic Patch Panels: Provide a Rack Mount Interconnect Center in the existing MDF in middle school and new MDF in high school. The fiber tray count or layout is to be equal to the total number of fiber backbones coming into the new MDF from middle school, auditorium, and vo-ag. All fiber trays are to utilize the Hubbell Compression fitting to secure the fiber to the fiber tray according to fiber diameter.

3. Fiber Optic Connectors: Hubbell fiber tray bulkheads are to be used to accommodate every strand of fiber that is specified. Any unused open bays shall be blanked off.
   a. Approved Manufacturer: Hubbell FSPLCQ53OR (6 quad LC adapters)
   b. Approved Manufacturer: Hubbell FSPB (Blank adapter plate)

4. Fiber Optic Jumpers: Hubbell Dual 50/125µm Optical fiber jumpers, 2 meter in length with LC fiber connectors on both ends. To be provided in the following quantities, (16) for High Schools.
   a. Approved Manufacturer: Hubbell KLCDPFLC550GMO2OR

PART 3 – EXECUTIONS

3.1 PRODUCTION INSPECTIONS

The Contractor shall inspect all cable prior to installation to verify that it is identified properly on the reel identification label that it is of proper gauge, containing correct number of pairs and is the material ordered. Any physical damage to the cable and wire must be noted: non-uniform jacket thickness and jacket tightness should also be identified. Note any buckling of the jacket, which would indicate possible problems.

3.2 CABLE INSTALLATION – GENERAL

A. The contractor shall insure that the communications cable is installed with care, using Techniques which prevent kinking, sharp bends, scraping cutting, deforming of the jacket or other damage. During inspection evidence of such damage will result in the material being declared unacceptable. The contractor shall replace unacceptable cabling at no additional expense.
COUNTY FAIRGROUNDS BUILDING
CACHE COUNTY

B. Conduit and Cable Tray Usage: Division 16000 Contractors shall install all Cable tray and conduit for communication cable. All conduits shall be routed in the ceiling space and not in the concrete slab. All conduits shall be ran from the station location in one complete and continuous path to the cable tray and bonded to the cable tray as per ANSI/TIA/EIA Standards and the NEC. Conduits shall not have more than 180° bend radius in the entire span of the conduit from end to end. If more bend radius is required, install a 2 gang electrical box with cover after the first 180° of bend radius and continue with this practice through the entire span of the conduit until the path is installed completely. Each conduit installed shall service only one location each. Each conduit will have a 200lb pull string, grounding bushing and ground wire also installed by division 16000 contractors.

C. Any spanning of cable will not be allowed in any span longer than 36” from cable tray to conduit. No cable run shall exceed 90 meters or 300 feet from station location to the IDF including service loop and patch cables.

D. Cable shall not be draped on, tied or otherwise secured to electrical conduit, plumbing, ventilation ductwork or any other equipment. Cable shall be secured to building supports or hangers specifically installed for this purpose. All wiring to be installed in a neat and inconspicuous manner, per local code requirements. Data and Voice cables to be bundled separately routed parallel to one another in the cable tray.

E. Allowable Cable Bend Radius and Pull Tension: In general, communications cable cannot tolerate shaper bends or excessive pull tension during installation. The minimum radius bend shall be ten (10) times the cable outer diameter with no tensile load applied and twenty (20) times the cable outer diameter with a maximum tensile load of 25 ft/lbs. is applied during installation.

F. Cable Lubricants: Lubrications specifically designed for installing communications cable may be used to reduce pulling tension as necessary when pulling cable into conduit. After installation, exposed cable and other surfaces must be cleaned of lubricant residue.

G. Conduit and Raceway Fill: Communication raceway shall not be filled beyond 40% capacity. A minimum of (1) 1 ¼” conduit will be used for each location – A, B, K, and L (1-6).

H. Backboard and Rack Cable Supports: Clams, “D-Rings” and Velcro tie-wraps are all acceptable ways to support cable. However, installation of these supports must be done with care so as not to cause crushing or distortion of the cable, nor cause tighter bends than the minimum radius permitted for each type cable. Refer to Part 2.4 Cable Management section for specified supports and tie-wraps.

3.3 DATA/TELEPHONE STATION CABLING

A. Provide 10’ of service loop using adequate support structures (ladder rack) on all cables routed to MDF. Provide 10’ of service slack in the ceiling secured neatly to the side of each drops respective conduit to accommodate future cabling system changes for the telecommunications outlets.
B. In addition, each cable type shall be terminated as indicated below:

1. Cables shall be dressed in a “Pencil-Weave” pattern from cable tray to equipment racks within IDF and terminated in accordance with the recommendations made in the TIA/EIA-568-A Document, manufacturer’s recommendations and/or best industry practices.
2. Pair untwist at the termination shall not exceed one-eighth of an inch for Category 6 UTP connecting hardware.
3. Bend radius of the cable in the termination area shall not be less than 4 times the outside diameter of the cable.
4. The cable jacket shall be maintained as close as possible to the termination point.

C. Station drop cable terminations shall be made at the data port at the patch panel and the same data outlet at the data/telephone station location. Label patch panel port and station outlet the same. At each outlet box, a sufficient length of spare cable will be provided for terminating outlet devices such that the outlet can be easily removed and inspected.

D. Horizontal distribution cables shall be bundled in groups of not greater than 40 cables. Cable bundle quantities in excess of 40 cables may cause deformation of the bottom cables within the bundle.

E. Cables shall not be attached to ceiling grid or lighting support wires.

F. The installation of cables around movable devices, instruments, sub panels, etc., shall be provided with adequate support, length, protection and flexibility so that the cable is not damaged in the event of equipment being moved.

G. Every attempt shall be made to avoid running telecommunications close to (less than 24”) and parallel to power raceway and wiring, or close to light fixtures.

3.4 CABLE LABELING

A. All cables shall be labeled at each end with the same numbering scheme as approved by the Owner and shall conform to ANSI/TIA/EIA-607 standards.

B. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme.

C. All label printing will be machine generated using indelible ink ribbons or cartridges. Self-laminating labels will be used on cable jackets, appropriately sized to the outside diameter of the cable and placed within view at the termination point on each end.

D. Station Drop Cable Labels: Each station outlet terminal shall be identified and marked on the patch panel with the outlet number as developed by Owner/Engineer.

1. Station Labels: Station Labels shall contain the fewest alphanumeric characters as necessary for a logical, consistent and user-friendly identification system. With the exception of Wireless Access Points (see Part 2.2.A.4), all labels shall be produced with a labeling machine producing black on white adhesive Mylar tape labels.
2. Label all patch panel jacks in an identical fashion.
3.5 GROUNDING AND BONDING

A. Division Contractors shall ground/bond all cable tray and conduit installed for communication cables.

1. All grounded cable trays will be done so with stranded #6 AWG.
2. Grounding bushings and #12 AWG shall be used to bond all communication conduits to the cable tray.
3. A stranded #6 AWG shall be provided by Division Contractors to each network closet. A TGB in each IDF is to be installed by Division contractor. The TGB must be a predrilled copper busbar with holes for use with standard-sized lugs, have a minimum dimension of 6.3mm (0.25in) thick by 50 mm (2 in) wide, and may be variable in length.
4. The Low Voltage contractor shall be responsible for providing one Rack Grounding Busbar to be installed horizontally 3-U from the bottom of every network rack or cabinet within each closet. The RGB is to be bonded to the TGB in each network closet using an insulated #6 AWG.
   a. Approved Manufacturer: Chatsworth P/N 10610-019
5. The low voltage contractor shall be responsible for bonding each rack, cabinet and ladder rack individually to the RGB. Each RGB shall be individually run back to the TMGB/TGB within the network closet. Serial connections (or “daisy-chaining”) will not be accepted.

3.6 TESTING

A. Testing UTP Cables and Links

1. The performance tests and their procedures have been defined in the ANSI/TIA/EIA-568-C.2 standard and the ISO/IEC 11801 standard. The TIA standard defines performance in categories (Cat 3, Cat 5e, Cat 6) and the ISO defines classes (Class C, D, E, and F). These standards define the procedure to certify that an installation meets performance criteria in a given category or class. Certifications shall include the following parameters for each pair of each cable installed:
   a. Wire map (pin to pin connectivity)
   b. Length (in feet)
   c. Attenuation
   d. Near End Crosstalk (NEXT)
   e. Far End Crosstalk (FEXT)
   f. Equal Level Far End Crosstalk (ELFEXT)
   g. Attenuation/Crosstalk Ration (ACR)
   h. Return Loss
   i. Propagation Delay
   j. Delay Skew

2. Test equipment shall provide an electronic and printed record of these tests. Test equipment shall be a level III field tester; Fluke Networks DTX-1800 using Permanent Link Adapters with the most current firmware is required.
3. If copper backbone cables contain more than one (1) percent bad pairs, remove and replace entire cable.
SECTION 16716 - TELEPHONE SYSTEM (CONDUIT ONLY)

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The extent of the telephone system is to provide and install 3/4" conduit from the point of service to the indicated outlets. Terminate the conduits in a standard device box, set at the indicated location and height. When complete install a nylon pull cord in the conduit for use of the cable installers.

B. Refer to the division 16 sections for requirements for conduit, fittings, device boxes, cover plates, etc. as applicable. The conduit installation shall comply with Section 16110 with supports as indicated.

C. The owner shall provide and install the telephone system.

END OF SECTION 16716
SECTION 16717 - TELEPHONE EQUIPMENT AND CABLING SYSTEM

PART 1 - GENERAL

1.1 SCOPE

A. The contractor shall provide and install a complete telephone system: switch, cable, service arresters, instruments, jacks, cover plates, etc., for a complete and operable system as stated herein and shown on the plans.

B. Extent of telephone system work is indicated by drawings and is herein defined to include, but not be limited to raceway outlets, device plates, backboards, cabinets, grounding and miscellaneous items required for complete raceway system.

C. The General Provision of the contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this section, as well as all codes and standards referenced.

1.2 QUALITY ASSURANCE

A. Comply with applicable portions of NEC as to type of products used and installation of components. Provide products and materials which have been UL-listed and labeled.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide complete raceway system for telephone including but not limited to, raceway, outlets, device plates, backboards, cabinets, grounding and miscellaneous items as required.

B. Provide terminal cabinets of code gauge steel, flush or surface, as indicated, with concealed trim clamps, concealed hinges and flush lock, with gray backed enamel finish to match finish of panelboard covers. Construct back boxes of code gauge galvanized steel with removable end walls.

2.2 TELEPHONE LINE PROTECTOR

A. The contractor shall provide and install on the telephone board a 25 line telephone protector unit that will dampen and/or ground out lightning and/or transient charges.

B. The unit shall be mounted on the plywood board at a location directed by the telephone installer.

C. The unit shall be grounded to the #6 telephone ground conductor.

D. The unit shall be a Reliance Comm/Tec unit #R66P25QC series with 89 stand-off brackets.
COUNTY FAIRGROUNDS BUILDING  
CACHE COUNTY

2.3 TELEPHONE CABLES

A. Provide and install the service cable (if not provided by the service company) a type Category 5, 25 pr telephone cable Mohawk M-57656.

B. From the control board install to each telephone station type Category 5 cable, Mohawk M-56876 cable.

PART 3 - EXECUTION

3.1 INSTALLATION OF TELEPHONE RACEWAY SYSTEM

A. GENERAL: Install raceway system as indicated to comply with NEC and recognized industry practices. Run 3/4” conduit from each telephone outlet to terminal backboard, tray, or terminal cabinet. Provide nylon pull cord in all installed raceway.

B. GROUNDING: Provide one #6 bare copper ground from each telephone terminal board to the service entrance ground. Enclose in suitable raceway for entire length. Coil six feet of conductor at each terminal board. Make connection at service entrance ground. See drawings for additional requirements.

C. POWER: Provide a minimum of one four-plex receptacle on dedicated circuit adjacent to each terminal backboard or cabinet. See drawings for additional power outlets.

D. Service entrance raceway to be 2” minimum unless noted and shall be installed with a nylon pull cord.

E. TELEPHONE SYSTEM: Main service entrance conduit to be 2” unless noted otherwise. Provide a nylon pull cord in entrance conduit. Coordinate the service and installation with the local telephone company.

END OF SECTION 16717
PART 1- GENERAL

1.1 GENERAL REQUIREMENTS

A. The contractor shall provide and install an Addressable Fire Alarm system in this facility as specified herein and shown on the plans. The system shall be complete, operable, and receive acceptance (in writing) from the governing authority.

B. The requirements of the Contract Documents, including the General and Supplementary General Condition and Division 1 - General Requirements shall apply to the work of this section.

C. Scope

1. The work covered by this Section of the Specification shall include all labor, equipment, materials and services to furnish and install a complete fire alarm system of the addressable, analog non-coded general alarm type. It shall be complete with all necessary hardware, software and memory specifically tailored for this installation. It shall be possible to permanently modify the software on site by using a plug-in programmer. The system shall consist of, but not be limited to, the following:
   a. Fire alarm control panel
   b. Remote Annunciator.
   c. Addressable manual fire alarm stations.
   d. Addressable analog smoke detectors.
   e. Addressable analog and conventional duct smoke detectors.
   f. Addressable analog and conventional heat detectors.
   g. Sprinkler water flow alarm switches.
   h. Audible notification appliances; bells, horns, chimes.
   i. Visual notification appliances; strobes.
   j. Air handling systems shutdown control.
   k. Magnetic door holder release.
   l. Sprinkler supervisory switches and tamper switch supervision.
   m. Battery Standby.
   n. Provide three (3) spare smoke detectors and one (1) heat detector (Deliver to owner). See section 16001.2.5.

D. Applicable Codes and Standards

1. All equipment shall be U.L. listed for its intended use.
2. NFPA Standards 72
4. All other local codes and authorities having jurisdiction.

E. Related Documents

1. Secure permits and approvals prior to installation.
2. Prior to commencement and after completion of work notify Authorities Having Jurisdiction.
COUNTY FAIRGROUNDS BUILDING
CACHE COUNTY

3. Submit letter of approval for installation before requesting acceptance of system.

F. Related Work

1. The Contractor shall coordinate work in this Section with all related trades. Work and/or equipment provided in other Sections and related to the fire alarm system shall include, but not be limited to:
   a. Sprinkler waterflow and valve position supervisory switches shall be furnished and installed by the plumbing contractor, but wired and connected by the electrical contractor.
   b. HVAC duct smoke detectors shall be furnished and installed by Division 15, but wired and connected by the electrical contractor. The HVAC contractor shall furnish necessary duct opening to install the duct smoke detectors. Provide a monitor module per duct detector and a control module for each HVAC unit for fire alarm shut down.
   c. Air handling and smoke exhaust system fan control circuits and status contacts to be furnished by the HVAC control equipment.
   d. Conduit: Section 16110.
   e. Wire and Cables: Section 16120.

2. Selection of a central station agency, its equipment, its fees and fees for leased telephone lines are the responsibility of the owner or his representative.

G. Submittals:

1. With the shop drawings, provide list of all types of equipment and components provided.
2. Provide description of operation of the system, similar to the provided in Part 2 of this Section of the Specification, to include any and all exceptions, variances or substitutions listed at the time of bid. Any such exceptions, variances or substitutions which were not listed at the time of bid and are identified in the submittal, shall be grounds for immediate disapproval without comment.
3. Provide manufacturer’s printed product data, catalog cuts and description of any special installation procedures.
4. Provide samples of various items when requested.
5. Provide shop drawings as follows:
   a. Drawing of the fire alarm control panel.
   b. Drawing of the remote annunciator.
   c. Single line riser diagram showing all equipment and type, number and size of all conductors.

H. Warranty

1. Manufacturer shall guarantee the system equipment for a period of one (1) year from date of final acceptance of the system. Equipment shall be guaranteed for two (2) years.
2. The contractor shall guarantee all wiring and raceways to be free from inherent mechanical or electrical defects for one (1) year from date of final acceptance of the system.
3. Upon completion of the installation of fire alarm system equipment, the electrical contractor shall provide to the architect a signed written statement, substantially in form as follows: “The undersigned, having engaged as the Electrical Contractor of the (Name of Project) confirms that the fire alarm system equipment was installed in accordance with the wiring diagrams, instructions and directions provided to us by the manufacturer.”

I. Manufacturers: This specification has been written around Edward Systems Technology Fire Alarm equipment; equals of Notifier, Auto Call, Game Well, or an approved equal, may be accepted provided it meets all of the conditions and criteria outlined herein.

PART 2 - PRODUCTS

2.1 CIRCUITING GUIDELINES

A. Each addressable analog loop shall be circuited as shown on the drawings but device loading is not to exceed 80% of loop capacity in order to leave for space for future devices. The loop shall have Class A operation.

B. Where it is necessary to interface conventional initiating devices provide intelligent input modules to supervise zone wiring.

C. Each of the following types of devices or equipment shall be provided with supervised circuits as shown on the drawings but shall be typically as follows:

1. Sprinkler valve supervisory switches: Provide one (1) supervisory module circuit for each sprinkler valve supervisory switch or floor.
2. Emergency generator: provide two (2) supervisory module circuits: one (1) for “Emergency Generator one”; one (1) for “Fire Pump Power Failure”.
3. Dry pipe/deluge sprinkler release valves: Provide one (1) releasing module circuit for each dry pipe/deluge sprinkler release valve.
4. Computer room smoke alarm control panels: Provide one (1) alarm module circuit for each computer room smoke alarm control panel.

D. Each of the following types of alarm notification appliances shall be circuited as shown on the drawings but shall be typically as follows:

1. Audible signals: provide one (1) notification appliance circuit for each twelve (12) alarm bells, horn strobes, horns, and chimes.

E. Each of the following types of remote equipment associated with the fire alarm system shall be provided with a form ‘C’ control relay contact as shown on the drawings, but shall be typically as follows:

1. HVAC fan systems: Provide one (1) shutdown addressable control relay contact for each HVAC fan system.
2. HVAC supply fans: Provide one (1) shutdown addressable control relay contact for each HVAC supply fan.
3. HVAC return fans: Provide one (1) shutdown addressable control relay contact for each HVAC return fan.
4. HVAC exhaust systems: Provide one (1) shutdown addressable control relay contact for each HVAC exhaust fan as required.

2.2 FIRE ALARM SYSTEM SEQUENCE OF OPERATION

A. The system shall identify any off normal condition and log each condition into the system database as an event.

1. The system shall automatically display on the control panel Liquid Crystal Display the first event of the highest priority by type. The priorities and types shall be alarm, supervisory, trouble, and monitor.

2. The system shall have a Queue operation, and shall not require event acknowledgment by the system operator. The system shall have a labeled color coded indicator for each type of event; alarm-red, supervisory - yellow, trouble- yellow, monitor - green which shall turn on when active events exist.

3. For each event, the display shall include the current time, the total number of events, the type of event, the time the event occurred and up to a 40 character custom user description.

4. The user shall be able to silence the local signal and review each event by simply selecting scrolling keys (up-down) for each event type.

5. New supervisory or trouble events shall sound a silence-able signal at the control panel.

B. Operation of any Alarm initiating device shall automatically:

1. Update the control/display as described above (B.1).

2. Sound all alarm signals throughout the building at the evacuation rate.

3. Turn on all strobe lights throughout the building.

4. Turn on a red alarm zone LED at the fire alarm control panel.

5. Operate the alarm relay contacts to initiate the transmission of an alarm to a central station agency via telephone dialer or on leased telephone lines.

6. Operate addressable control relay contacts to shutdown all HVAC units serving floor of alarm.

7. Operate control relay contacts to start the stairwell pressurization fan system.

8. Operate control relay contacts to start the Atrium smoke exhaust fan system.

9. Operate control relay contacts to return all elevators that serve the floor of alarm initiation to the ground floor. If the alarm originates from the ground floor, operate control circuits contacts to return all elevators to the floor above or to a level as directed by the local fire department.

10. Operate control relay contacts to release all magnetically held smoke doors throughout the building.

11. Visually annunciate the zone of alarm on the remote annunciator panel. The visual indication shall remain on until the alarm condition is reset to normal.

C. Activation of a sprinkler supervisory initiating device shall:

1. Update the control/display as described above and turn on the trouble relay.

2. Turn on a yellow zone LED at the fire alarm control panel.

3. Operate the supervisory relay contacts to initiate the transmission of an alarm to a central station agency via leased telephone lines.

4. Visually annunciate the zone of alarm on the remote annunciator panel. The visual indication shall remain on until the alarm condition is reset to normal.
D. The entire fire alarm system wiring shall be electrically supervised to automatically detect and report trouble conditions to the fire alarm control panel. Any opens, grounds or disarrangement of system wiring and shorts across alarm bell/strobe wiring shall automatically:

1. Update the control/display as described above (B.1).
2. Operate the supervisory relay contracts to initiate the transmission of an alarm to a central station agency via leased telephone lines.
3. Visually and audibly annunciate a general trouble condition, on the remote annunciator panel. The visual indication shall remain on until the trouble condition is repaired.

E. Support for Installer and Owner Maintenance

1. Provide a coded one man walk test feature. Allow audible or silent testing. Signal alarms and troubles during test. Allow receipt of alarms and programmed operations for alarms from areas not under test.
2. Provide internal system diagnostics and maintenance user interface controls to display/report the power, communication, and general status of specific panel components, detectors, and modules.
3. Provide loop controller diagnostics to identify common alarm, trouble, ground fault, Class A fault, and map faults. Map faults include wire changes, device type changes by location, device additions/deletions and conventional open, short, and ground conditions. Ground faults on the circuit wiring of remote module shall be identified by device address.
4. Allow the user to display/report the condition of addressable analog detectors. Include device address, device type, percent obscuration, and maintenance indicator. The maintenance indicator shall provide the user with a measure of contamination of a device upon which cleaning decisions can confidently be made.
5. Allow the user to report history for alarm, supervisory, monitor, trouble, smoke verification, and restore activity. Include Facility Name, Licensee, Project Program Compilation date, Compiler Version, Project Revision Number, and the time and date of the History Report.
6. Allow the user to disable/enable devices, zones, actions, timers and sequences. Protect the disable function with a password.
7. Allow the user to activate/restore outputs, actions, and sequences.
8. Allow the service user to enter time and date, reconfigure an external port for download programming, initiate auto programming and change passwords. Protect these functions with a password.

F. Materials:

1. Fire Alarm Control Panel:
   a. The fire alarm control panels shall be Edwards Systems Technology (EST) type EST2 series and shall incorporate all control electronics, relays, and necessary modules and components in a semi-flush mounted cabinet. The operating controls and zone/supervisory indicators shall be located behind locked door with viewing window. All control modules shall be labeled, and all zone locations shall be identified. The cabinet shall be steel, with a gray finish. The assembly shall contain a base panel, system power supply and battery charger with optional modules suitable to meet the requirements of these specifications. Manufacturers: This specification has been written around Edwards Systems Technology, which establishes a standard.
b. System circuits shall be configured as follow: Addressable analog loops Class A; Notification Appliance Circuits Class A.

c. Single stage operation.

d. The system shall be supervised, site programmable, and of modular design with expansion modules to serve up to 192 detectors and 188 remote modules, and multiple notification appliance circuits (NACs) convertible to power risers to serve remote multiple NAC modules for zoned signal applications. The system shall be expandable to a minimum of 960 detectors and 940 remote modules.

e. The system shall store all basic system functionality and job specific data in non-volatile memory. The system shall survive a complete power failure intact.

f. The system shall have built-in automatic system programming to automatically address and map all system devices and provide a minimum default single stage alarm system operation with support of alarm silence, trouble silence, drill, lamp test, and reset common controls.

g. The system shall allow down loading of a job specific custom program created by system application software. It shall support programming of any input point to any output point. The system shall support the use of Bar Code readers to assist custom programming functions. It shall allow authorized customization of fundamental system operations using initiating events to start actions, timers, sequences and logical algorithms.

h. The system shall support distributed processor intelligent detectors with the following operational attributes; integral multiple differential sensors, automatic device mapping, electronic addressing, environmental compensation, pre-alarm, dirty detector identification, automatic day/night sensitivity adjustment, dual normal/alarm LEDs, relay bases, and isolator bases.

i. The system shall use full digital communications to supervise all addressable loop devices for placement, correct location, and operation. It shall allow swapping of “same type” devices without the need of addressing and impose the “location” parameters on replacement device. It shall initiate and maintain a trouble if a device is added to a loop and clear the trouble when the new device is mapped and defined into the system.

j. The system shall have a U.L. Listed Detector Sensitivity test feature, which will be a function of the smoke detectors and performed automatically every 4 hours.

k. The system shall support 100% of all remote devices in alarm and provide support for a 100% compliment of detector isolator bases.

l. All panel modules shall be supervised for placement and return trouble if damaged or removed.

m. The system shall have a CPU watchdog circuit to initiate trouble should the CPU fail.

n. The system evacuation signal rate shall be March time at 120 PPM.

o. Provide a signal silence inhibit feature set to enter integer time between 0-99 minutes and an automatic signal silence timer set to enter integer time between 0-99 minutes. Audible notification appliances shall be affected by signal silence features. Visual signal appliance shall not be affected by signal silence features.

p. The system program shall meet the requirements of this project, current codes and standards, and satisfy the local Authority Having Jurisdiction.

q. Passwords shall protect any changes to system operations.
r. The power supply shall be a high efficiency switch mode type with line monitoring to automatically switch to batteries for power failure or brown out conditions. The automatic battery charger shall have low battery discharge protection. All outputs shall be power limited. The battery shall be sized to support the system for 24 hours of supervisory and trouble signal current plus general alarm for 5 minutes.

s. The LCD Display Module shall be membrane style construction with a 4 line by 20 character Liquid Crystal Display. The LCD shall use supertwist technology and backlighting for high contrast visual clarity. In the normal mode display the time, the total number of active events and the total number of disable points. In the alarm mode display space for user custom messages. The module shall have visual indicators for the following common control functions; AC Power, alarm, supervisory, monitor, trouble, disable, ground fault, cpu fail, and test. There shall be common control keys and visual indicators for; reset, alarm, silence, trouble silence, drill, and one custom programmable key/indicator. Provide four pairs of display control keys for selection of event display by type (alarm, supervisory, monitor and trouble) and forward/backward scrolling through event listings. The operation of these keys shall be integrated with the related common control indicators to flash the indicators when undisplayed events are available for display and turn on steady when all events have been displayed. Allow the first event of the highest priority to capture the LCD for display so that arriving fire fighters can view the first alarm event “hands free”. Provide system function keys; status, reports, enable, disable, activate, restore, program, and test. The module shall have a numeric keypad, zero through nine with delete and enter keys.

t. The Main Controller Module shall control and monitor all local or remote peripherals. It shall support the LCD Display Module, power supply, remote LCD and zone display annunciators, strip and carriage printers, and support communication interface standard protocol (CSI) devices such as color computer annunciators and color graphic displays. The RS-485 port shall be capable of supporting up to 32 remote annunciators. The MCM shall provide one loop controller circuit, two notification appliance circuits, and common form ‘C’ contacts for alarm, supervisory, and trouble. Contact ratings shall be 1Amp at 24Vdc.

u. The panel shall have:
   1) A march time module for signal rate control to provide 20 spm, 120 spm, or temporal 3-3-3 signal patterns.
   2) An interface module for remote site monitoring. The module shall have a local energy municipal look and reverse polarity connections for each of alarm, supervisory and trouble.

v. The Fire Alarm Contractor shall provide and install a laminated 1/16" building plan in a frame at the main Fire Alarm Panel and the Annunciator Panel showing the building zones. The plan shall have a red LED light therein indicating that will illuminate when an alarm is activated in that zone. The lamp will remain illuminated until the alarm has been cleared.

w. The system shall support and relate to an Annunciator Panel all the functions that are pertinent to a fireman as he visits the Annunciator Panel on a fire alarm. The panel shall be located at the designated entrance and shall be electrically called thereto.
2.3. SIGNATURE SERIES INTELLIGENT ADDRESSABLE ANALOG DEVICES

A. General, All Devices

1. Furnish and install where indicated on the plans.
2. Each remote device shall have a microprocessor with non-volatile memory to support its functionality and serviceability. Each device shall store as required for its functionality the following data: device serial number, device address, device type, personality code, date of manufacture, hours in use, number of alarms and troubles, time and date of last alarm, amount of environmental compensation left/used, last maintenance date, job/project number, current detector sensitivity values, diagnostic information (trouble codes) and algorithms required to process sensor data and perform communications with the loop controller.
3. Dependent on its functionality each device shall be capable of monitoring up to 32 diagnostic codes. This data shall be stored at the device and available for system maintenance.
4. Each device shall be capable of performing its intended function independent of the control panel to lower loop data traffic. Each device shall immediately alert the loop controller of a status change to achieve a loop response time of less than 500 ms.
5. Each device shall be capable of performing its intended function independent of the control panel to lower loop data traffic. Each device shall immediately alert the loop controller of a status change to achieve a loop response time of less than 500 ms.
6. The operating environment shall be restricted to a temperature of 32 degrees F to 100 degrees F, humidity: 0-93% RH, non-condensing.

B. Detector Devices General

1. Each detector shall continually monitor the environmental impact of temperature, humidity, barometric pressure and air-borne contaminants. The process shall adapt the detector to long term environmental changes and signal the loop controller when the detector approaches 50% and 100% of the allowable environmental compensation value.
2. Differential sensing algorithms shall maintain a constant sensitivity setting between the alarm threshold and a compensated base line sensitivity setting between the alarm threshold and a compensated base line sensitivity. The base line sensitivity shall be updated approximately once every hour.
3. Each detector shall have a separate means of displaying communication and alarm status. A green LED shall flash to confirm communication. A red LED shall flash to display alarm status. LEDs shall be visible through a full 360 degree viewing angle.
4. Each detector shall be capable of transmitting pre-alarm and alarm signals.
5. Each detector shall be suitable for mounting on Signature Series detector mounting base.
6. All detectors shall be suitable for wall mount applications.
C. Sensor Devices

1. Each detector sensor shall use differential sensing to provide accurate data to the detector’s alarm algorithm processor. The fire decision algorithm shall combine all sensor analog signal dimensions and time to increase reliability and distinguish real fire conditions from unwanted deceptive nuisance alarms. The detector shall respond faster to fire signal patterns affecting more than one sensor. Signal patterns not typical of fires shall be eliminated. Devices not capable of combining different fire parameters shall not be acceptable.

2. Sensor devices shall be:
   a. SIGA-PS Intelligent Photo Detector shall use a light scattering type photo sensor. The detector shall be suitable for area protection and direct insertion into air ducts up to 3 feet high and 3 feet wide with air velocities up to 5000 ft./min. without requiring specific duct detector housings or supply tubes. The detector shall have a UL Smoke Sensitivity Range 0.67 - 3.77% Obscuration/ft. The detector shall be rated for ceiling installation at a minimum of 30 foot centers.
   b. Single Sensor Devices shall be:
      1) SIGA-HRS Fixed Temperature/Rate-of-Rise Heat Detector shall have a low mass thermistor and operate at a nominal fixed temperature of 135 degrees F and at a temperature rise at or exceeding 15 degrees F per minute. It shall have a minimum linear space rating of 70 foot centers.
      2) SIGA-HFS Intelligent Fixed Temperature Heat Detector shall have a low mass thermistor and operate at a fixed temperature of 135 degree F. It shall have a minimum linear space rating of 70 foot centers.

D. Detector Bases

1. Detector bases shall mount to North American 1 gang, 3 ½” or 4” octagon boxes, and a 4”square box. Removal of the respective detector shall not affect communications with other detectors. Terminal connections shall be made on the room side of the base. All detectors shall be compatible with any base.
   a. The SIGA-SB and SIGA-SB4 standard bases shall provide terminals to connect a SIGA-LED Remote Alarm Indicator.
   b. The SIGA-RB and SIGA-RB4 relay bases shall have a bi-stable relay with form ‘C’ contacts rated at 30 Vdc at 1.0 A, supervised for position and tested on power up. The relay shall be controlled by its respective detector processor and in the event of a communication failure the operation of the relay shall not be affected. Upon removal of the detector the relay shall automatically de-energized.
   c. The SIGA-IB and SIGA-IB4 Isolator Base shall be controlled by its respective detector processor and operate within 23 msec. Of a short circuit condition on the data lines. An active isolator base shall continue to test for the short condition and automatically return to normal should the fault condition clear.

E. Duct Detectors

1. SIGA-DH Duct Detector Enclosure shall include an assembly suitable for mounting a Signature Series Detector into a duct.
F. Modules General

1. It shall be possible to change the personality or function of a device.
2. All modules shall be gang mounted and complete with the necessary mounting hardware, cover plates, and end-of-line devices.
3. Input wiring shall be supervised for opens and grounds.
4. Output wiring shall be supervised for opens, shorts, and grounds.
5. Each module shall have a minimum of 2 diagnostic LEDs. A green LED shall flash to confirm communications. A red LED shall flash to confirm active status.
6. SIGA-CT1 Single Input Module shall be of single gang construction and programmable.
7. SIGA-CT2 Dual Input Module shall be of single gang construction and each circuit shall be independently programmable.
8. SIGA-WTM Waterflow/Supervisory Input Module shall be of single gang construction and have two factory programmed circuits. Circuit one shall have personality code 2 (delayed waterflow) and circuit two shall have personality code 4 (latching supervisory).
9. SIGA-CC1 Single Input Signal Module shall be of two gang construction and have one signal riser input and one supervised Class ‘B’ output circuit rated a 24Vdc 2A or 50W. Programmed with personality code 5 it shall be capable of operating 24 Vdc polarized signals, or 25V or 70V speaker appliances.
10. SIGA-CC2 Dual Input Signal Module shall have two gang construction and provide two signal riser inputs and one Class ‘B’ supervised output circuit rated a 24Vdc 2A or 50W. It shall be capable of selecting one of two inputs (alert/page or evacuation) for operating 24 Vdc polarized signals, or 25V or 70V speaker appliances.
11. SIGA-CR Control Relay Module shall have single gang construction and provide one form ‘C’ dry relay contact rated 24Vdc at 2 amps. To control external appliances or equipment shutdown.
12. SIGA-UM Universal Class A/B Module shall have two gang construction and shall be configurable for a single riser input with a single output, single or dual inputs, or as a control relay. It shall be programmable.
13. SIGA-278 Intelligent Double Action Fire Alarm Station shall be of single gang construction and provide double action, single stage, non-coded, breakglass operation. The fire alarm station shall be of lexan construction with an internal toggle switch. Provide a keyed locked test feature. Finish the station in red with white “LIFT THEN PULL HANDLE” and “PULL FOR FIRE” lettering.

2.4 FIRE ALARM NOTIFICATION APPLIANCES

A. General Notification Appliances

1. All appliances shall be U.L. Listed for Fire Protective Services.
2. All strobe appliances or combination appliances with strobes shall be capable of providing the “Equivalent Facilitation” which is allowed under the Americans with Disabilities Act Access abilities Guidelines (ADA(AG)), and shall be UL 1971, UL 1638, and ULC S526 Listed.

B. Furnish and install where shown on the plans:

1. Horns shall be manufactured by EST, Cat. No. 757 Series. In-Out Screw terminals shall be provided for wiring. A sound output level of 103 dBA Peak shall be provided.
COUNTY FAIRGROUNDS BUILDING  
CACHE COUNTY

2. Horn/Strobes shall be manufactured by EST, Cat. No. 757 Series. They shall provide synchronized flash strobe output, and 100 dBA Peak sound output level from the horn. Provide strobe outputs as indicated on drawing.

3. Mini-Horn/Strobes shall be manufactured by EST, Cat. No. 692 Series. They shall provide strobe output, and 91 dBA Peak sound level output from the horn. Provide strobe outputs as indicated on drawing.

4. Strobes shall be manufactured by EST, Cat. No. 202 Series. They shall provide synchronized flash output. Provide strobe outputs as indicated on drawing.

2.5 ANCILLARY DEVICES

A. Furnish and install where shown on the plans.

1. Furnish and install magnetic door holders, EST Cat. No. 1500 Series, for flush wall mounting as shown on the plans. The housings and contact plates shall have a brushed zinc finish. All units shall have a holding of force of approximately 25 lb. ft.

B. Acceptable Manufacturers:

1. The catalog numbers used are those of Edwards Systems Technology (EST), and constitute the type and quality of equipment to be furnished.

2. Approved Bidders:
   a. Notifier.

3. Other manufactures/bidders must submit products for approval at least 10 working days prior to bid date. Approved suppliers shall be required to meet all requirements of the specification.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The entire system shall be installed in a workmanlike manner, in accordance with approved manufacturer’s wiring diagram. The contractor shall furnish all conduit, wiring, outlet boxes, junction boxes, cabinets and similar devices necessary for the complete installation. All wiring shall be of the type recommended by the manufacturer, approved by the local Fire Department, and shall be installed in EMT conduit throughout.

B. All penetration of floor slabs and fire walls shall be fire stopped in accordance with all local fire codes.

C. End of Line Resistors: Shall be furnished as required for mounting as directed by the manufacturer.

D. All wiring shall be color coded throughout, to National Electrical Code standards.

E. The system shall be arranged to receive power from one three wire 120 VAC, 15 A supply. All low voltage operation shall be provided from the fire alarm control panel.
COUNTY FAIRGROUNDS BUILDING
CACHE COUNTY

F. Field Quality Control: The system shall be installed and fully tested under the supervision of a trained manufacturer’s representative. The system shall be demonstrated to perform all of the function as specified.

3.2 TESTS

A. Reports of any field testing during installation shall be forwarded to the Engineer in writing.

B. In the presence of the code enforcing authority, each individual component in the system shall be tested for operation on a circuit by circuit basis shall be tested for its complete operation. The procedure for testing the entire fire alarm system shall be set forth with the consent of the code enforcement official, the contractor, the school official, and the manufacturer representative. When complete, a statement of approval shall be written and signed by each of the testing parties, confirming acceptance shall be sent to the engineer, owner, and general contractor.

3.3 DOCUMENTATION AND TRAINING

A. The contractor shall compile and provide to the owners three (3) complete manual on the completed system to include operating and maintenance instruction, catalog cuts of all equipment and components, as-built wiring diagrams and a manufacturer’s suggested spare parts list.

B. In addition to the above manuals, the contractor shall provide the services of the manufacturer’s trained representative for a period of four (4) hours to instruct the owners designated personnel on the operation and maintenance of the entire system. An EST2 End-User Training Video shall be included as part of the system documentation.

END OF SECTION 16721
PART 1 - GENERAL

The contractor shall provide and install a complete and operable sound system as specified herein and shown on the plans

1.1 DESCRIPTION OF WORK

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

B. Division 16 Basic Materials and Methods sections apply to work specified in this section. Equipment backboxes are also included.

1.2 QUALITY ASSURANCE

A. MANUFACTURERS: Firms regularly engaged in manufacture of sound systems, components and accessories, of types, capacities and characteristics required, whose products have been in satisfactory use in similar service for not less than 5 years. Equipment supplier shall be the local authorized representative of the manufacturer of the specified equipment and be currently authorized by the manufacturer to furnish, install and service that particular equipment.

B. INSTALLER: Qualified with at least 5 years of successful installation experience with sound systems.

C. QUALIFICATIONS: Any system and/or equipment proposed as an equal to that specified must be proven to conform to the standards established herein. The contractor must obtain the architect’s or engineer’s approval in writing, prior to bidding equipment other than that specified. The manufacturer’s name, model numbers and three (3) copies of shop/working drawings complete with catalog sheets, technical and installation data shall be submitted for approval.

Anyone seeking approval to bid must submit booklets of what is proposed and a letter stating that the equipment submitted is either equal to or better than that which is specified and the reasons why. Companies seeking approval must also guarantee that the system which is being submitted will meet the requirements of the state, county and city over the building project. Pre-qualification of contractor shall be done 8 working days prior to bidding of the project. There will be no blanket approval. Contractors allowed to bid this project will appear in addendum.

1.3 SUBMITTALS

A. PRODUCT DATA: Submit manufacturer’s data sheet including specifications, installation instructions, and general recommendations for each piece of equipment specified.

B. SHOP DRAWINGS: submit dimensioned drawings and wiring layout for any changes in wiring from the layout in the drawings.
PART 2 – EXHIBIT HALL SOUND SYSTEM

2.1 DESCRIPTION

A. The system shall provide sound reproduction of signals originating from microphones, disc player and auxiliary sources. (iPOD)

B. A hearing assist transmitter shall be rack mounted and wired to an antenna located near the ceiling. The transmitter shall be wired to the system to distribute all speech and music.

C. Speakers shall be switched in three zones to allow division of exhibit hall in the future.

2.2 APPROVED EQUIPMENT

A. Microphone floor stand - Atlas MS-20E (provide 2)

The stand shall weigh at least 15 pounds, have a 12" round base and be user adjustable from 37 to 66 inches. A positive locking grip-lock friction clutch in the 1 1/8" outer tube shall grip the 7/8" inner movable tube portion of the stand. A 5/8"-27 threaded adapter shall accept all standard microphone holders. The finish shall be black.

B. Microphone boom stand - Atlas BB-77E

The boom shall be screw-on, single knob type which will attach to any standard microphone floor stand. The seamless tube shall be 5/8" in diameter, 34" long with an ebony finish and a permanently attached counterweight. A swivel shall allow for adjustment of any angle and extension.

C. Wireless microphone – Shure QLXD124/85-G50 Bodypack w/Lapel mic.

The microphone system shall include a microphone, a transmitter and a receiver. The system shall provide the following characteristics: Frequency response +/- 2 dB from 50 to 15,000 Hz; Audio distortion less than 1.0%; Carrier frequency selected, any of 1112 channels from 648 to 865 MHz.

1. The microphone/transmitter shall be a cardioid, dynamic hand-held type with Neodymium magnet. The transmitter and antenna shall be built as a part of the microphone with no external wires or devices required. The transmitter shall provide an audio level trim control plus and ON/OFF switch for carrier and audio. A 9 volt alkaline battery shall power the transmitter for over 8 hours of typical use. Power output shall be 30 mW.

2. The receiver shall be 12 VDC powered. Two antennas shall be attached to the receiver case to operate in diversity mode. Outputs shall be provided at 1/4" (10 mV-1V) and XLR switchable at mic (-10 dBV) or line (10 mV-2V) connectors.

The system frequency shall be coordinated for the local area and other operating microphones. The microphone shall be portable for use in any part of the school.
COUNTY FAIRGROUNDS BUILDING
CACHE COUNTY

D. Hearing Assist System – Listen LS-42-072 Essentials System

The system shall provide intelligible, high level sound and shall be fully ADA compliant for hearing assist systems. Supplied components shall include a base station transmitter, a transmitter rack mount kit, a remote dipole antenna and 10 receivers with earbud transducers.

The transmitter shall be 117VAC powered and rack mount in two rack spaces. Audio input may be balanced mic or line level or unbalanced auxiliary level as selected at installation. Acceptable levels shall be between -50 and -10 dBm for mic level and -20 to +20 dBm for line level. The wideband RF output shall operate on one of 8 bands selected between 72 and 76 MHz. Power output shall be at the legal limit which produces a signal strength of 8,000 uV/m at 30 meters. The transmitter shall be FCC type approved under Part 15.

The antenna shall be remotely mounted and shall include connecting cable and required elements to cover the required area.

Each receiver shall be powered by a 9 volt alkaline or Ni-Cad battery which may be easily replaced without tools. Typical operating battery life shall be 25 hours for alkaline and 5 hours with Ni-Cad cells. The contractor shall provide 2 fresh alkaline cells for each receiver. The receiver shall automatically be switched off when the headset jack is removed. An LED shall indicate battery condition.

Receiver electrical performance shall be: audio output 2.5 volts RMS/100 ohms; frequency response 100 to 10,000 KHz; signal-to-noise ratio 65 dB; RF sensitivity 1 uV for 20 dB of quieting; selectivity -55 dB with 50 KHz channel spacing; frequency stability 0.005% (crystal controlled); ultimate quieting 65 dB.

E. Line Source

1. (5) ALS-LF1220WH AtlasIED Line Source, x16’4” Extended Range Drivers with 16 Channel Amplification and Integrated DSF.

F. Ethernet Adapter

1. (1) ALS-NA3 AtlasIED Ethernet Adapter for Local Ethernet Connectivity.

G. Wall Bracket


H. DSP Audio Processor

1. (1) BB-1616DT AtlasIED BlueBridge® 16 Input x 16 Output DSP Audio Processor with Dante™.

I. DSP Controller

1. (1) BBPWP-S4K1B AtlasIED BlueBridge® DSP Controller with 4 Action Buttons and 1 Level Control (Black).
COUNTY FAIRGROUNDS BUILDING
CACHE COUNTY

J. Touch Panel Wall Controller
   1. (3) BBWP-TOUCH7B AtlasIED Blue Bridge® 7” Touch Panel Wall Controller (Black).

K. Dual-Channel Commercial Audio Amplifier
   1. (1) CP400 AtlasIED 400W High-Performance, Dual-Channel Commercial Audio Amplifier.

L. Power Conditioner and Spike Suppressor
   1. (7) ECM-20SH AtlasIED 20A AC Power Conditioner and Spike Suppressor (Single Housing).

M. Remote Control Panel
   1. ECS-KSW6 AtlasIE Remote Control Panel for Use with ECS-6RM.

N. Dual Fan Panel Recessed Mount
   1. EFP3-2 AtlasIED Dual Fan Panel Recessed Mount.

O. Coaxial Speaker System
   1. (2) FAP82T AtlasIED 8” Coaxial Speaker System with 70.7V/100V-60W Transformer and 8Ω Bypass.

P. Deep Micro Perf Door
   1. (1) MPFD24 AtlasIED 1” Deep Micro Perf Door for WMA, 100, and 200 Series Racks 24RU.

Q. Power Supply

R. Series Rack Mount Kit
   1. (1) TSD-RMK AtlasIED TSD Series Rack Mount Kit.

S. Sequence Controller
   1. (1) TSD-SEQ6 AtlasIED AC Sequence Controller.

T. Wall Cabinet
   1. (1) WMA24-23 AtlasIED 24RU High Strength Wall Cabinet with Adjustable Rails, 23.5” Deep.

U. Switch Plate
   1. Emtech MSC-L
2.3 FUNCTION ROOM SOUND SYSTEM

A. DESCRIPTION

1. The contractor shall provide and install a complete, operating sound reinforcement and sound distribution system for the function areas indicated. The system shall consist of equipment specified on E-401.

2. All installed electronic equipment shall be rated for continuous duty and shall be UL listed for safety.

PART 3 – EXECUTION

3.1 Wiring shall be installed in metallic conduit and provided with necessary junction and pull boxes. All wiring shall be color coded and in accordance with the manufacturer's instructions, local and national codes. Care shall be exercised in wiring to avoid damage to the cables. All boxes shall be plumb and square. Cables shall be pulled continuous without splicing, leaving ends in lengths as directed by the manufacturer’s representative.

A. After all circuits and cables have been pulled and completed from one extremity to the other, the electrical contractor shall check all circuits free of opens, shorts and grounds. The electrical contractor shall identify and tag all cables.

B. The manufacturer's representative shall make all final connections to the equipment, shall test and adjust the systems, and shall instruct the proper parties as to care and operation.

C. Any additional equipment required for a fully functional system to meet the intent of the specifications shall be provided whether or not specifically listed herein.

3.2 INSTALLATION OF SOUND SYSTEMS

A. Install sound systems as indicated, in accordance with equipment manufacturer’s instructions, and with recognized industry practices, to ensure that system equipment complies with requirements. Comply with requirements of NEC and applicable portions of NECA’s "Standard of Installation" practices.

B. Equalize systems using industry recognized practices and equipment.

C. Coordinate with other electrical work, including cable/wire, raceways, electrical boxes and fittings, as appropriate to interface installation of clock and program systems work with other work.

3.3 GROUNDING

A. Provide equipment grounding connections, sufficiently tight to assure permanent and effective ground.

3.4 FIELD QUALITY CONTROL

A. EQUIPMENT CHECK-OUT: Provide equipment checkout by an authorized technician before energized circuits. Make final connections under their direction.
B. TESTING: Upon completion of installation of sound system and after electrical circuitry has been energized, demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

C. WARRANTY: The contractor shall warrant the equipment to be new and free from defects in material and workmanship, and will, within one year from date of installation, repair or replace any equipment found to be defective. This warranty shall not apply to any equipment which has been subject to misuse, abuse, negligence, accident or unauthorized modification.

D. SERVICE FACILITIES: The contractor shall make available and maintain a satisfactory service department capable of furnishing equipment inspection and service.

3.5 INSTALLATION

A. The system shall function without audible hum, buzz or rattle under normal operating conditions.

B. All equipment shall be installed plumb and square. Hanging equipment shall be supported with a safety factor of three (3).

C. Cable shall be installed with no splices in the entire length between termination points. Excess cable shall be left at all devices to ensure ease of connection.

D. Equipment shall be installed and adjusted to obtain the finest possible performance.

E. The contractor shall supply any and all other required items not specifically mentioned herein to fulfill the intent of the specification and provide a first class sound system.

F. Systems shall be covered by a 1 year guarantee after acceptance by the owner.

END OF SECTION 16722
SECTION 16786 - DIGITAL SURVEILLANCE SYSTEM

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division – 16 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

A. Provide a complete and operating 100% solid-state, color video system complete with cameras, monitors, protective enclosures, lenses, mounting hardware, cables, switching equipment and other such products, equipment and wiring normally and reasonably required for the operation of a complete video surveillance and digital recording system.

B. Equipment shall conform to the requirements of FCC and EIA rules and regulations including, EIA Standard RS-170A covering color television equipment.

C. The work of this section includes electrical raceways (minimum ¾”), boxes and fittings, as specified in applicable Division-26 Basic Materials and Methods section, which are used to enclose surveillance cabling.

1.3 QUALITY ASSURANCE:

A. Installer: Qualified with at least 5 years of successful installation experience on projects with surveillance system installation work similar to that required for product.

B. NEC Compliance: Comply with applicable requirements pertaining to radio and surveillance equipment and signal distribution.

C. UL Compliance: Comply with applicable requirements of UL safety standards, pertaining to surveillance equipment and accessories. Provide surveillance equipment and accessories which are UL-Listed and labeled.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer’s data on surveillance and recording systems including, but not limited to, roughing-in diagrams and instructions for installation, operating and maintenance, suitable for inclusion in maintenance manuals. Also include standard or typical riser and complete wiring diagrams for control and system components.

B. Shop Drawings: Provide shop drawings showing equipment/device locations and connecting wiring of entire surveillance system. Include wiring diagrams and riser diagrams.

C. Provide to the Owner the following:

1. A complete set of shop drawings indicating: Locations of all cameras, power supplies and controllers; point-to-point wiring diagrams for all devices.
2. Wiring diagrams for: Cameras, environmental enclosures, pan-tilt-zoom mounts (if applicable); controllers; auxiliary devices.
3. A complete equipment list identifying: Type; model; manufacturer; manufacturer’s data sheets.

PART 2 - PRODUCTS

2.1 PROVIDE EQUIPMENT AS FOLLOWS IN QUANTITIES AS SHOWN IN DRAWING:

A. EQUIPMENT:

2. Interior Camera: Axis M3046-V.
3. Outdoor Camera: (180-360° view): On cam Grandeye EVO-05NMD
4. Parking Lot Mount: SVWMT.
6. Power Supply: High Power 161 POE.
8. Network head end and remote Switch: Managed 28 Port Gig POE.
9. Equipment Cabinet: Middle Atlantic DWR12-26/VFD-12 with vented door.

B. VIDEO CABLING: Provide 4-pair category 6 cables as specified in Division 16. Provident with a jacket color of green. Coordinate work with Division 16715 contractor.

PART 3 – EXECUTION

3.1 INSTALLATION OF DIGITAL SURVEILLANCE SYSTEM SYSTEMS:

A. Install surveillance systems in raceway and ancillary equipment as indicated in accordance with equipment manufacturer’s written instructions, and the NEC, and with recognized industry practices, to ensure that surveillance systems fulfill requirements.

B. Coordinate with other work, including raceways, and electrical boxes and fittings work, as necessary to interface installation of surveillance systems with other work.

C. Use extreme care in handling, fishing and pulling-in electronic coaxial cable to avoid damage to cable and shield. Avoid excessive number of bends and sharp bends.

D. Install individual cables from camera to the POE switch.

E. Coordinate installation of DVR and monitor.

3.2 GROUNDING:

A. Provide equipment grounding connections, sufficiently tight to assure a permanent and effective ground, for system components, as indicated.
3.3 FIELD QUALITY CONTROL:

A. Testing: Upon completion of installation of surveillance system and after electrical circuitry has been energized, test compatibility and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

3.4 TRAINING:

A. The contractor shall include in the base contract all costs required to train the owner in the use and maintenance of systems provided under this division of the specifications. Provide factory training for (3) people on the specified system at no cost to the Owner.

3.5 WARRANTY:

A. Provide one year parts and on-site labor warranty.

END OF SECTION 16786