

PROJECT MANUAL

HOOVER HIGH SCHOOL - MULTIPURPOSE BUILDING HVAC EQUIPMENT REPLACEMENT

5550 North First Street
Fresno, California

FRESNO UNIFIED SCHOOL DISTRICT

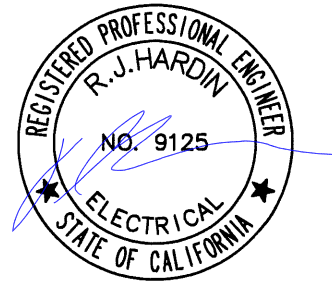
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DIV. OF THE STATE ARCHITECT

APP: 02-118643 INC:

REVIEWED FOR

SS ☒ FLS ☒ ACS ☐

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**SECTION 01000
GENERAL REQUIREMENTS**

PART 1 - GENERAL

1.1 GENERAL CONDITIONS

- A. The preceding General Conditions and General Requirements shall form a part of this Section with the same force and effect as though repeated here. The provisions of this Section shall also apply to all of the following Sections of these Specifications and shall be considered a part of those Sections.

1.2 CODES AND REGULATIONS

- A. All work and materials shall be in accordance with current rules and regulations of applicable codes. Nothing in these Drawings or Specifications is to be construed to permit work not conforming to these codes. Should the Drawings or Specifications call for material or methods of construction of a higher quality or standard than required by these codes, the Drawings and Specifications shall govern. Applicable codes and regulations include, but are not necessarily limited to, the following:

California Administrative Code	CCR Title 24, Part 1
California Building Code	CCR Title 24, Part 2
California Electrical Code	CCR Title 24, Part 3
California Mechanical Code	CCR Title 24, Part 4
California Plumbing Code	CCR Title 24, Part 5
California Energy Code	CCR Title 24, Part 6
California Fire Code	CCR Title 24, Part 9
Local Codes	

1.3 PERMITS AND FEES

- A. The Contractor shall take out all permits and arrange for all tests in connection with the work as required. All charges are to be included in the work.

1.4 GUARANTEE

- A. Guarantee shall be in accordance with the General Requirements. The Contractor shall repair any defects due to faulty materials or workmanship and pay for any resulting damage to other work which appears within the guarantee period. These Specifications may extend the period of the guarantee for certain items. Where such extensions are called for, or where items are normally provided with guarantee periods in excess of that called for in the General Requirements, the certificate of guarantee shall be furnished to the Owner through the Engineer.

1.5 EXAMINATION OF SITE

- A. The Contractor shall examine the site, compare it with Plans and Specifications, and shall be satisfied as to the conditions under which the work is to be performed. No allowance shall subsequently be made for any extra expense due to failure or neglect to make such an examination.

1.6 COMPATIBILITY WITH EXISTING SYSTEMS

- A. Any work which is done as an addition, expansion or remodel of an existing system shall be

compatible with that system.

1.7 MATERIALS AND EQUIPMENT

- A. Materials and equipment shall be new unless otherwise noted. Materials and equipment of a given type shall be by the same manufacturer. Materials and equipment shall be free of dents, scratches, marks, shipping tags and all defacing features at time of project acceptance. Materials and equipment shall be covered or otherwise protected during construction as required to maintain the material and equipment in new factory condition until project acceptance.

1.8 SUBMITTALS

- A. Shop Drawings: Unless otherwise noted in the General Conditions, within 30 days of contract award, the Contractor shall submit shop drawings for all materials, equipment, etc. proposed for use on this project. Material or equipment shall not be ordered or installed until written review is processed by the Engineer.

All shop drawings must comply with the following:

1. Shop drawings are required for all material and equipment items and shall include manufacturer's name and catalog numbers, dimensions, capacities, performance curves, and all other characteristics and accessories as listed in the specifications or on the drawings. Descriptive literature shall be current factory brochures and submittal sheets. Capacities shall be certified by the factory.
 2. All shop drawings shall be submitted at one time in a neat and orderly fashion in a suitable binder with title sheet including Project, Engineer and Contractor, table of contents, and indexed tabs dividing each group of materials or item of equipment. All items shall be identified by the specification paragraph number for which they are proposed. All equipment shall also be identified by the mark number as indicated on drawings.
 3. All capacities, characteristics, and accessories called for in the specifications or on the drawings shall be high-lighted, circled or underlined on the shop drawings. Calculations and other detailed data indicating how the item was selected shall be included for items that are not scheduled. Data must be complete enough to permit detailed comparison of every significant characteristic which is specified, scheduled or detailed.
- B. Substitutions: Manufacturers and model numbers listed in the specifications or on the drawings represent the standard of quality and features desired. Proposed substitutions shall comply with the Owner's General Requirements. Calculations and other detailed data indicating how the item was selected shall be included. The Contractor shall assume full responsibility that substituted items or procedures will meet the specifications and job requirements and shall be responsible for the cost of redesign and modifications to the work caused by these items. At the Engineer's request, furnish locations where equipment similar to the substituted equipment is installed and operating along with the user's phone numbers and contact person. Satisfactory operation and service history will be considered in the acceptance or rejection of the proposed substitution. Substitutions affecting DSA regulated items shall be submitted to DSA for approval as a CCD.
 - C. Review: Submittals will be reviewed for general conformance with the design concept, but this review does not guarantee quantity shown, nor does it supersede the responsibility of the Contractor to provide all materials, equipment and installation in accordance with the

drawings and specifications. The Contractor shall agree that shop drawing submittals processed by the Engineer are not Change Orders; that the purpose of shop drawing submittals by the Contractor is to demonstrate to the Engineer that the Contractor understands the design concept, demonstrates understanding by indicating which equipment and material is intended to be furnished and installed and by detailing the fabrication and installation methods intended for use. The Contractor shall agree that if deviations, discrepancies or conflicts between shop drawings and design drawings and specifications are discovered either prior to or after shop drawing submittals are processed by the Engineer, the design drawings and specifications shall control and shall be followed. If a resubmittal is required, submit a complete copy of the Engineer's review letter requiring such with the resubmittal.

1.9 MANUFACTURER'S RECOMMENDATIONS

- A. All material, equipment, devices, etc., shall be installed in accordance with the recommendations of the manufacturer of the particular item. The Contractor shall be responsible for all installations contrary to the manufacturer's recommendations. The Contractor shall make all necessary changes and revisions to achieve such compliance. Manufacturer's installation instructions shall be delivered to and maintained at the job site through the construction of the project.

1.10 SCHEDULING OF WORK

- A. All work shall be scheduled subject to the review of the Engineer and the Owner. No work shall interfere with the operation of the existing facilities on or adjacent to the site. The Contractor shall have at all times, as conditions permit, a sufficient force of workers and quantity of materials to install the work contracted for as rapidly as possible consistent with good work, and shall cause no delay to other Contractors engaged upon this project or to the Owner. HVAC equipment and functions, whether existing or new, shall be maintained in operating condition whenever the facility is occupied, unless otherwise approved by the Owner.

1.11 HAZARDOUS MATERIAL REMOVAL

- A. All hazardous material removal will be by the Owner. Hazardous material is to be removed before the work is started. If the Contractor discovers hazardous material which has not been removed, the Contractor shall immediately cease work in that area and promptly notify the Owner.

1.12 CLEANING

- A. Progressively and at completion of the job, the Contractor shall thoroughly clean all of the work, removing all debris, stain and marks resulting from the work. This includes but is not limited to building surfaces, piping, equipment and ductwork, inside and out. Surfaces shall be free of dirt, grease, labels, tags, tape, rust, and all foreign material.

1.13 RECORD DRAWINGS

- A. The Contractor shall obtain one set of prints for the project, upon which a record of all construction changes shall be made. As the work progresses, the Contractor shall maintain a record of all deviations in the work from that indicated on the drawings. Final location of all underground work shall be recorded by depth from finished grade and by offset distance from permanent surface structures, i.e. building, curbs, walks. In addition, the water, gas, sewer, under floor duct, etc. within the building shall be recorded by offset distances from building walls. An electronic copy of the original drawings will be made available to the

Contractor. The Contractor shall transfer the changes, notations, etc. from the marked-up prints to the electronic copy. The record drawings (marked-up prints, electronic drawings disc and a hard copy) shall be submitted to the Engineer for review.

PART 2 - PRODUCTS (not used)

PART 3 - EXECUTION (not used)

END OF SECTION

SECTION 09900 PAINTING

PART 1 - GENERAL

RELATED DOCUMENTS:

Drawings and general provisions of the Contract, including General and Special Conditions and Division 1 specification sections, apply to work of this section.

DESCRIPTION OF WORK:

The work includes painting of new ductwork, electrical conduit, exposed gas, condensate and other piping in occupied spaces. Also included is painting of all surfaces in occupied spaces such as walls and ceilings where cutting and patching of these surfaces is required. At these locations, painting shall be from wall corner to wall corner. New supports, hangers, and other miscellaneous metals shall also be painted. Colors shall be selected by the District.

The work under these specifications shall include the furnishing of all labor, equipment, materials, transportation, and services for the painting as outlined in these specifications.

All work must be complete to the satisfaction of the Owner.

"Paint" as used herein means all coating systems materials, including primers, emulsions, enamels, stains, sealers and fillers, and other applied materials whether used as prime, intermediate or finish coats.

Do not paint over any code-required labels, such as Underwriters' Laboratories and Factory Mutual, or any equipment identification, performance rating, name, or nomenclature plates.

Bidder shall thoroughly examine specifications, site of work and conditions under which work will be performed before submitting proposal. Questionable conditions will be clarified by the Owner. No allowance for lack of knowledge of obvious existing conditions will be made.

QUALITY ASSURANCE:

Single Source Responsibility: Provide primers and other undercoat paint produced by same manufacturer as finish coats. Use only thinners approved by paint manufacturer, and use only within recommended limits.

SUBMITTALS:

Product Data: Submit manufacturer's technical information including paint label analysis and application instructions for each material proposed for use.

DELIVERY AND STORAGE:

All paint must be delivered in its original sealed containers. Containers shall bear manufacturer's name and label, and following information:

- Name or title of material.
- Material Safety Data Sheet (MSDS)
- Manufacturer's stock number and date of manufacture.
- Manufacturer's name.
- Contents by volume, for major pigment and vehicle constituents.
- Thinning instructions.
- Application instructions.
- Color name and number.

Store materials not in use in tightly covered containers. Maintain containers used for storage of paint in a clean condition, free of foreign materials and residue.

Protect from freezing where necessary. Keep storage area neat and orderly. All oily paint rags shall be removed from premises each night before workers leave the job or they shall be kept in metal containers approved by the Underwriters Laboratories. Take all precautions to ensure that workers and work areas are adequately protected from fire hazards and health hazards resulting from handling, mixing and application of paints.

JOB CONDITIONS:

Apply water-base paints only when temperature of surfaces to be painted and surrounding air temperatures are between 50°F (10°C) and 90°F (32°C), unless otherwise permitted by paint manufacturer's printed instructions.

Apply solvent-thinned paints only when temperature of surfaces to be painted and surrounding air temperatures are between 45°F (7°C) and 95°F (35°C), unless otherwise permitted by paint manufacturer's printed instructions.

Do not paint in rain or fog, or when relative humidity exceeds 85%, or on damp or wet surfaces, unless otherwise permitted by paint manufacturer's printed instructions.

Painting may be continued during inclement weather if areas and surfaces to be painted are enclosed and heated within temperature limits specified by paint manufacturer during application and drying periods.

MAINTENANCE MATERIAL

Provide a minimum of one gallon of paint of each type and color used.

PART 2 - PRODUCTS

ACCEPTABLE MANUFACTURERS:

Manufacturer: Subject to compliance with requirements, provide products of one of the following:

Sinclair (ICI)
Dunn-Edwards
Frazee

MATERIALS:

Material Quality: Provide best quality grade of various types of coatings as regularly manufactured by acceptable paint materials manufacturers. Materials not displaying manufacturer's identification as a standard, best-grade product will not be acceptable.

Proprietary names used to designate color or materials are not intended to imply that products of named manufacturers are required to exclusion of equivalent products of other manufacturers.

Color Pigments: Pure, non-fading, applicable types to suit substrates and service indicated.

PART 3 - EXECUTION

SURFACE PREPARATION:

General: Perform preparation and cleaning procedures in accordance with paint manufacturer's instructions and as herein specified, for each particular substrate condition.

- Remove all dust from all surfaces specified to be painted by brushing, washing, or other satisfactory methods in order to secure a clean surface upon which to paint. All grease, oil, or other foreign substances shall be removed.
All existing glossy paint surfaces shall be sanded to removed gloss before painting.
- All efflorescence, alkali and/or mildew/mold/fungus shall be removed by scrubbing affected areas with an approved solution and rinsed with clear water before painting. In areas with mildew/mold/fungus, use paint with fungicide added.

- Protect surrounding surfaces upon which paint might be splattered. Contractor shall be held fully responsible for any damage to property.
- Provide barrier coats over incompatible primers or remove and re-prime as required. Notify Engineer in writing of any anticipated problems in using the specified coating systems with substrates primed by others.

SPECIAL REQUIREMENTS

- Inspection will be required as follows before Contractor proceeds with work:
 - After all cleaning, washing, sanding, patching, removal of paint and after any other surface preparation has been done. No paint shall be applied until surface preparation has been inspected and approved by District's Painting Inspector.
 - After each coat of paint has been applied. No credit will be given if succeeding coats of paint are applied before inspection of prior coats.
 - The District will make other inspections as necessary. Any painting done contrary to District's specifications must be removed and then painted in accordance with specification.
- Painting Contractor will be required to furnish a written statement from the agent of the manufacturer of the paints used that they have inspected the site and approved the following:
 - All surface over which paint is to be applied before patching or painting is started.
 - Patching materials used for patching cracks. Note: patching material must be new from unopened packages.
 - Method used in patching cracks and of removal of patching material from plastered surfaces adjacent to cracks.
 - Type of paint used for first and second coats and method of applications.
- All paint which is skinned over or dirty shall be strained through cheese cloth to remove dirt, grit, skins, etc., before using.
- All materials used in the work shall be in accordance with current approved materials or an equal and must be submitted and approved.

MATERIALS PREPARATION:

All paint shall be thoroughly mixed before applying and shall be applied in accordance with manufacturer's specifications.

Maintain containers used in mixing and application of paint in a clean condition, free of foreign materials and residue.

Stir materials before application to produce a mixture of uniform density, and stir as required during application. Do not stir surface film into material. Remove film and strain material before using.

APPLICATION:

General: Apply paint in accordance with manufacturer's directions. Use applicators and techniques best suited for substrate and type of material being applied.

- Provide finish coats which are compatible with prime paints used or existing paint system.
- Apply additional coats when undercoats, stains or other conditions show through final coat of paint, until paint film is of uniform finish, color and appearance. Give special attention to insure that surfaces, including edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.

Scheduling Painting: Apply first-coat material to surfaces that have been cleaned or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

Allow sufficient time between successive coatings to permit proper drying. Do not re-coat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and application of another coat of paint does not cause lifting or loss of adhesion of the undercoat.

Minimum Coating Thickness: Apply materials at not less than manufacturer's recommended spreading rate, to establish a total dry film thickness as indicated or, if not indicated, as recommended by coating manufacturer.

Prime Coats: Apply prime coat on material as specified.

Stipple Enamel Finish: Roll and redistribute paint to an even and fine texture. Leave no evidence of rolling such as laps, irregularity in texture, skid marks, or other surface imperfections.

Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness or other surface imperfections will not be acceptable.

Completed Work: Match approved samples for color, texture and coverage. Remove, refinish or repaint work not in compliance with specified requirements.

CLEAN-UP AND PROTECTION:

Clean-Up: During progress of work, remove from site discarded paint materials, rubbish, cans and rags at end of each work day.

Upon completion of painting work,

- ☐ Remove all paint which might have become spattered on building, walk or equipment, due to this contract, and leave in a clean condition.
- ☐ Remove all of contractor's painting equipment and leave premises in as good a condition as was found.

Protection: Provide "Wet Paint" signs as required to protect newly-painted finishes. Remove temporary protective wrappings provided by others for protection of their work, after completion of painting operations.

PAINT SCHEDULE

Provide the following paint systems for the various substrates, as indicated. Model numbers are Sinclair (ICI).

Interior wood - alkyd enamel

First coat	1770	Pigmented PVA sealer
Second coat	975	Sinco prime undercoater
Third coat	SG25	Sinco satin enamel

Interior metal (ductwork, piping, conduit and miscellaneous metal) – enamel – Prepare and prime galvanized metal as indicated below.

First coat	15	Red oxide primer
Second coat	MG6-11	Semi-gloss synthetic enamel
Third coat	MG6-11	Semi-gloss synthetic enamel

Exterior galvanized metal - acrylic semi-gloss enamel

Pretreatment	7113	Vinyl wash primer
First coat	25	Zinc dust primer
Second coat	248	Sash and trim primer
Third coat	4800	Aqua sash enamel

Exterior ferrous metal - acrylic semi-gloss enamel

First coat	15	Red oxide primer
Second coat	14	Corro primer
Third coat	4800	Aqua sash enamel

END OF SECTION

SECTION 15100 GENERAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 DEFINITIONS

- A. Provide: The term "provide" as used in these specifications or on the drawings shall mean furnish and install.
- B. Piping: The term "piping" as used in these specifications or on the drawings shall mean all pipe, fittings, valves, hangers, insulation, etc. as may be required for a complete and functional system.
- C. Ductwork: The terms "duct" or "ductwork" as used in these specifications or on the drawings shall mean all ducts, fittings, joints, dampers, hangers, insulation, etc. as may be required for a complete and functional system.
- D. Wiring: The term "wiring" as used in these specifications or on the drawings shall mean all wiring, conduit, boxes, connections, transformers, relays, switches etc. as may be required for a complete and functional system.

1.2 COORDINATION OF WORK

- A. Examination: Before starting work, thoroughly examine existing and newly completed underlying and adjoining work and conditions on which the installation of this work depends. Report to the Engineer in writing all conditions which might adversely affect this work.
- B. Layout: Layout of materials, equipment and systems is generally diagrammatic unless specifically dimensioned. Some work may be shown offset for clarity. The actual locations of all materials, piping, ductwork, fixtures, equipment, supports, etc. shall be carefully planned prior to installation of any work in order to avoid all interference with each other, or with structural, electrical, architectural or other elements.
- C. Verification: If discrepancies are discovered between drawing and specification requirements, the more stringent requirement shall apply. All conflicts shall be called to the attention of the Engineer prior to the installation of any work or the ordering of any equipment. No work shall be prefabricated or installed prior to this coordination. No costs will be allowed to the Contractor for any prefabrication or installation performed prior to this coordination. Verify the proper voltage and phase of all equipment with the electrical plans.
- D. Location of Utilities Prior to Trenching or Earthwork: The Contractor shall notify the Owner a minimum of two business days prior to beginning trenching or earthwork. Prior to this notification, the Contractor shall have marked all proposed trenches with paint and shall have contacted a utility locating company and have had this company mark all found underground utilities with paint. The Contractor shall then coordinate and arrange for a site visit with the Owner to review the proposed trenching and/or earthwork areas. Trenching and/or earthwork shall not begin until the Owner agrees. Repair and/or compensation for repair of marked utilities is the responsibility of the Contractor. The Owner retains the right to either self-perform the repair or require the Contractor to complete the repair, as directed by the Owner. If while performing the work, the Contractor discovers utilities that have not been marked, the Contractor shall immediately notify the Owner verbally and in writing.

1.3 QUIETNESS

- A. Piping, ductwork and equipment shall be arranged and supported so that vibration is a minimum and is not transmitted to the structure.

1.4 DAMAGES BY LEAKS

- A. The Contractor shall be responsible for damages caused by leaks in the temporary or permanent piping systems prior to completion of work and during the period of the guarantee, and for damages caused by disconnected pipes or fittings, and the overflow of equipment prior to completion of the work.

1.5 DEMOLITION

- A. Existing equipment, ducts, piping, etc. noted for removal shall be removed and delivered to the Owner at a location to be determined by the Owner. Those items determined by the Owner to be of no value shall become the property of the Contractor and shall be removed from the job site by the Contractor at the Contractor's expense. Existing piping, ducts, services, etc. requiring capping shall be capped below floors, behind walls, above ceilings or above roof unless otherwise noted. Where items are removed, patch the surfaces to match the existing surfaces.

1.6 OPENINGS, CUTTING AND PATCHING

- A. The locations and dimensions for openings through walls, floors, ceilings, foundations, footings, etc. required to accomplish the work under this Specification Division shall be provided under this Division. Except as noted below, the actual openings and the required cutting and patching shall be provided by other Divisions. Coring through existing concrete or masonry walls, floors, ceilings, foundations, footings, etc., and saw cutting of concrete floors or asphaltic concrete required to accomplish the work under this Specification Division shall be provided under this Division. Patching of these surfaces shall be provided by other Divisions. Cutting or coring shall not impair the strength of the structure. Any damage resulting from this work shall be repaired at the Contractor's expense to the satisfaction of the Engineer.

1.7 EXCAVATION AND BACKFILL

- A. General: Barrel of pipe shall have uniform support on sand bed. Sand shall be free from clay or organic material, suitable for the purpose intended and shall be of such size that 90 percent to 100 percent will pass a No. 4 sieve and not more than 5 percent will pass a No. 200 sieve. Unless otherwise noted, minimum earth cover above top of pipe or tubing outside building walls shall be 24", not including base and paving in paved areas.
- B. Excavation: Width of trench at top of pipe shall be minimum of 16", plus the outside diameter of the pipe. Provide all shoring required by site conditions. Where over excavation occurs, provide compacted sand backfill to pipe bottom. Where groundwater is encountered, remove to keep excavation dry, using well points and pumps as required.
- C. Backfill:
 - 1. 6" Below, Around, and to 12" Above Pipe: Material shall be sand. Place carefully around and on top of pipe, taking care not to disturb piping, consolidate with vibrator.
 - 2. One Foot Above Pipe to Grade: Material shall be sandy or silty loam, free of lumps,

laid in 6" layers, uniformly mixed to proper moisture and compacted to required density. If backfill is determined to be suitable and required compaction is demonstrated by laboratory test, water compaction in 6" layers may be used, subject to review by Engineer.

- D. Compaction: Compact to density of 95% within building and under walkways, driveways, traffic areas, paved areas, etc. and to 90% elsewhere. Demonstrate proper compaction by testing at top, bottom and one-half of the trench depth. Perform these tests at three locations per 100' of trench.

1.8 CONTINUITY OF SERVICES

- A. Existing services and systems shall be maintained except for short intervals when connections are made. The Contractor shall be responsible for interruptions of services and shall repair damage done to any existing service caused by the work. If utilities not indicated on the drawings are uncovered during excavation, the Contractor shall notify the Engineer immediately.

1.9 PROTECTIVE COATING FOR UNDERGROUND PIPING

- A. All ferrous pipe below grade (except cast iron) shall have a factory applied protective coating of extruded high density polyethylene, 35 to 70 mils total thickness, X-Tru-Coat, Scotchkote. All fittings and areas of damaged coating shall be covered with two layer double wrap of 10 mil polyvinyl tape to total thickness of 40 mils. John-Mansville. Protective coating shall be extended 6" above surrounding grade.

1.10 ACCESS DOORS

- A. Provide access doors as required where equipment, piping, valves, ductwork, etc. are not otherwise accessible. Access doors shall match the wall or ceiling finish and fire rating as indicated on the Architectural drawings. 16-gage steel frame and 14-gage steel door with paintable finish, except in ceramic tile, where door shall be 16-gage stainless steel with satin finish. Continuous hinge. Deliver doors to the General Contractor for installation. Milcor. Unless otherwise noted, the minimum sizes shall be as follows:

1 valve up to 1-1/2"	12" x 12"
1 valve up to 3"	16" x 16"
Fire damper, VAV box, coil	20" x 24"

1.11 HOUSEKEEPING PAD

- A. Housekeeping pads shall be 6" high concrete, 3000 PSI strength, unless otherwise noted. Pad shall extend 6" beyond the largest dimensions of the equipment, unless otherwise noted. The top edge of the pad shall have a 3/4" chamfer. Unless otherwise noted, the pad shall have #4 reinforcing bars at 12" on center, each way, located at mid-depth of the pad. If not poured at the same time as the slab with pad rebar tied to slab rebar, the pad shall be anchored as follows: Drill 5/8" diameter, 3" deep hole in slab. Install 7" long, #4 rebar with Simpson Set epoxy system. Provide a minimum of 4 of these anchors per pad, but no more than 4 feet apart in either direction. Anchor points shall be 12" from the edge of the pad.

1.12 CONCRETE ANCHORS

- A. Steel stud with expansion wedge requiring a drilled hole – powder driven anchors are not acceptable. Minimum spacing shall be 12 diameters center to center and 10 diameters center to edge of concrete. Maximum allowable stresses for tension and shear shall be

80% of the ICC Evaluation Service Report (ESR) values. Minimum concrete embedment shall be the nominal embedment listed in the ESR table. Hilti Kwik Bolt TZ.

1.13 EQUIPMENT ANCHORING AND OTHER SUPPORTS

- A. Mechanical systems (equipment, ductwork, piping, conduit, etc.) shall be anchored in accordance with the CBC. All systems mounted on concrete shall be secured with a concrete anchor at each mounting point. All air handlers shall be mounted on spring isolators. Secure base plate as indicated above. Attachment of equipment, ductwork, piping, conduit, etc. supported on curbs or platforms shall be made to the side of curbs and platforms, where possible. Where screws or lag bolts must be installed through the top of a sheet metal cap, the installation shall be as follows. Pre-drill pilot hole. Fill pilot hole with polyurethane sealant. Install screw or lag bolt with a flat washer and an EPDM washer adjacent to the sheet metal.

1.14 SUPPORTS AND SEISMIC RESTRAINTS

- A. Any structural element required to hang or support piping, ducts or equipment provided under this Division and not shown on other drawings shall be provided under this Division.
- B. Mechanical systems (equipment, ductwork, piping, etc.) shall be provided with supports and seismic restraints in accordance with the CBC. Submit anchorage calculations and details stamped and signed by a structural engineer registered in the State of California. Submit shop drawings showing location, type and detail of restraints. Submit manufacturer's data for restraints. Restraint system shall be Mason West, Inc. (OSHPD OPM 0043-13).

1.15 PAINTING

- A. Paint all black iron supports, hangers, anchors, etc. with two coats of rust resisting primer. Also paint all uninsulated black iron piping exposed to weather with two coats of rust resisting primer.

1.16 ROOF PENETRATIONS AND PATCHING

- A. Whenever any part of the mechanical systems penetrates the roof or exterior wall, the openings shall be flashed and counter-flashed water tight with minimum 22 gauge galvanized sheet metal. Flashing shall extend not less than eight inches from the duct, pipe, or supporting member in all directions unless detailed otherwise. All roof penetrations and patching shall be in accordance with the recommendations of the National Roofing Contractor's Association and the Owner's roofing standards.

1.17 SYSTEM IDENTIFICATION

- A. Above Grade Piping: Provide markers on piping which is either exposed or concealed in accessible spaces. For piping systems, other than drain and vent lines, indicate the fluid conveyed or its abbreviation, either by pre-printed markers or stenciled marking, and include arrows to show direction of flow. Pre-printed markers shall be the type that wrap completely around the pipe, requiring no other means of fastening such as tape, adhesive, etc. Comply with ANSI A13.1 for colors. Locate markers at ends of lines, near major branches and other interruptions including equipment in the line, where lines pass through floors, walls or ceilings or otherwise pass into inaccessible spaces, and at 50' maximum intervals along exposed portions of lines. Marking of short branches and repetitive branches for equipment connections is not required.
- B. Below Grade Piping: Bury a continuous, pre-printed, bright-colored, metallic ribbon marker

capable of being located with a metal detector with each underground pipe. Locate directly over buried pipe, 6" to 8" below finished grade.

- C. Equipment: All equipment shall be identified with a plastic laminated, engraved nameplate which bears the unit mark number as indicated on the drawings (e.g. AC-4). Provide 1/2" high lettering - white on black background. Nameplates shall be permanently secured to the exterior of the unit.
- D. Valves: Provide brass valve tags with brass hooks or chains on all valves of each piping system, excluding check valves, valves within equipment, faucets, stops and shut-off valves at fixtures and other repetitive terminal units. Prepare and submit a tagged-valve schedule, listing each valve by tag number, location and piping service. Deliver to Owner through the Engineer.

1.18 OPERATION AND MAINTENANCE INSTRUCTIONS

- A. Printed: Copies of Operation and Maintenance Instructions and Wiring Diagrams for all equipment and parts list for all faucets, trim, valves, etc. shall be submitted to the Engineer. All instructions shall be clearly identified by marking them with the same designation as the equipment item to which they apply (e.g. AC-3). All Wiring Diagrams shall agree with reviewed Shop Drawings and indicate the exact field installation. All instructions shall be submitted at the same time and shall be bound in a suitable binder with tabs dividing each type of equipment (e.g. Pumps, Fans, Motors, etc.). Each binder shall be labeled indicating "Operating and Maintenance Instructions, Project Title, Contractor, Date" and shall have a Table of Contents listing all items included.
- B. Verbal: The Contractor shall verbally instruct the Owner's maintenance staff in the operation and maintenance of all equipment and systems. The controls contractor shall present that portion of the instructions that apply to the control system. The Engineer's office shall be notified 48 hours prior to this meeting.
- C. Acknowledgment: The Contractor shall prepare a letter indicating that all operation and maintenance instructions (printed and verbal) have been given to the Owner, to the Owner's satisfaction. This letter shall be acknowledged (signed) by the Owner and submitted to the Engineer.

1.19 ACCEPTANCE TESTING

- A. The Contractor shall perform, document and submit all acceptance testing as required by California Code of Regulations, Title 24, Part 6.

PART 2 - PRODUCTS (not used)

PART 3 - EXECUTION (not used)

END OF SECTION

SECTION 15400 PLUMBING

PART 1 - GENERAL

1.1 GENERAL MECHANICAL PROVISIONS

- A. The preceding General Mechanical Provisions shall form a part of this Section with the same force and effect as though repeated here.

1.2 SCOPE

- A. Included: Provide all labor, materials and services necessary for complete, lawful and operating systems as shown or noted on the drawings or as specified here. The work includes, but is not necessarily limited to, the following:
 - 1. Sanitary sewer system.
 - 2. Domestic water system.
 - 3. Fuel gas system.
 - 4. Drain system (including condensate drain).
 - 5. All equipment as shown or noted on the drawings or as specified.
 - 6. Demolition as indicated on drawings. Where demolition is called for, remove all equipment, piping, braces, housekeeping pads, supports and related items no longer required.
- B. Work Specified Elsewhere:
 - 1. Line voltage power wiring to equipment, disconnect switches and installation of all starters are included in the Electrical Sections unless otherwise noted.
 - 2. Circulating water piping for heating and air conditioning work.
 - 3. Concrete and reinforcing steel unless specifically called for on the drawings or specifications.
 - 4. Painting unless specifically called for in the drawings or specifications.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Sanitary Sewer:
 - 1. Soil, Waste and Vent Piping (Non-Pressurized):
 - a. Inside Building and Within Five Feet of Building Walls: Standard weight coated cast iron pipe and fittings. Plain end with neoprene gasket and stainless steel retaining sleeve, CISPI 301, ASTM A888. AB&I, Charlotte, Tyler. Size 2" and smaller above grade may be standard weight galvanized steel, ASTM A120/A53, with coated cast iron recessed drainage fittings, ANSI B16.12. 2" and smaller exposed to view shall be galvanized steel, ASTM A120/A53, with coated cast iron recessed drainage fittings, ANSI B16.12.
 - b. Outside Building: Polyvinyl chloride (PVC), SDR-35, ASTM D3034 with

PVC fittings with rubber ring joints. Piping with less than 24" of cover outside building walls shall be cast iron.

2. Cleanouts: Comparable models of Josam, Wade or Zurn are acceptable. Floor Cleanouts: Smith 4020 with nickel bronze top in finished areas; Smith 4220 in utility areas. Wall Cleanouts: Smith 4530 with stainless steel cover and screw. Pipe Cleanouts: Iron body with threaded brass plug.
3. Cleanout Box: Precast reinforced concrete. Cast iron lid marked for service. Christy F22 in foot traffic areas; G5 in roadways.

B. Water and Gas:

1. Water Piping: (Match existing)

a. Inside Building, Within Five Feet of Building Walls, and All Above Grade:

- 1) Schedule 40 galvanized steel pipe, ASTM A120/A53. 150 psi galvanized malleable iron screwed fittings, ANSI B16.3.

-or-

- 2) Hard temper seamless copper, ASTM B88. Wrought copper fittings, ANSI B16.22. Type L with brazed joints (1100F, min.). 1-1/2" and smaller above grade may be soldered, 95-5 tin-antimony solder. All nipples shall be red brass (85% copper).

b. Outside Building - Below Grade:

- 1) Same as Inside Building. Galvanized steel shall have protective coating.

-or-

- 2) 3" and Smaller: Schedule 80 Polyvinyl chloride (PVC) with solvent weld fittings where approved by administrative authority.

-or-

- 3) 4" and Larger: Polyvinyl chloride, AWWA C900. Class 200 for fire protection service - Class 150 for other than fire protection service. ASTM D1784, ASTM D2241, where approved by administrative authority, cast iron fittings with rubber ring joints, ASTM D1869.

2. Gas Piping:

- a. Inside Building and All Above Grade: 2" and Smaller: Schedule 40 galvanized steel pipe, ASTM A120/A53. 150 psi galvanized malleable iron screwed fittings, ANSI B16.3, ANSI B31.8. Flexible connections shall be convoluted yellow brass with dielectric couplings, AGA approved. 2-1/2" and larger: Schedule 40 black steel pipe, ASTM A120/A53. Standard weight carbon steel welding fittings, long radius ells, ANSI B16.9.

- b. Inside Building - Below Grade to Five Feet Outside Building: Same as Inside Building and All Above Grade. Provide sleeves and vents acceptable to administrative authority.

- c. Outside Building - Below Grade: Polyethylene pipe and fittings, ANSI B31.8, ASTM D2513, IAPMO or NSF listed. Performance Pipe, PE 2406/2708. Otherwise, piping shall be coated schedule 40 steel.

3. Valves and Specialties:

a. Valves:

- 1) General: Manufacturer's model numbers are listed to complete description. Equivalent models of Crane, Milwaukee, Nibco, Stockham or Walworth are acceptable. All valves of a particular type or for a particular service shall be by the same manufacturer. Ball valves may be substituted for 2" and smaller gate valves above grade. Butterfly valves may be substituted for 2-1/2" and larger gate valves above grade.
- 2) Gate Valve: 2" and Smaller: All bronze. Rising stem. Union bonnet. Wedge disk. Malleable iron handwheel. 200 psi WOG. Stockham B-105. 2-1/2" and Larger: Iron body, bronze mounted. Non-rising stem. Resilient wedge disk. 200 psi WOG. Flanged or AWWA hub end as applicable. Stockham G-612. Underground valves shall have square operating nut. Provide one operating "T" handle for underground valves.
- 3) Butterfly Valve: Iron threaded lug body. Aluminum bronze disk. O-ring seals. Resilient, removable seat. 416 stainless steel shaft. 6" and smaller valves shall have multi-position lever handle. 8" and larger valves shall have gear operator. Provide 2" extension neck at insulated pipes. Demco Series NE, Stockham.
- 4) Globe Valve: 2" and Smaller: All bronze. Renewable TFE disk. Union bonnet. Malleable iron handwheel. 300 psi WOG. Stockham B-22. 2-1/2" and Larger: Iron body. Flanged. Bronze mounted. Rising stem. Bolted bonnet. Renewable seat and disk. 200 psi WOG. Stockham G-512.
- 5) Check Valve: 2" and Smaller: All bronze swing check, regrinding. 200 psi WOG. Stockham B-319. Check valves for air systems shall be the spring-loaded, quick-closing type, Stockham B-322-TS. 2-1/2" and Larger: Iron body, flanged, bronze mounted, swing check. 200 psi WOG. Stockham G-931.
- 6) Ball Valve: Full port. Bronze or brass body, cap, stem, disk and ball. Screwed connection. Lever handle. TFE seat. O-ring seals. 300 psi WOG. Valves in gas piping systems must be UL listed for gas distribution. Apollo, Jomar.
- 7) Plug Valve: Valves in gas piping systems must be UL listed for gas distribution. 4" and Smaller: Eccentric bronze or nickel plated semi-steel plug. Semi-steel body. Bronze bushings. Buna-N-rings. 175 psi WOG. DeZurik Series 400. 1-1/2" and smaller may be full port ball valves. Apollo, Jomar. 6" and Larger: Lubricated plug cock. Cast iron or semi-steel body and plug. 200 psi WOG. Flanged. Wrench handle. Provide one operating "T" handle for underground valves. Resun R-1431.

- 8) Valve Box: Precast reinforced concrete. Cast iron lid marked for service. Christy F22 in foot traffic areas; G5 in roadways.

b. Miscellaneous Specialties:

- 1) Union: 2" and Smaller: AAR malleable iron, galvanized, bronze to iron ground seat. 300 psi. Size 2-1/2" and Larger: Grooved pipe, synthetic gasket, malleable iron housing. Victaulic Style 77, Type "E" gasket.
- 2) Dielectric Coupling: Insulating union or flange rated for 250 psig. EPCO.
- 3) Shock Absorber: Multiple bellows. All stainless steel construction. Designed and applied in accordance with PDI WH201. Amtrol, Smith, Wade, Zurn.
- 4) Gas Pressure Reducing Valve: Capacity and pressure ratings as indicated on drawings. Elster, American Meter.
- 5) Flexible Connection: Corrugated bronze core covered with high tensile bronze tubular braid. 150 psi working pressure. 2" and smaller shall have screwed connections. 2-1/2" and larger shall have flanged connections. Flexonics, Keflex.
- 6) Water Pressure Reducing Valve: Iron body. Brass internal parts. Built-in strainer and check valve. Field adjustable range of 8-25 psi. 125 psi maximum working pressure. Bell and Gossett No. 12.

C. Drain Piping (including Condensate): Same as inside building water piping.

D. Miscellaneous Piping Items:

1. Pipe Support:

- a. Pipe Hanger: Steel "J" hanger with side bolt for piping 4" and smaller; steel clevis hanger for piping 5" and larger. Load and jam nuts. Size and maximum load per manufacturer's recommendation. Felt liner for copper piping. Hanger and rod shall have galvanized finish. B-Line, Unistrut.
- b. Isolating Shield: Galvanized steel shell and reinforcing ribs. 1/4" non-conducting hair felt pad. Pipe hanger in accordance with paragraph above. Increase hanger size per manufacturer's recommendation. B-Line, Semco, Superstrut.
- c. Construction Channel: 12-gage, 1-5/8" x 1-5/8" galvanized steel channel. Single or multiple section. Self-locking nuts and fittings. B-Line, Unistrut.

2. Flashing: Vent flashing shall be 4 lb/ft² lead, 16" sq. flange, length sufficient to be turned down 2" into vent. Except as noted below, flashing for other piping through roof shall also be 4 lb/ft² lead with 16" sq. flange. For single ply roofing, provide galvanized steel with 16" square flange. Provide counter flashing clamp-on storm collar with stainless steel band, and seal water tight with mastic.

2.2 PIPING INSULATION MATERIALS

- A. General: All piping insulation materials shall have fire and smoke hazard ratings as tested under ASTM E-84 and UL 723 not exceeding a flame spread of 25 and smoke developed of 50.
- B. Pre-Molded Fiberglass: Heavy density sectional pre-molded fiberglass with vapor barrier laminated all service jacket and pressure sealing vapor barrier lap. Thermal conductivity shall not exceed 0.25 Btu-in/hr-ft²-F at a mean temperature of 50F. Perm rating 0.02, ASTM E96. Puncture rating 50 Beach units, ASTM D781. Provide 3" (min.) wide tape of same material as lap for butt joints. Certainteed, Knauf, Johns-Manville, Owens-Corning.
- C. Fiberglass Blanket: Unfaced. Thermal conductivity shall not exceed 0.25 Btu-in/hr-ft²-F at a mean temperature of 50F. 1-1/2" thickness. Knauf, Johns-Manville, Owens-Corning.
- D. PVC Jacket (for pipe, fittings and valves): Pre-molded polyvinyl chloride (PVC) jackets, 0.020" thickness. Size to match application. Provide solvent weld adhesive and PVC vapor barrier pressure sealing tape by same manufacturer. Zeston.
- E. Stretchable Glass Fabric: Reinforcing mesh. 10 X 20 continuous filament glass yarns per inch. Johns-Manville.
- F. Vapor Barrier Coating: Childers CP-30LO.
- G. Lagging Adhesive: Childers CP-50A.
- H. Aluminum Jacketing: Aluminum pipe and fitting jacketing. 0.016" thickness for straight pipe. 0.024" thickness for fittings. Stucco-embossed finish. Integral moisture barrier. Provide pre-fabricated aluminum strapping and seals by same manufacturer. Childers.
- I. Outdoor Mastic: Childers CP-10.
- J. Flexible Elastomeric: Closed cell flexible elastomeric preformed pipe insulation. Thermal conductivity shall not exceed 0.27 Btu-in/hr-ft²-°F at a mean temperature of 70°F. 1/2" thick. Provide #520 adhesive and Armaflex insulation pipe hangers by same manufacturer. Armacell Armaflex.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. General:
 - 1. Piping Layout: Piping shall run parallel to room surfaces. No structural member shall be weakened by cutting, notching, boring or otherwise, unless specifically allowed by structural drawings and/or specifications. Where such cutting is required, reinforcement shall be provided as specified or detailed. All piping shall be installed in a manner to ensure unrestricted flow, eliminate air pockets, prevent any unusual noise, and permit complete drainage of the system. All piping shall be installed to permit expansion and contraction without strain on piping or equipment.
 - 2. Joints:

- a. Threaded: Pipe shall be cut square and reamed to full size. Threads shall be in accordance with ANSI B2.1. Joint compound or tape suitable for conveyed fluid shall be applied to male thread only. Joints shall be made with three threads exposed.
 - b. Welded or Brazed: Filler rod shall be of suitable or the same alloy as pipe. Brazing filler metal shall have a minimum melting point of 1100F. Welding or brazing shall be performed by a Certified Welder or Brazer as certified by an organization/institution that uses standards recognized by the American Welding Society (AWS) and meets the requirements of the ASME Boiler and Pressure Vessel Code, Section 9.
 - c. Open Ends: Open ends of piping shall be capped during progress of work to preclude foreign matter.
 - d. Electrical Equipment: Piping shall not be run over electrical panels, motor control centers or switchboards.
3. Fittings and Valves:
- a. Standard Fittings: All joints and changes in direction shall be made with standard fittings. Close nipples shall not be used.
 - b. Reducers: Pipe size reduction shall be made with bell reducer fittings. Bushings shall not be used.
 - c. Unions: A union shall be installed on the leaving side of each valve, at equipment connections, and elsewhere as necessary for assembly or disassembly of piping.
 - d. Valves: All valves shall be full line size. Provide shut-off valve for each building and each equipment connection. Provide shut-off valve at each point of connection to existing piping. At equipment connections, valves shall be full size of upstream piping, except that gas valves within 18" of the point of connection to the equipment may be the same size as the equipment connection.
4. Pipe Support:
- a. General: Hangers shall be placed to support piping without strain on joints or fittings. Maximum spacing between supports shall be as specified below. Actual spacing requirements will depend on structural system. Side beam clamps shall be provided with retaining straps to secure the clamp to the opposite side of the beam. Support pipe within 12" of all changes in direction. Support individual pipes with pipe hanger.

1) Pressure Pipe:

Pipe Size (Inches)	Maximum Spacing Between Supports (ft.)	
	Copper	Steel
1/2	6	6
3/4	6	8
1	6	8
1-1/4	6	10
1-1/2	6	10
2	10	10
2-1/2	10	10
3	10	10
4	10	10
6	10	10
8	10	10
10	10	10

2) Gravity Drain Pipe: Piping shall be supported at each length of pipe or fitting, but in no case at greater spacing than indicated above for pressure pipe.

b. Isolating Shield: All water piping shall have isolating shield; no portion of this piping shall touch the structure without an isolating shield.

5. Miscellaneous:

a. Escutcheons: Provide plated metal escutcheons where piping penetrates walls, ceilings, or floors in finished areas.

b. Pipe Sleeves: All piping passing through concrete shall be provided with pipe sleeves. Allow 1" annular clearance between sleeve and pipe for piping 3" and smaller, otherwise 2" annular clearance.

c. Pipes Passing through Fire Rated Surfaces: Pipes passing through fire rated walls, floors, ceilings, partitions, etc. shall have the annular space surrounding the pipe or pipe insulation sealed with fire rated materials in accordance with the requirements of the fire authority having jurisdiction.

d. Concrete Thrust Blocks: Shall be constructed at all valves, tees, elbows, bends, crosses, reducers and dead ends in loose-joint pipe. Blocks shall cure a minimum of 7 days before pressure is applied. Concrete shall be 2500 psi mix.

e. Dielectric Couplings: Dielectric couplings shall be installed wherever piping of dissimilar metals are joined, except that bronze valves may be installed in ferrous piping without dielectric couplings.

B. Sanitary Sewer Piping:

1. General: Where inverts are not indicated, sanitary sewer piping shall be installed at 1/4" per foot pitch. Piping 4" and larger may be installed at 1/8" per foot pitch where structural or other limitations prevent installation at a greater pitch. Bell and spigot

pipng shall be installed with barrel on sand bed; excavate hole for bell.

2. Cleanouts: Install cleanouts at ends of lines, at changes of direction greater than 45 degrees, and at not greater than 100 foot intervals. Locate interior cleanouts in accessible locations and bring flush to finished surface.
 3. Vents: Vents shall terminate not less than 6" above the roof nor less than 12" from any vertical surface nor within 10' of any outside air intake. Install horizontal vent lines at 1/4" per foot pitch. Offset vents 2' minimum from gutters, parapets, ridges and roof flashing.
- C. Water Piping: Connections to branches and risers shall be made from top of main. Minimum pipe size shall be 3/4", unless otherwise noted. Provide shut off for each building and each connection to equipment. Only equipment mounted on vibration isolators shall be connected with flexible connections.
- D. Gas Piping: Installation shall comply with CPC and NFPA 54 (National Fuel Gas Code). Shall be pitched to drain to dirt legs at low points. No unions shall be installed except at connections to equipment. Provide shutoff and dirt leg at each equipment connection. Only equipment mounted on vibration isolators shall be connected with flexible connectors. Under floor piping shall be sleeved and vented. Plastic pipe and fittings shall be joined in accordance with manufacturer's recommendations. Metal to plastic transition fittings shall be installed at all transitions. Provide 14-gage insulated tracer wire secured to pipe at 10' intervals with nylon ties. Terminate tracer 6" above grade at both ends.
- E. Drain Piping (Including Condensate): Install with constant pitch to receptacle, 1/4" per foot where possible, otherwise 1/8" per foot minimum. Provide TEE with clean-out plug at all changes of direction. Provide trap at each air handling unit to prevent air leakage. Only equipment mounted on vibration isolators shall be connected with flexible connection.

3.2 PIPING INSULATION INSTALLATION:

- A. Cold Water Piping-Freeze Protection: All cold water piping exposed to weather shall be insulated with flexible elastomeric. Cover valves to stem and jacket with aluminum.

3.3 TESTS AND ADJUSTMENTS

- A. General: Unless otherwise directed, tests shall be witnessed by a representative of the Engineer. Work to be concealed shall not be enclosed until prescribed tests are made. Should any work be enclosed before such tests, the Contractor shall, at his expense, uncover, test and repair all work to original conditions. Leaks and defects shown by tests shall be repaired and entire work retested. Tests may be made in sections, however, all connections between sections previously tested and new section shall be included in the new test.
- B. Gravity Systems:
1. Sanitary Sewer: All ends of the sanitary sewer system shall be capped and lines filled with water to the top of the highest vent, 10' above grade minimum. This test shall be made before any fixtures are installed. Test shall be maintained until all joints have been inspected, but no less than 2 hours.
 2. Drains (Including Condensate): Similar to Sanitary Sewer.

C. Pressure Systems:

1. General: There shall be no drop in pressure during test except that due to ambient temperature changes. All components of system not rated for test pressure shall be isolated from system before test is made.
2. Water Piping: Maintain 100 psig water pressure for 4 hours.
3. Backflow Preventer: All backflow preventers shall be tested according to manufacturer's recommendations and the USC Cross Connection Control and Hydraulic Research Manual (8th Edition). Testing shall be performed by an AWWA Certified Backflow Prevention Assembly Tester. Contractor shall certify in writing to the Engineer the date which backflow preventers were tested and by whom test was witnessed.
4. Gas Piping: Maintain 100 psig air pressure for 4 hours.

3.4 DISINFECTION

- A. Disinfect all domestic water piping systems in accordance with AWWA Standard C651, "AWWA Standard for Disinfecting Water Mains", and in accordance with administrative authority. Disinfection process shall be performed by the Contractor and witnessed by a representative of the Engineer. During procedure signs shall be posted at each water outlet stating, "Chlorination - Do Not Drink". After disinfection, the Contractor shall collect water samples and send them to an independent lab for bacteriological analysis. Certificate of Bacteriological Purity shall be obtained and delivered to the Owner through the Engineer.

END OF SECTION

SECTION 15800
HEATING, VENTILATING AND AIR CONDITIONING

PART 1 - GENERAL

1.1 GENERAL MECHANICAL PROVISIONS

- A. The preceding General Mechanical Provisions shall form a part of this Section with the same force and effect as though repeated here.

1.2 SCOPE

- A. Included: Provide all labor, materials and services necessary for complete, lawful and operating systems as shown or noted on the drawings or as specified here. The work includes, but is not necessarily limited to, the following:
1. Air distribution system.
 2. All equipment as shown or noted on the drawings or as specified.
 3. Circulating water system.
 4. System energy balance.
 5. Coordinate with Section 15975 (Building Automation System) regarding location and installation of system sensors, valves, actuators, etc. and to provide simultaneous start-up.
 6. Refrigeration system.
 7. Demolition as indicated on drawings. Where demolition is called for, remove all equipment, piping, ductwork, braces, supports, housekeeping pads, temperature controls and related items no longer required.
- B. Work Specified Elsewhere:
1. Line voltage power wiring to equipment, motor starters in motor control centers, disconnect switches and installation of all starters are included in the Electrical Sections, unless otherwise noted.
 2. Connection of gas, condensate drains and domestic water to equipment.
 3. Painting unless specifically called for in the drawings or specifications.
 4. Building Automation System.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Hot or Chilled Water Piping:
1. Above Grade:
 - a. 2" and Smaller: Schedule 40 black steel pipe, ASTM A53. 150 psi black malleable iron screwed fittings, ANSI B16.3. Piping at floor mounted unit ventilators may be hard drawn Type L copper, soldered joints, 95-5 tin-antimony solder.
 - b. 2-1/2" Through 4": Screwed pipe as above -OR- welded or grooved pipe as below.

- c. 6" and Larger: Schedule 40 black steel pipe, ASTM A53. Standard weight carbon steel welding fittings, long radius ells, ANSI B16.9. Exposed joints may be grooved pipe unions, EPDM gaskets. Anvil International, Victaulic.

2. Valves and Specialties:

a. Valves:

- 1) General: Manufacturer's model numbers are listed to complete description. Equivalent models of Crane, Milwaukee, Nibco, Stockham, Walworth, Anvil International or Victaulic (grooved joint systems only) are acceptable. All valves of a particular type or for a particular service shall be by the same manufacturer. Ball valves may be substituted for 2" and smaller gate valves above grade. Butterfly valves may be substituted for 2-1/2" and larger gate valves above grade; see specification below.
- 2) Gate Valve: Provide 2" extension necks at insulated pipes, where required. 2" and Smaller: All bronze. Rising stem. Union bonnet. Wedge disk. Screwed connection. Malleable iron handwheel. Class 125. Stockham B-105. 2-1/2" and Larger: Iron body, bronze mounted. Non-rising stem. Wedge disk. Class 125. Flanged or AWWA hub end as applicable. Stockham G-612. Underground valves shall have square operating nut. Provide one operating "T" handle for underground valves.
- 3) Butterfly Valve: Iron threaded lug body. Aluminum bronze disk. O-ring seals. Resilient, removable seat. 416 stainless steel shaft. 6" and smaller valves shall have multi-position lever handle. 8" and larger valves shall have gear operator. Provide 2" extension neck at insulated pipes. Demco Series NE, Stockham.
- 4) Plug Valve: 4" and Smaller: Eccentric bronze or nickel plated semi-steel plug, semi-steel body, bronze bushings, Buna-N-rings. 175 psi WOG. DeZurik Series 400. 6" and Larger: Lubricated plug cock. Cast iron or semi-steel body and plug. 200 psi WOG. Flanged connections. Wrench handle. Provide one operating "T" handle for underground valves. Resun R-1431.
- 5) Check Valve: Non-slam, lift type. Replaceable bronze seat, disk and bushings. Stainless steel helical spring. Disk guided at top and bottom. Flow area through valve shall exceed cross sectional area of pipe. 150 psi WOG. CPV, Muessco. 2" and Smaller: Shall be screwed brass with hand lapped bronze disk. 2-1/2" and Larger: Shall be iron body, wafer or flanged with resilient Buna-N or TFE facing on seat.
- 6) Ball Valve: Full port. Bronze body, cap, stem, disk and ball. Screwed connection. Lever handle. TFE seat. O-ring seals. 300 psi WOG. Apollo, Jomar.
- 7) Globe Valve: 2" and Smaller: All bronze. Renewable TFE disk. Screwed connection. Malleable iron handwheel. Union bonnet.

Class 150. Stockham B-22. 2-1/2" and Larger: Iron body, flanged. Bronze mounted. Class 125. Rising stem. Bolted bonnet. Renewable seat and disk. Stockham G-512.

- 8) Valve Box: Pre-cast reinforced concrete. Cast iron lid marked for services. Christy F22 in foot traffic areas; G5 in roadways.

b. Instruments:

- 1) Pressure Gage: Phosphor bronze tube. Bronze bushed. 1% accuracy. Cast aluminum case. 3-1/2" white dial. Adjustable pointer. Operating pressure at midscale. 1/4" NPT brass socket. Provide brass porous core pressure snubber and gage cock. Terice, Weksler, Winters.
- 2) Thermometer: 3" dial. Glass window. Stainless steel case. Back or bottom connected as required. 1/2" NPT. 20-240F, 2F divisions for hot water, 25-125F, 2F divisions for chilled water. 2" insertion length. Allowance shall be made for insulation thickness. Weksler.
- 3) Thermometer Well: Brass well. Suitable for 3" dial thermometer above. Provide 2" extension at insulated pipes.
- 4) Gage Cock: Lever handle brass cock. 1/4" NPT connections. Provide 2" extension at insulated pipes.
- 5) Instrument Well: Suitable for temperature sensing element. Coordinate with supplier of temperature controls.

c. Miscellaneous Specialties:

- 1) Pressure Relief Valve: Bronze body. ASME rated fully automatic, reseating pressure relief valve sized in accordance with energy input. 75 psig rating. Bell and Gossett.
- 2) Union: 2" and Smaller: AAR malleable iron, bronze to iron ground seat. 300 psi. Size 2-1/2" and Larger: Grooved pipe, synthetic gasket, malleable iron housing. Victaulic Style 77, type E gasket, or Anvil International, Style 7001, type EP gasket.
- 3) Pressure Reducing Valve: Brass body. Diaphragm operated. Brass internal parts. Reducing valve shall have a built-in strainer and check valve and have a field adjustable range of 25-60 psi and a 125 psi maximum working pressure. Bell and Gossett.
- 4) Balancing Cock: Calibrated all bronze balancing valve. Screwed connections. Memory stop. Position indicator. Drain connection. Taps for differential pressure gage, with check valves or shutoffs. 125 psi working pressure. Internal seals. Preformed insulation block. FlowSet by Flow Design, Inc.
- 5) Strainer: "Y" type, 125 psi. Machined seats. Stainless steel screens. Provide gate valve blowoff with hose threads. Bailey, Muessco.

2" and Smaller: Screwed bronze body. Perforation size 0.057".

2-1/2" and Larger: Flanged or grooved iron body, perforation size as follows:

<u>Pipe Size</u>	<u>Perforation Dia.</u>
2-1/2" - 3"	1/16"
4" - 6"	3/32"
8" and Larger	1/8"

- 6) Dielectric Coupling: Insulating union or flange rated for 250 psig. EPCO, Victaulic Clearflow (grooved joint system only).
 - 7) Suction Diffuser: Cast iron angle type body with inlet vanes and combination diffuser/strainer/orifice cylinder with 3/16" openings. Provide fine mesh start-up strainer (to be removed after 30 days of operation). Strainer free area to be not less than five times the sectional area of pump connection. Adjustable support foot, drain tapping and gage tapping. Anvil International, Bell and Gossett, Taco, Thrush.
 - 8) Expansion Tank: Pressurized diaphragm type. Welded steel, ASME code construction with ASME stamp and certification, 125 psi, 240F. Sealed elastomer diaphragm. Pre-charged with air to initial fill pressure of system. Base or saddle as required for mounting. Sight glass (hot water service only). Amtrol, Taco.
 - 9) Flexible Connection: 2" and Smaller: Screwed connection. Corrugated bronze core covered with high tensile bronze tubular braid. 150 psi working pressure. Flexonics, Keflex. 2-1/2" and Larger: Contoured, molded Teflon bellows. Minimum of three convolutions. Monel reinforcing rings. Limit bolts. Flanged connection. 100 psi working pressure. Belmont, Resistoflex. -Or- Multiple laminations of 321 stainless steel. 150 psi working pressure. Limit bolts. Flanged connection. Hyspan Series 5500.
- B. Condensate Drain Piping: Schedule 40 galvanized steel pipe, ASTM A53. 150 psi galvanized malleable iron screwed fittings, ANSI B16.3.
- C. Flue Piping: Per the recommendations of the manufacturer of the equipment item being served.
- D. Miscellaneous Piping Items:
1. Pipe Support:
 - a. Pipe Hanger: Steel "J" hanger with side bolt for piping 4" and smaller; steel clevis hanger for piping 5" and larger. Load and jam nuts. Size and maximum load per manufacturer's recommendations. Felt liner for copper piping. Hanger and rod shall have galvanized finish. B-Line, Unistrut.
 - b. Insulation Support: Calcium silicate insulation, 100 psi, or heavy density

fiberglass, 100 psi. Insulation thickness equal to adjoining pipe insulation. Steel support shield or saddle. Provide vapor barrier for chilled water piping. Insulation and/or vapor barrier shall extend 1" beyond steel support. Pipe hanger in accordance with paragraph above. Increase hanger size per manufacturer's recommendation. B-Line, Pipe Shields, Inc., Uni-Grip.

- c. Isolating Shield: Galvanized steel shell and reinforcing ribs. 1/4" non-conducting hair felt pad. Pipe hanger in accordance with paragraph above. Increase hanger size per manufacturer's recommendation. B-Line, Semco.
- d. Construction Channel: 12-gage, 1-5/8" x 1-5/8" galvanized steel channel. Single or multiple section. Self-locking nuts and fittings. B-Line, Unistrut.

- 2. Flashing: Except as noted below, flashing for piping through roof shall be 4 lb/ft² lead with 16" square flange. For single ply roofing, provide galvanized steel with 16" square flange. Provide counter flashing clamp-on storm collar with stainless steel band, and seal water tight with mastic. Maintain dielectric separation between copper and galvanized materials.

2.2 PIPING INSULATION MATERIALS

- A. General: All piping insulation materials shall have fire and smoke hazard ratings as tested under ASTM E-84 and UL 723 not exceeding a flame spread of 25 and smoke developed of 50.
- B. Pre-Molded Fiberglass: Heavy density sectional pre-molded fiberglass with vapor barrier laminated all service jacket and pressure sealing vapor barrier lap. Thermal conductivity shall not exceed 0.25 Btu-in/hr-ft²-°F at a mean temperature of 50°F. Perm rating 0.02, ASTM E96. Puncture rating 50 Beach units, ASTM D781. Provide 3" (min.) wide tape of same material as lap for butt joints. 1" thickness for chilled water piping. For hot water piping 140°F and less, thickness shall be 1" for pipe sizes less than 2-1/2", 1-1/2" thickness for pipe sizes 2-1/2" and larger. For hot water piping over 140°F, thickness shall be 1-1/2" for all pipe sizes. CSG Insulation Corp., Knauf, Johns-Manville, Owens-Corning.
- C. Fiberglass Blanket: Unfaced, 1-1/2" thick. Thermal conductivity shall not exceed 0.25 Btu-in/hr-ft²-°F at a mean temperature of 50°F. Knauf, Johns-Manville, Owens-Corning.
- D. PVC Jacket (for pipe, fittings and valves): Pre-molded polyvinyl chloride (PVC) jackets, 0.020" thickness. Size to match application. Provide solvent weld adhesive and PVC vapor barrier pressure sealing tape by same manufacturer. Zeston.
- E. Stretchable Glass Fabric: Reinforcing mesh. 10 x 20 continuous filament glass yarns per inch. Johns-Manville.
- F. Vapor Barrier Coating: Childers CP-30 LO.
- G. Lagging Adhesive: Childers CP-50A.
- H. Aluminum Jacketing: Aluminum pipe and fitting jacketing, 0.016" thickness for straight pipe. 0.024" thickness for fittings. Integral moisture barrier. Stucco-Embossed finish. Provide pre-fabricated aluminum strapping and seals by same manufacturer. Childers.
- I. Outdoor Mastic: Childers CP-10.

- J. Flexible Elastomeric: Closed cell flexible elastomeric preformed pipe insulation. Thermal conductivity shall not exceed 0.27 Btu-in/hr-ft²-°F at a mean temperature of 70°F. 1/2" thick. Provide #520 adhesive and Armaflex insulation pipe hangers by same manufacturer. Armacell Armaflex.

2.3 DUCTWORK MATERIALS

- A. General: All ductwork materials shall have fire and smoke hazard ratings as tested under ASTM E-84 and UL 723 not exceeding a flame spread of 25 and smoke developed of 50. Shall comply with CMC.
- B. Metal Ductwork: Metal ductwork shall be galvanized sheet steel, lock forming quality, ASTM A-653, with gage and construction to match SMACNA Standard for pressure required (26 gage minimum).
- C. Flexible Ductwork: Insulated flexible ductwork. One pound per cubic foot glass fiber insulation, 1" thick where ductwork is within the building thermal insulation envelope, 1-1/2" thick where ductwork is outside the building thermal insulation envelope. Thermal conductivity shall not exceed 0.25 Btu-in/hr- ft²-°F at a mean temperature of 75°F. Seamless vapor barrier jacket. Duct shall comply with NFPA 90A. Continuous solid internal liner bonded to galvanized steel wire helix. Duct shall be capable of continuous operation at 1-1/2" of water static pressure and 4,000 ft/min air velocity. Genflex, JPL.
- D. Duct Joints / Duct Sealants:
1. Rectangular Ducts: Duct joint connector shall be Ductmate 25/35 factory fabricated connector system with #440 gasket tape.
 2. Round Ducts: All Joints Exposed to Weather: Sealant shall be G.E. "Silglaze II" silicone. Joints Not Exposed to Weather (Except Spiral Wound and Greater than 2" Pressure Class): Fiber tape and liquid adhesive. Hardcast DT-5300 or DT-5400 tape and FTA-20 adhesive, United McGill Uni-Cast. Spiral Wound Joints Not Exposed to Weather and All Joints on Greater than 2" Pressure Class: Sealant shall be Eco-Duct Seal 44-60, or United Duct Sealer.
- E. Spiral Wound Metal Ductwork: Spiral wound factory fabricated, galvanized steel, gages in accordance with the CMC. Spiral lockseam shall be 6" on center, maximum, and shall comply with SMACNA spiral lockseam RL-1. All fittings shall be factory fabricated with all seams fully welded. Tees and laterals shall be conical type. Connections to plenums shall be with bell-mouth fittings. 8" and smaller ells shall be two piece die-stamped. Ells larger than 8" shall be five piece. United McGill. Shop fabricated fittings are not acceptable.

2.4 AIR TERMINALS AND DUCT FITTINGS

- A. Grilles: (Grilles, Registers, Diffusers and Louvers)
1. Information on Drawings: Refer to Grille Schedule on the drawings for the list of grilles. Manufacturer's model numbers are listed to complete the description. Equivalent models of Krueger, Price, Titus or Tuttle and Bailey are acceptable. Manufacturer's facilities must include a testing lab. Refer to the floor plans for neck size, CFM, air diffusion pattern and fire damper, if required.
 2. Performance: Submit complete performance data (throw, pressure drop, noise level, etc.) for all grilles proposed, other than those scheduled. Testing shall be in

accordance with ANSI/ASHRAE 70. Sound level testing shall be in accordance with ARI Standard 885. If, according to the certified data of the manufacturer of the proposed units, the sizes indicated on the drawings will not perform satisfactorily, the units shall be reselected by the Contractor for the proper diffusion, spread, pressure drop, throw and noise level.

3. Frame and Accessories: All surface mounted grilles shall have a perimeter gasket and flanged edge. All grilles shall have frames suitable for mounting in the surfaces designated by the architectural drawings.
 4. Finish: All ceiling and wall grilles and all louvers shall have a paintable white finish unless otherwise noted. Interior components (everything behind the face plate) shall be flat black. Floor grilles shall have an anodized aluminum finish unless otherwise noted.
- B. Branch Duct Volume Damper: Volume control damper (VCD) in rectangular ducts shall be as follows: Opposed blade, 6" maximum blade width, 16-gage blade, 48" maximum length, nylon or oil impregnated bronze bearings, 1/2" diameter pin shaft, 16-gage channel frame, actuating rod and linkage out of air stream. VCD in round duct shall be as follows: Damper blade full height of branch and 1" less than branch width. All branch dampers shall have regulator with stamped steel handle, spring loaded shaft nut, cast body and serrated self-locking die cast core. Secure a 12" length of brightly colored plastic ribbon to handle for ease of location. Where rectangular or round ductwork is insulated, slit insulation to allow handle to protrude. Duro Dyne SRH-228 (with SB-112 end bearing for round ducts).
- C. Extractor: Curved blade turns in adjustable position rigid frame. Tuttle and Bailey Deflectrol.
- D. Turning Vanes: Double wall, hollow metal, air foil shape with trailing edge. Spacing in accordance with manufacturer's recommendations. Aero Dyne HEP.
- E. Flexible Connection: UL listed neoprene coated 30 ounce fiberglass cloth. 3" metal, 3" fabric, 3" metal.
- F. Fire and Combination Fire/Smoke Damper: California State Fire Marshal listed. UL listed. Hour rating as required by the rating of the wall, ceiling, floor, etc. in which it is installed. All dampers shall be Leakage Class II. Include mounting sleeve and angles. Combination fire/smoke dampers shall have normally-closed, non-stall factory electric actuator rated for 250°F (min.). Damper position switch. Remote test and reset switch with open/closed indicator lights. Dampers in round ducts shall be round sleeve with round blade, two retainer plates and mounting hardware for actuator.
- G. Duct Access Door: Insulated double wall door. Full piano hinge. Cam latch. Pressure rating to match application. Minimum size 10"x10". Air Balance.
- H. Relief Vent: Factory fabricated, curb mounted gravity relief vent. Galvanized steel or aluminum. Throat area as indicated on drawings. Outlet area equal or greater than throat area. 1/2" birdscreen. Provide backdraft damper as specified elsewhere. Cook, Penn.
- I. Back Draft Damper: Aluminum interlinked blades with felt strip on mating surfaces. Aluminum or galvanized steel frame. Bronze bearings. Adjustable counter balanced damper. Ruskin.
- J. Back Draft Damper: Fabric blades. Aluminum or galvanized steel frame. Wire mesh stop. Ruskin NMS2.

- K. Mixing Dampers: Opposed blade, 6" (max.) blade width, 16-gage blade, 48" (max.) length. Nylon or oil impregnated bronze bearings. 1/2" diameter pin shaft. 16-gage channel frame. 1% (max.) leakage at 4" WC in accordance with AMCA 500 for outside air dampers. Actuating rod and linkage out of air stream. Arrow.

2.5 DUCTWORK INSULATION MATERIALS

- A. General: All ductwork insulation materials shall have fire and smoke hazard ratings as tested under ASTM E-84 and UL 723 not exceeding a flame spread of 25 and smoke developed of 50.
- B. Fiberglass Blanket: Thermal conductivity shall not exceed 0.27 Btu-in/hr-ft²-°F at a mean temperature of 75°F. 3/4 lb/ft³, 1-1/2" installed thickness. Installed R-value of 4.2 where installed inside the building insulation envelope. Installed R-value of 8.0 where installed outside the building insulation envelope. Faced with glass reinforced foil laminated to Kraft paper. Certainteed, Knauf, Johns-Manville, Owens-Corning.
- C. Acoustic Lining: Glass fiber. Thermal conductivity shall not exceed 0.24 Btu-in/hr-ft²-°F at a mean temperature of 75°F. Coated to prevent fiber erosion up to 6,000 ft/min. Noise reduction coefficient of 0.70 for 1" thickness; 0.85 for 2" thickness. 2" thick where installed outside the building insulation envelope; 1" thick where installed inside the building insulation envelope. Johns-Manville Permacote Linacoustic with Superseal anti-microbial edge treatment.
- D. Bonding Adhesive: Childers CP-85.
- E. Acoustic Lining: Flexible elastomeric, closed cell. Thermal conductivity shall not exceed 0.25 Btu-in/hr-ft²-°F at a mean temperature of 75°F. Erosion resistance up to 10,000 ft/min. 1" thick. Noise reduction coefficient of 0.50. AP Armaflex. Armaflex 520 adhesive.

2.6 EQUIPMENT

- A. General Requirements:
1. Start-up: All equipment shall be started and tested in accordance with the manufacturer's written instructions. Start-up procedure shall be performed by a factory trained service technician – not the installing contractor. Provide the inspector of record with factory start-up literature for each mechanical equipment item. Demonstrate to inspector that the start-up procedure has been completed. Start-up sheets shall be completed and submitted with O&M manuals. Start-up sheets shall be submitted, certifying that start-up has been completed per manufacturer's written instructions.
 2. Capacity: Capacities shall be in accordance with schedules shown on drawings. Capacities are to be considered minimum.
 3. Dimensions: Equipment must conform to space requirements and limitations as indicated on drawings and as required for operation and maintenance. Equipment will not be accepted that does not readily conform to space conditions. Prepare and submit layout drawings for all proposed equipment (different than scheduled units) showing actual job conditions, required clearances for proper operation, maintenance, etc.

4. Ratings:
 - a. Gas: Gas burning equipment shall be furnished with 100% safety gas shut-off, intermittent pilot ignition, and be approved by AGA, except that boilers shall be AGA approved or UL listed.
 - b. Electrical: Electrical equipment shall be in accordance with NEMA Standards and UL or ETL listed where applicable standards have been established.
5. Piping: Each item or assembly of items shall be furnished completely piped for connection to services. Control valves and devices shall be provided. For equipment mounted on springs, provide flex connections. Equipment requiring domestic water for non-potable use shall be provided with backflow preventer acceptable for intended use by local governing authorities.
6. Electrical:
 - a. General: Each item or assembly of items shall be furnished completely wired to individual terminal blocks for connection to electrical power. All electrical accessories required by equipment shall be furnished. Provide terminal blocks for controls and interlocks not included in equipment package. Manual and magnetic starters shall have ambient compensating running overcurrent protection in all ungrounded conductors. Magnetic starters shall be NEMA rated, manual reset, shall have H-O-A switches and auxiliary contacts. Controllers and other devices shall be in NEMA 1 or 3R enclosures as applicable.
 - b. Wiring: Conductors, conduit, and wiring shall be in accordance with Electrical Specifications. Individual items within assembly shall be separately protected with dead front, fused disconnect, fuse block, or circuit breaker for each ungrounded conductor, all accessible on operating side of equipment. Switches, contacts and other devices shall be in ungrounded conductors.
 - c. Motors: Shall be rated, constructed and applied in accordance with NEMA and ANSI Standards without using service factor. Single-phase motor shall be of type to suit application. Three-phase motors shall be NEMA B design on pumps and fans, NEMA C on reciprocating equipment, sealed ball bearing, three-phase induction unless otherwise noted. Motors 1 HP and above shall be NEMA premium efficiency, Class F insulation. Motors in a fan air stream shall be TEFC or TEO. Vertical motors exposed to weather shall be TEFC and shall have rain caps. Horizontal motors exposed to weather shall be TEFC. Motors for use with VFD's shall be inverter ready.
 - d. Starters: Motor starters shall be furnished for all equipment except where starter is in a motor control center as designated on the electrical drawings. Deliver starter to Electrical Contractor for installation and wiring.
 - e. Control Voltage: Equipment connected to greater than 240 volts shall be provided with 120 volt control circuit from integral protected transformer if separate source is not indicated on plans. 240 volt control is acceptable if confined within control panel.

- f. Submittals: Included in shop drawings shall be internal wiring diagrams and manufacturer's recommended external wiring.
- 7. Fan Selection:
 - a. Fan Curves: Performance curves shall be submitted for all units of 3000 CFM or greater. Operating point for forward curved fans shall be from point of maximum efficiency toward increased CFM limited by horsepower scheduled. Operating point for backward inclined fans shall be selected near point of maximum efficiency. Curves shall plot CFM verses static pressure with constant brake horsepower, RPM and efficiency lines.
 - b. Static Pressure: Unless otherwise noted, pressure scheduled as external static pressure (ESP) includes all ductwork and accessory losses external to the unit housing. Unless otherwise noted, pressure scheduled as total static pressure includes all ductwork, filter, coil, cabinet, damper and other accessory losses. Unless otherwise noted, pressure scheduled as duct static pressure includes all supply and return ductwork and accessory losses external to the unit housing and plenum (as applicable). The allowance for filter losses is 0.3" WC, unless otherwise noted. Submit itemized static pressure losses for all components.
- 8. Filters:
 - a. General: Tested and rated in accordance with ASHRAE Standard 52.2 and SFM 12-71-1, Part 12, Title 24, C.C.R. Furnish and install one complete change of all filters after air balance is completed and prior to acceptance. Provide pressure differential gage across all filter banks.
 - b. Filter Media: 2" media. MERV 8. Clean filter resistance 0.10" water at 300 fpm. Throw-away frame. Class 2. Camfil Farr.
 - c. Pressure Differential Gage: Diaphragm actuated. 4" dial. Zero adjustment. Accuracy +/- 2% of full scale. Range as required. Provide static pressure sensors, tubing and mounting brackets. Dwyer Series 2000.
- 9. Screens and Safety Grating: All duct or louver openings to the outside shall be covered with 1/4", 16-gage, galvanized wire mesh screen. Provide safety grating at all openings in equipment floors.
- 10. Mixing Dampers: Opposed blade, 16-gage. Six-inch maximum blade width, 48" maximum length. Nylon or oil impregnated bronze bearings. One-half inch diameter pin shaft. 16-gage channel frame. One percent maximum leakage at 4" WC in accordance with AMCA 500 for outside air dampers. Actuating rod out of air stream. Arrow.
- 11. Sound Ratings: Shall be in accordance with ASHRAE 36 - 72. Sound ratings shall not exceed scheduled values.
- 12. Drives: Unless noted as direct connected, drives shall be V-belt, rated at 150% of motor horsepower. Multiple drive belts shall be matched set. Drive sheaves shall be dynamically balanced, adjustable, range +/- 10%, selected at mid range. Adjustable relative movement shall be lockable to shaft. Belts shall be aligned within 1-1/2 degrees at all times. Open drives shall be provided with OSHA approved open

mesh belt guards. Belt guards exposed to weather shall be weatherproof enclosure with louvered face for adequate ventilation. Driving motor shall be mounted on adjustable rails. T.B. Woods, Browning. Submit RPM range of driven machine with drive selection.

13. Vibration Isolation:

- a. General: The vibration isolation manufacturer shall be responsible for the proper selection of all isolators, support rails, and bases. Isolator selection shall be based on deflection as indicated. Lowest disturbing frequency shall be the basis for design. Isolator shall be selected for uniform deflection according to weight distribution. Shop drawings shall include a plan of equipment showing point loads, design data for each isolator including spring outside diameter, free, operating and solid heights, and ratio of horizontal to vertical stiffness, efficiency and design of support rails and bases. Consolidated Kinetics, Mason Industries, M.W. Sausse. All isolators shall be the product of a single manufacturer.
- b. Neoprene in Shear: 2500 psi tensile strength, oil resistant neoprene. Cast-in top and base plates. Isolator shall be selected for maximum static deflection without exceeding load capacity.
- c. Springs: Laterally stable steel springs. Horizontal stiffness equal to or greater than 1.3 times vertical stiffness. Outside spring diameter shall be a minimum of 0.8 times operating height. Springs shall be selected to provide operating static deflection plus a 50% overload capacity before reaching solid height. Spring shall be housed in a welded steel assembly designed and engineered to limit movement of supported equipment without degrading the vibration isolation during normal operating conditions. Base plate shall have a 1/4" thick ribbed neoprene pad. Assembly shall have a drilled and tapped load plate and leveling bolt. Static deflection shall be 2" unless otherwise noted. Isolator shall be designed in accordance with the CBC. Submit calculations to indicate compliance.

14. Coils:

- a. Construction: Copper tube. Copper or aluminum 0.0075" min. thickness fins hydraulically or mechanically bonded to tube. 16-gage galvanized steel rigid channel coil casing. Rated working pressure 200 psig min. All coils shall have connections at the same end. Wherever two or more coils are being controlled by a single control valve, each coil shall be installed with a separate balancing cock and a Pete's Plug at each outlet.
- b. Capacity: Ratings certified by ARI in accordance with ARI Standard 410. Cooling coil face velocity shall not exceed manufacturer's published ratings or 550 fpm. Heating coil face velocity shall not exceed 1000 fpm. Include coil selection calculations in shop drawings.
- c. Hot or Chilled Water Coils: Copper or cast iron headers, brazed or spun to tube. Tube wall minimum thickness 0.024". 10 fins/inch maximum. Two row minimum. Install hot water coils upstream of chilled water coils.
- d. Direct Expansion Coils: Copper suction header silver brazed to distributing

tubes and expansion valve. Copper tubes with aluminum fins. 10 fins/inch maximum.

B. Air Conditioning Unit:

1. General: Self-contained heating/cooling unit designed for outdoor installation. Factory assembled and tested. Refer to Paragraph 2.6A for general requirements. Provide all starters and relays required for operation. 24-volt control circuit from integral transformer. Weatherproof cabinet, galvanized steel with enamel finish. Fresh air inlet. Drain pan. Multivane centrifugal supply fan. Factory hold down devices. Coil guards as follows: 3/4"x1-3/4" 16 gage expanded galvanized steel, 18 gage galvanized steel frame, fully welded. ARI certified. Gas equipment AGA certified.
2. Refrigeration: Sealed hermetic compressor with internal vibration isolating mount. Crankcase heater, high/low pressure switch, recycling timer. Air-cooled condenser with propeller fan. Non-ferrous finned coil. Low ambient control to 45°F. Single phase units shall have compressor start assist kit. 5-year extended warranty on compressor(s).
3. Heat: Natural gas fired. Aluminized or ceramic coated welded steel heat exchanger. Electric intermittent ignition. Automatic gas valve. Power venting. Fan and limit controls.

C. Exhaust Fan:

1. General: Exhaust fans shall bear the AMCA certified ratings seal for air and sound performance. Fans exposed to weather shall have ventilated weatherproof housing over motor and drive assembly. Refer to Paragraph 2.6A for general requirements. All direct drive fans shall be provided with unit mounted speed controllers, unless otherwise noted. All motors 1 horsepower and larger shall be the high efficiency type.
2. Ceiling Fan: Ceiling mounted direct drive centrifugal exhaust fan with exhaust grille. Motor mounted in rubber-in-shear isolators. Motor and fan removable through grille. Acoustically lined housing. Backdraft damper. UL listed. Acme, Carnes, Cook, Greenheck, Penn.
3. Roof Fan: Multivane centrifugal fan, statically and dynamically balanced. Ball bearings. Vibration isolating mount. All aluminum construction with steel or aluminum wheel. Factory curb. Backdraft damper. Birdscreen. Dome type or up-blast type as indicated on drawings. Range hood fans shall be in accordance with UL 762. Acme, Carnes, Cook, Greenheck, Penn.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. General:

1. Piping Layout: Piping shall be concealed in walls, above the ceilings, or below grade unless otherwise noted. Exposed piping shall run parallel to room surfaces; location to be approved by Engineer. No structural member shall be weakened by cutting,

notching, boring or otherwise, unless specifically allowed by structural drawings and/or specifications. Where such cutting is required, reinforcement shall be provided as specified or detailed. All piping shall be installed in a manner to ensure unrestricted flow, eliminate air pockets, prevent any unusual noise, and permit complete drainage of the system. All piping shall be installed to permit expansion and contraction without strain on piping or equipment. Vertical lines shall be installed to allow for building settlement without damage to piping. Lines shall be adequately braced against vertical and lateral movement. For piping connected to equipment mounted on springs, provide flex connections. Pipe sizes indicated on the drawings are nominal sizes unless otherwise noted. Pipe sizes shall not decrease in direction of flow, unless otherwise noted.

2. Joints:

- a. Threaded: Pipe shall be cut square, and reamed to full size. Threads shall be in accordance with ANSI B2.1. Joint compound or tape suitable for conveyed fluid shall be applied to male thread only. Joints shall be made with three threads exposed.
- b. Welded or Brazed: Welding and brazing shall conform to American Welding Society (AWS) standards. Filler rod shall be of suitable or the same alloy as pipe. Brazing filler metal shall have a minimum melting point of 1100°F. Welding or brazing shall be performed by a Certified Welder or Brazer as certified by an organization/institution that uses standards recognized by the AWS and meets the requirements of the ASME Boiler and Pressure Vessels Code, Section 9.
- c. Open Ends: Open ends of piping shall be capped during progress of work to preclude foreign matter.
- d. Electrical Equipment: Piping shall not be run over electrical panels, motor control centers or switchboards.

3. Fittings and Valves:

- a. Standard Fittings: All joints and changes in direction shall be made with standard fittings. Close nipples shall not be used.
- b. Reducers: Pipe size reduction shall be made with bell reducer fittings. Bushings shall not be used.
- c. Unions: A union shall be installed on the leaving side of each valve, at all sides of automatic valves, at equipment connections, and elsewhere as necessary for assembly or disassembly of piping.
- d. Valves: All valves shall be full line size. At equipment connections, valves shall be full size of upstream piping. Provide a shut-off valve at each point of connection to existing piping.

4. Pipe Support:

- a. General: Hangers shall be placed to support piping without strain on joints or fittings. Maximum spacing between supports shall be as specified below. Actual spacing requirements will depend on structural system. Refer to

drawings for additional requirements and attachment to structure. Side beam clamps shall be provided with retaining straps to secure the clamp to the opposite side of the beam. Vertical piping shall be supported with riser clamp at 20' on center (maximum). Support pipe within 12" of all changes in direction.

<u>Pipe Size (In.)</u>	<u>Maximum Spacing Between Supports (Ft.)</u>	
	Copper	Steel
1/2	6	6
3/4	6	8
1	6	8
1-1/4	6	8
1-1/2	6	10
2	10	10
2-1/2	10	10
3	10	10
4	10	10
6	10	10
8	10	10
10	10	10

- b. Non-Insulated Piping: Support individual pipes with pipe hanger.
- c. Hot Water Piping: Support individual pipes with insulation support and pipe hanger. Install per manufacturer's recommendations.
- d. Chilled Water Piping: Support individual pipes with insulation support and pipe hanger. Install per manufacturer's recommendations. Piping shall have complete vapor seal.
- e. Refrigerant Piping: Support insulated refrigerant line with construction channel and sheet metal support saddle. 5' spacing. Use isolating shield for uninsulated pipe. When using pre-charged tubing, all changes of direction shall be made with bending tools producing neat uniform bends. Free hand bends will not be accepted.
- f. Trapeze: Trapeze hangers of construction channel and pipe clamps may be used. Submit design to Engineer for review.

5. Miscellaneous:

- a. Escutcheons: Provide chrome plated metal escutcheons where piping penetrates walls, ceilings, or floors in finished areas.
- b. Pipe Sleeves: All piping passing through concrete shall be provided with pipe sleeves. Allow 1" (nominal) clearance between sleeve and pipe or pipe insulation.
- c. Pipes Passing through Fire Rated Surfaces: Pipes passing through fire rated walls, floors, ceilings, partitions, etc. shall have the annular space surrounding the pipe or pipe insulation sealed with fire rated materials in

accordance with the requirements of the fire authority having jurisdiction.

- d. Dielectric Couplings: Dielectric couplings shall be installed wherever piping of dissimilar metals are joined, with the following exceptions: Bronze valves may be installed in ferrous piping without dielectric couplings. Do not install dielectric couplings at coil connections; provide red brass union in place of dielectric coupling.
- B. Hot or Chilled Water Piping: Provide shut-off valve for each building and at each connection to equipment. Before installing, all pipe shall be rapped along entire length to loosen sand, mill scale, etc. Pipe 2" and larger shall be cleaned internally with wire brush. Before connection to equipment, all piping shall be thoroughly flushed with water. All portions of the system shall be piped to allow for the removal of air. All high points shall have accessible air vents (e.g. highest point of all risers, circulating mains with branch connections off of the bottom or side, highest point of all piping branches, etc.). Unless otherwise noted all vents shall be 1/4" petcocks with 1/4" copper tube discharge. Route tube to condensate pan, floor sink, etc. If a drain point is not available, terminate tube with a return bend to allow water to be collected. Only equipment mounted on vibration isolators shall be connected with flexible connection.
- C. Condensate Drain Piping: Install with constant pitch to receptacle. 1/4" per foot where possible, otherwise 1/8" per foot minimum. Provide TEE with cleanout plug at all changes of direction. Provide trap at each air handling unit to prevent air leakage. Connections to equipment mounted on vibration isolators shall be made with flexible connection. Except in equipment rooms, piping not concealed in wall structure, above ceilings or below floors shall be chrome plated brass.
- D. Flue Piping: Flue piping shall be installed in accordance with its UL listing and the manufacturer's instructions.

3.2 PIPING INSULATION INSTALLATION

- A. Chilled and Hot Water Supply and Return:
 - 1. General: All chilled and hot water supply and return piping (including all fittings and accessories) and all chilled water equipment shall be insulated. Insulate a sufficient length of make-up water piping to prevent condensation.
 - 2. Pipe: Apply pre-molded fiberglass sections to pipe using integral pressure sealing lap adhesive in accordance with manufacturer's recommendations. Stagger longitudinal joints. Seal butt joints with factory supplied pressure sealing tape.
 - 3. Fittings and Valves:
 - a. Wrap all fittings and valves with pre-cut fiberglass blanket to thickness matching adjoining insulation. Cover blanket with PVC jacket, solvent welded. Seal all joints with factory supplied pressure sealing vapor barrier tape with a 1-1/2" (min.) overlap on both sides of joint. Insulate all flanges, unions and valves except stems and operators. All joints on chilled water piping shall be sealed with vapor barrier coating in addition to the vapor barrier tape.
 - b. For miscellaneous fittings and accessories for which PVC jackets are not available or where proximity of fittings precludes a neat-appearing

installation, the Contractor may cover the fiberglass blanket with stretchable glass fabric, one coat of lagging adhesive, and a final coat of vapor barrier coating.

4. Vapor Barrier Continuity: All exposed ends of insulation and all gaps or voids in vapor barrier shall be sealed with stretchable glass fabric, one coat of lagging adhesive and a final coat of vapor barrier coating. Build up all horizontal areas to prevent water accumulation.
 5. Pipe Hangers: Seal all joints at pipe hangers with vapor barrier tape. Joints on chilled water piping shall be sealed with vapor barrier coating in addition to the vapor barrier tape.
 6. Piping Exposed to Weather:
 - a. All piping and fittings exposed to weather shall have, in addition to the above described insulation, an aluminum jacketing. Insulation at grooved pipe couplings shall be covered with aluminum flange fitting covers. Secure in place with factory supplied straps. Install all joints to prevent water entry. All joints shall be sealed with outdoor mastic.
 - b. For miscellaneous fittings for which aluminum jackets are not available or where proximity of fittings precludes a neat-appearing installation, the Contractor may cover the insulation with stretchable glass fabric and at least two coats of outdoor mastic. Plastic fitting covers shall not be used where exposed to weather.
 7. Additional Finish for Exposed Piping and Equipment: All piping and equipment exposed to view but protected from the weather shall be given an additional finish of PVC jackets. Do not install this jacket where it will be subjected to a temperature of 150°F or more such as immediately adjacent to boilers. In these locations install stretchable glass fabric, one coat of lagging adhesive and a final coat of vapor barrier coating.
 8. Equipment: Chilled water equipment with continuous circulation (pumps, heat exchanger, etc.), shall be insulated with materials similar to those described in Paragraph 2.2. It shall be the Contractor's responsibility to provide adequate insulation to prevent condensation, a complete vapor barrier, weatherproofing for equipment exposed to the weather, and a neat-appearing installation. Insulate hot water equipment same as above except no vapor barrier. At pumps, insulate the suction and discharge pipes and the suction diffuser the same as other piping. Use flexible elastomeric insulation at pump volutes and the access end of the suction diffuser. Submit materials and method of installation to Engineer for review.
- B. Flue Piping: Insulate all single wall flue piping and boiler smoke box with 1-1/2" thick calcium silicate. Jacket with stretchable glass fabric, one coat of lagging adhesive, and a final coat of vapor barrier coating if inside or with aluminum if exposed to weather.

3.3 DUCTWORK INSTALLATION

A. General:

1. Standards: Unless otherwise noted, all ductwork shall be constructed and installed in accordance with current SMACNA Standards. Ductwork shall be built to a

pressure classification equal to or greater than the maximum operating pressure at that point in the ductwork. A copy of these standards shall be maintained at the job site at all times. Duct work and accessories shall be installed in a manner to prevent vibration and rattling.

2. Access: Provide duct access doors as required to adjust equipment and dampers. Provide wall or ceiling access panels, or remote actuators as required where equipment and dampers are not otherwise accessible. Duro Dyne SRC-120 concealed remote actuator with zinc finish on cover.
3. Flexible Connections: Connection of ductwork to any vibrating equipment shall be with 3" (min.) flexible connection. Install with ample slack and uniform gap. There shall be no metal to metal contact across flexible connection. Flexible connections exposed to weather shall have a protective sheet metal cover.
4. VAV System: For all variable air volume (VAV) systems, the supply ductwork between the fan discharge and the VAV boxes shall be constructed per SMACNA standards to a pressure level equal to the maximum shut-off pressure the fan can generate. All joints in this ductwork shall be sealed with duct sealant in accordance with manufacturer's recommendations. Install VAV boxes with four diameters of straight duct on up-stream side.
5. Flanges and Escutcheon: Where ductwork penetrates walls, ceilings, or floors, furnish and install flange or escutcheon of same material as duct.
6. Ductwork Passing through Fire Rated Surfaces: Where ductwork passes through fire rated walls, floors, ceilings, partitions, etc., provide fire damper(s) or fire/smoke damper(s) in accordance with the requirements of the fire authority having jurisdiction.

B. Low Velocity-Low Pressure (up to 2,000 ft/min and up to 2.0 in water):

1. Sheet Metal Ductwork:
 - a. Ells: Ells with less than standard radius and square ells shall be fitted with turning vanes.
 - b. Tees: Tees in supply ductwork shall be straight tap-in with extractor or 45 degree take-off as shown on drawings. Duct mounted supply grilles shall be installed with an extractor. Grilles or branches in supply ductwork shall be a minimum of 8 duct diameters downstream of tees.
 - c. Duct Joints / Duct Sealants: Rectangular Ducts: Ducts shall be joined with duct joint connectors. Round Ducts: Ducts shall be joined with male-female slip joints and a minimum of three sheet metal screws. All joints and seams which are not exposed to weather shall be sealed airtight with fiber tape and liquid adhesive. Tape shall extend 1" on both sides of joints. All joints and seams exposed to weather shall be sealed air and water tight with G.E. "Silglaze II" silicone sealant. All joints on spiral wound metal ductwork not exposed to weather shall be sealed air tight with duct sealant.
 - d. Dampers: Install volume control damper and damper regulator in all branch ducts.

2. Flexible Glass Fiber Ductwork: The use of flexible duct is limited to the last 7 feet of each branch duct (i.e. one 7 foot section of flexible duct may be used to connect the grille to the sheet metal branch duct). No joints are permitted in this 7' length. Hangers shall be 4" wide metal straps spaced to prevent sagging, 42" spacing maximum. Insert 6" wide fiberglass pad between duct and hanging strap. Joints shall be installed with stainless steel or nylon draw bands, Duro Dyne Dyn-O-Tie. Minimum turn radius shall be in accordance with SMACNA Standards (turn radius of duct centerline not less than 1.5 times the duct diameter).
3. Spiral Wound Metal Ductwork: At side duct grilles, the grille shall be cut directly into the spiral duct. Duct to duct joints shall be made with factory joint connectors and the spiral seam rotated so that the seam forms a continuous helical pattern across the joint.

3.4 AIR TERMINALS AND DUCT FITTINGS INSTALLATION

- A. General: Unless otherwise noted, all air terminals and duct fittings shall be installed in accordance with current SMACNA Standards. Terminals and fittings shall be installed in a manner to prevent vibration and rattling. Metal surfaces exposed to view behind grilles and registers shall be painted flat black.
- B. Fire and Combination Fire/Smoke Damper: Shall be installed in accordance with the manufacturer's recommendations. Provide access doors as required. The remote test and reset switch shall be located in the ceiling, the shortest possible distance from the damper. Manufacturer's instructions shall be available to the inspecting authorities. Shall be tested according to State Fire Marshal requirements.

3.5 DUCTWORK INSULATION INSTALLATION

- A. General: Insulate all sheet metal supply and return ductwork except as noted below. Insulation shall be continuous through walls and floors except at fire dampers.
- B. Where Insulation Is Not Required: Do not insulate factory-insulated ducts or casings, acoustic lined ducts, underground ductwork, supply or return ductwork exposed to view in the space that it serves, or exhaust ductwork.
- C. Concealed Ductwork: Wrap concealed ductwork with fiberglass blanket lapped 6" minimum. Secure with staples 4" on centers maximum on straight runs and 3" maximum at elbows and fittings. Insulation on bottom of ducts wider than 36" shall also be secured with mechanical fasteners at 24" on center.
- D. Acoustic Lining: Unless otherwise indicated, all supply and return ductwork in equipment rooms including outside air intakes, all ductwork exposed to weather and other ducts as indicated on drawings, shall have acoustic lining. Acoustic line all supply, return or exhaust duct connections to HVAC units or fans for a minimum of 10 lineal feet upstream and downstream of unit or fan, unless otherwise indicated on drawings. Where acoustic lining is installed, increase each sheet metal dimension to accommodate lining and maintain clear inside duct dimensions shown on drawings. Apply lining with adhesive in accordance with manufacturer's recommendations. For glass fiber lining, also secure with mechanical fasteners in accordance with SMACNA Standards and seal exposed edges of lining with anti-microbial edge treatment. Unless otherwise noted, lining shall be glass fiber. Lining for evaporative cooled ductwork shall be flexible elastomeric.
- E. Exposed Ductwork: All externally insulated ductwork which is exposed to view but protected

from the weather shall be insulated with fiberglass board. Secure with mechanical fasteners at 12" on center. Reinforce all edges with corner angles and apply a finish coat of canvas or stretchable glass fabric and lagging adhesive.

- F. Ductwork Exposed to Weather and Externally Insulated: Ductwork which is exposed to weather, but not internally insulated such as ductwork downstream of high efficiency filters or ductwork on combination evaporative cooled and heated air systems shall be externally insulated with fiberglass board. The fiberglass board shall then be protected with a galvanized sheet metal jacket per SMACNA standards.

3.6 EQUIPMENT INSTALLATION

- A. General: It shall be the responsibility of the equipment installer to ensure that no work done under other specification sections shall in any way block or otherwise hinder the equipment. All equipment shall be securely anchored in place. All equipment shall be installed level.
- B. Air Handling Units: Spring isolators shall be adjusted to allow movement to maximum free spring length. Piping support shall be designed so that piping weight does not bear on equipment. Hot water coil shall be mounted upstream of chilled water coil.
- C. Balance: Fans shall be statically and dynamically balanced in unit. Maximum allowances are: 2 mils to 600 rpm; 1-1/2 mils to 900 rpm; 1 mil to 1200 rpm; 3/4 mil to 1800 rpm; and 1/2 mil to 2200 rpm.
- D. Gage Taps: Gage taps, such as Pete's Plugs, shall be installed immediately adjacent to all heat exchanger and pump connections (i.e. inlet and outlet of all pumps, boilers, chillers, condensers, coils, etc.). Taps shall be installed to allow for a pressure gage or thermometer to be easily inserted and read.
- E. Connections to Equipment: Where size changes are required for connections to equipment, they shall be made immediately adjacent to the equipment and, if possible, inside the equipment cabinet.
- F. Pumps: Install pumps with a minimum of 8 diameters of straight pipe at the pump suction unless a suction diffuser is installed. Sufficient clearance to wall or other obstructions shall be provided so that motor and rotating parts can be removed without disassembly of volute or piping. Anchor bolt configuration shall be compatible with this method of removal. Pedestal mounted pumps shall have their bases grouted. Realign pump and motor according to Hydraulic Institute Standards after grouting and connection of piping.
- G. Boiler: Installation shall be in accordance with California Code of Regulations, Title 8, Industrial Relations. Where required, permit for system operation shall be obtained and permanently posted at installation.
- H. Equipment Platforms: Shall be as shown on drawings and as follows: Flashing and platform cover shall be 22 gage (min.) sheet metal. All joints and seams shall be soldered with 2" (min.) overlaps. Provide 3/4" gap around perimeter between roofing and drip lip to facilitate re-roofing. Extend drip lip down 3" (min.). Provide 30# felt under platform cover.

3.7 TESTS AND ADJUSTMENTS

- A. General: Unless otherwise directed, tests shall be witnessed by a representative of the Engineer. Work to be concealed shall not be enclosed until prescribed tests are made. Should any work be enclosed before such tests, the Contractor shall, at his expense,

uncover, test and repair all work to original conditions. Leaks and defects shown by tests shall be repaired and entire work retested.

B. Piping Tests:

1. General: Tests may be made in sections, however, all connections between sections previously tested and new section must be included in the new test. There shall be no drop in pressure during test except that due to ambient temperature changes. All components of system not rated for test pressure shall be isolated from system before test is made.
2. Water Piping: Maintain 100 psig water pressure for 4 hours.

3.8 SYSTEM ENERGY BALANCE

- A. Scope: Provide the services of an independent test and balance agency to test, adjust and balance, retest and record performance of the system to obtain design quantities as specified. The agency must prove that they have no affiliation with any equipment manufacturer, design engineer, installing contractor, or any other party which might lead to a conflict of interest, in order to provide an unbiased, third party system balance and report.
- B. Qualifications: Prior to commencing work, the agency shall be reviewed by the Engineer and shall be certified by the Associated Air Balance Council or National Environmental Balancing Bureau. The agency shall provide documentation of having successfully completed at least five projects of similar size and scope. The Contractor must have sufficient personnel to respond to a trouble call at the site within two hours.
- C. Instruments: All instruments shall be accurately calibrated; calibration histories shall be available for examination. Application of instrumentation shall be in accordance with AABC or NEBB standards.
- D. Submittals: Include in shop drawings copies of forms to be used for testing and balancing showing all data which is to be recorded. Three copies of completed balance report shall be submitted for review.
- E. Procedure - General: Procedure shall be in accordance with Associated Air Balance Council's "National Standards for Field Measurements and Instrumentation - Total System Balance", Volume Two, No. 12173, or equivalent NEBB standards. System shall be in full, continuous operation during test. Balanced quantities shall be plus 10%, minus 0% of design quantities. All nameplate data, manufacturer, model and serial numbers shall be recorded for each item tested.
- F. Extended Warranty: The test and balance agency shall include an extended warranty of 90 days after completion of test and balance work, during which time the Engineer, at his discretion, may request a recheck or resetting of any item or items in test report. The agency shall provide technicians to assist the Engineer in making any tests he may require during this period of time.
- G. Air Balance Procedure (For Each Air Handling System):
 1. All air filters shall be clean when air balance is performed.
 2. Provide a sketch of the equipment showing exactly where all pressure readings were taken.

3. Adjust blower RPM to design requirements.
4. Record motor full load amperes.
5. Make pitot tube traverse of main supply and return ducts and obtain design CFM at fans.
6. Record system static pressures, inlet and discharge.
7. Record filter quantity, size(s) and pressure drop across filter(s) at each filter bank.
8. Adjust system for design CFM recirculated air.
9. Adjust system for design CFM outside air.
10. Adjust all main supply and return air ducts to design CFM.
11. Adjust all zones to design CFM, supply and return.
12. Adjust all equipment and grilles to design flow.
13. Adjust CFM at all exhaust fans, make-up units, etc. (high and low speed, where applicable). Record applicable data from items above.
14. Each grille, diffuser and register shall be identified as to location.
15. Verify proper diffusion pattern for all ceiling grilles and that all sidewall grilles are set for 5 degrees upward deflection unless otherwise noted. Make a notation of any that are not set properly.
16. Size, type and manufacturer of diffusers, grilles, registers and all tested items shall be identified and listed. Manufacturer's ratings shall be used to make required calculations on all items.
17. Readings and tests of diffusers, grilles, and registers shall include required FPM velocity and test resultant velocity, required CFM and test resultant CFM after adjustments.
18. In cooperation with the control manufacturer's representative, set adjustments of automatically operated dampers to operate as specified. Testing agency shall check all controls for proper calibrations and list all controls requiring adjustment by control installers.
19. All diffusers, grilles and registers shall be adjusted for required air patterns and to minimize drafts.
20. As a part of the work of this contract, the air conditioning contractor shall make any changes in pulleys, belts and dampers or the addition of dampers required for correct balance as recommended by air balance agency, at no additional cost to Owner.

H. Water Balance Procedure (For Each Pumping System):

1. Set valves for maximum coil flow.
 2. Remove and clean all strainers.
 3. Examine water in system and determine if water has been treated and cleaned.
 4. Check expansion tanks to determine that they are properly charged and that the system is completely full of water. Bleed air from system.
 5. Air balance must be complete before water balance begins.
 6. Adjust pumps to design flow by use of differential pressure gage calibrated in feet of water.
 7. Adjust water flow through all equipment to design flow.
 8. Balance all coils for design flow and mark settings on flow controllers.
 9. After coils are balanced, recheck settings at all equipment and readjust if required.
 10. Record pressure drop through coils, and reset to design flow. Set pressure drop across bypass valve to match coil full flow pressure drop.
 11. Record the following at each coil:
 - a. Pressure drop across coil.
 - b. Pressure drop across bypass valve.
 12. Record pump suction and discharge pressures at operating condition and also with pump discharge valve completely closed.
 13. Record running amperage of pump motor at operating condition and also with pump discharge valve completely closed.
 14. Record water metering device readings.
- I. Additional Scope: Test, adjust and retest water bleed rates from evaporative coolers, make-up air units and cooling towers. Record all data.

END OF SECTION

SECTION 15870 WATER PIPE CLEANING AND TREATMENT

PART 1 - GENERAL

1.1 GENERAL MECHANICAL PROVISIONS

- A. The preceding General Mechanical Provisions shall form a part of this Section with the same force and effect as though repeated here.

1.2 SCOPE

- A. Included: Provide all labor, materials and services necessary to clean and flush the chilled/hot water system piping, and to provide water treatment as specified. The cleaning process shall not include any device with a plate and frame heat exchanger or any other device with similar small openings.

PART 2 - PRODUCTS (refer to Part 3)

PART 3 - EXECUTION

3.1 WATER CLEANING, FLUSHING AND TREATMENT

- A. General: All HVAC water piping systems shall be cleaned and treated as indicated below using a chemical compound for treatment.
 - 1. The piping system shall be checked for bacteria and corrosion deposit prior to cleaning. Disinfection may be required.
 - 2. The water in the closed loop system is treated by chemicals. If both old and new piping exists, clean the old piping first - then clean the new piping.
 - 3. Coordination:
 - a. Coordinate with Owner as to when the existing loops can be shut down for draining, cleaning and filling.
 - b. Coordinate with General Contractor and the controls sub-contractor regarding the extent of work required on their parts to complete the flushing and charging of the existing piping systems.
 - 3. Pre-approved chemical treatment suppliers:
 - a. San Joaquin Chemicals, Inc. - Fresno
 - b. High Value Engineering – Madera
 - c. Substitutions shall be approved as determined by the Engineer.
- B. Closed Loop Water Piping System Washdown, Flushing and Chemical Treatment:

1. All system flushing and testing shall be performed under the supervision of the chemical treatment supplier. Each step of the process shall be documented in writing and submitted to the engineer for review. The chemical treatment supplier shall be notified and be present for final pipe and strainer inspection before acceptance to proceed is given. The chemical supplier shall be responsible to document and provide an analysis report verifying the system has been cleaned and treated in accordance with the specifications. If the system has existing treatment present, the water treatment supplier shall verify compatibility of cleaning chemicals with existing treatment chemicals or treatment chemicals must be flushed from the system prior to commencement of the cleaning process.
2. Open system valves and clean the system with SANASOLV® 6103 (or equal) alkaline cleaner.
3. Add ten (10) gallons SANASOLV® 6103 (or equal) per each one thousand gallons contained water, recirculate through water loops for a minimum of 24 hours, dump and flush system. Flush until recirculating water is neutral to phenolphthalein and conductivity, pH, iron & copper levels are within 10% of make-up water levels, and there is no color or suspended matter present at which time coil strainers shall again be removed, cleaned and or replaced.
4. Immediately after flushing is completed, add SANACOR® 2301-A (or equal) inhibitor (non-metallic, no Mo, Zn or phosphate). Add ten (10) gallons per one thousand gallons contained water. Products proposed for systems inhibitors may be proprietary, therefore, these inhibitor formulas shall be submitted to the engineer with recommended active corrosion inhibitor limits and active antiscalant limits, for approval. This inhibitor must contain an anti-scalant/anti-foulant.
5. The inhibitor levels shall be tested each week for 6 weeks to assure the system is closed and treatment levels are not depleted. Twelve months thereafter, the chemical treatment supplier shall test inhibitor levels, and add chemical treatment as needed, to assure the system is closed and treatment levels are not depleted.

C. Microbiological Control:

1. Microbiological control shall be maintained using biocides which do not yield halogen containing disinfection by-products. Addition rates and frequency of addition shall be established to maintain 104 Colony Forming Units (CFU)/mL, or less, as measured by dip slides.
2. Biological testing shall be performed by qualified water treatment company representatives. Corrective actions shall be taken immediately to rectify any problems displayed by this test.

END OF SECTION

**SECTION 15890
DUCT CLEANING**

PART 1 - GENERAL

1.1 GENERAL CONDITIONS:

- A. The preceding General Mechanical Provisions shall form a part of this section with the same force and effect as though repeated here.

1.2 SCOPE:

- A. Provide all labor, materials, cleaning equipment and services necessary for duct cleaning and services as specified herein. The work includes, but is not necessarily limited to, the following:
 - 1. Clean all existing metal ductwork, grilles, registers and diffusers to remain.
 - 2. Replace all flexible ductwork.
 - 3. Inspect lined ductwork to determine if protective coating is required, and prepare written report. Submit 3 copies to Engineer.
 - 4. Provide temporary air filter(s) at supply air discharge of existing units.
 - 5. Protect building contents as required.
 - 6. Debris removed during cleaning shall be collected and properly disposed of off-site by Contractor. Disposal shall comply with all federal, state and local requirements.
 - 7. Duct cleanliness verification testing by independent agency.

1.3 CONTRACTOR QUALIFICATIONS:

- A. All duct cleaning shall be provided by a Contractor who is properly licensed by the State of California for this type of work (both C-61 and D-64) and is a member of the National Air Duct Cleaners Associates (NADCA). The Contractor shall have a minimum of four years experience in the duct cleaning business. The Contractor shall submit a list of at least five projects which are similar in size, scope and contract value to this project. This list shall include the Owner's contact person, phone number and contract value.

1.4 SUBMITTALS:

- A. Submittals shall include the following:
 - 1. Contractor Qualifications: Copies of current State of California license for this type of work and certification of NADCA membership shall be submitted.
 - 2. Description of proposed cleaning devices and methods for review.
 - 3. Manufacturer's data for all materials.
 - 4. Submit product information labels, material data safety sheets and any other relevant information upon request by Engineer and/or Owner.

5. Submit cleaning schedule for review by Engineer and Owner.

1.5 COORDINATION:

- A. Coordinate with Owner for access to the building during working hours, HVAC system downtime and for when Contractor will need to be in specific areas.
- B. Review the existing safety and fire evacuation procedures with the Owner. Coordinate any required disconnection of fire alarm or other fire safety devices with the Owner and fire authority. After each work period is finished and at the end of the project, all fire safety systems shall be reconnected and tested.
- C. Coordinate and make a survey of existing conditions with Owner prior to starting work. List items and submit 3 copies of list to Engineer.

PART 2 - PRODUCTS

2.1 STANDARDS:

- A. All cleaning equipment and materials shall be in accordance with NADCA Standard 1992-01, "Mechanical Cleaning of Non-Porous Air Conveyance System Components".

2.2 DUCTWORK MATERIALS AND ACCESSORIES:

- A. General: All ductwork materials shall have fire and smoke hazard ratings as tested under ASTM E-84 and UL 723 not exceeding a flame spread of 25 and smoke developed of 50. All ductwork materials shall comply with 2016 California Mechanical Code, Chapter 6 and SMACNA Duct Construction Standards.
- B. Flexible Ductwork: Insulated flexible ductwork. One pound per cubic foot glass fiber insulation, 1" thick where ductwork is within the building thermal insulation envelope, 1-1/2" thick where ductwork is outside the building thermal insulation envelope. Thermal conductivity shall not exceed 0.25 Btu-in/hr-ft²-°F at a mean temperature of 75F. Seamless vapor barrier jacket. Continuous internal liner bonded to galvanized steel wire helix. Duct shall be capable of continuous operation at 1-1/2" of water static pressure and 4,000 ft/min. air velocity. Duct shall comply with NFPA 90A. Genflex, JP Lamborn, Wiremold.
- C. Duct Access Door: Insulated double wall door. Full piano hinge. Cam latch. Pressure rating to match application. Air Balance.
- D. Duct Sealant: All Joints Exposed to Weather: Sealants shall be G.E. "Silglaze II" silicone without substitution. Joints Not Exposed to Weather (Except Spiral Wound and Greater than 2" Pressure Class): Fiber tape and liquid adhesive without substitution. Hardcast DT-5300 or DT-5400 tape and FTA-20 adhesive, United McGill Uni-Cast. Spiral Wound Joints Not Exposed to Weather and All Joints on Greater than 2" Pressure Class: Sealant shall be Eco-Duct Seal 44-60, or United Duct Sealer.
- E. Filters:
 1. General: Tested and rated in accordance with ASHRAE Standard 52-76 and SFM 12-71-1, Part 12, Title 24, C.C.R.
 2. Filter Media: Designed to fit 1" or 2" filter rack. Internal wire frame support and

heat-sealed construction. Upstream ply(s) shall be heavy weight single denier polyester, downstream ply shall be needed all-polyester with dual directional strength. Class 2. Anti-microbial treated with EPA registered anti-microbial system. Tri-Dek.

3. Air Handlers: 3-ply media. Particle efficiency 1-1.5 microns, 78%; 1.5-2 microns, 91%; 2-3 microns, 93%. Clean filter resistance 0.28" water at 400 fpm. Tri-Dek 15/40 with Aegis Anti-Microbial System.
4. All Other Equipment: 2-ply media. Particle efficiency 1-1.5 microns, 76%; 1.5-2 microns, 88%; 2-3 microns, 91%. Clean filter resistance 0.20" water at 400 fpm. Tri-Dek 3/67 with Aegis Anti-Microbial System.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. All duct cleaning shall be in accordance with NADCA Standard 1992-01, "Mechanical Cleaning of Non-Porous Air Conveyance System Components". Contractor shall maintain a copy of these standards at the site during construction.
- B. Electronic devices and flooring (carpeted or tiled) shall be protected during duct cleaning by covering with clean protective coverings. Plastic coverings used on electronic equipment shall be anti-static.
- C. Contractor shall employ measures designed to prevent cross-contamination within the HVAC system and the facility.
- D. Contractor shall take special care not to damage any components while making entry points and while cleaning fiberglass lined ductwork.
- E. Gasoline or petroleum powered compressors must be located outside the facility.

3.2 DUCTWORK AND ACCESSORIES INSTALLATION:

- A. General:
 1. Standards: Unless otherwise noted, all ductwork shall be constructed and installed in accordance with current SMACNA Standards. Ductwork shall be built to a pressure classification equal to or greater than the maximum operating pressure at that point in the ductwork. A copy of these standards shall be maintained at the job site at all times. Ductwork and accessories shall be installed in a manner to prevent vibration and rattling.
 2. Access: Provide duct access doors as required for inspecting, cleaning and vacuum testing of ductwork.
 3. Flexible Glass Fiber Ductwork: The use of flexible duct is limited to replacement of existing flexible duct. Hangers shall be 4" wide metal straps spaced to prevent sagging, 42" spacing maximum. Insert 6" wide fiberglass pad between duct and hanging strap. Joints shall be installed with stainless steel or nylon draw bands, Duro-Dyne Dyn-O-Tie. Minimum turn radius shall be in accordance with SMACNA Standards (turn radius of duct centerline not less than 1.5 times the duct diameter).

- B. Air Terminals and Duct Fittings: Unless otherwise noted, all air terminals and duct fittings shall be installed in accordance with current SMACNA Standards. Terminals and fittings shall be installed in a manner to prevent vibration and rattling.

3.3 TESTS AND ADJUSTMENTS:

- A. General: Unless otherwise directed, tests shall be witnessed by a representative of the Engineer and Owner. Work to be concealed shall not be enclosed until prescribed tests are made. Should any work be enclosed before such tests, the Contractor shall at his expense, uncover, test and repair all work to original conditions. Leaks and defects shown by tests shall be repaired and entire work retested.

3.4 CLEANLINESS VERIFICATION TESTING:

- A. Vacuum Test: Provide the services of an independent testing agency to perform Vacuum Test in accordance with NADCA Standard 1992-01, "Mechanical Cleaning of Non-Porous Air Conveyance System Components". The agency must prove that they have no affiliation with any equipment manufacturer, design engineer, contractor, or any other party which might lead to a conflict of interest, in order to provide an unbiased, third party system cleanliness test and report.

END OF SECTION

**FRESNO UNIFIED SCHOOL DISTRICT
BUILDING AUTOMATION SYSTEM (BAS)**

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The intent of this document is to describe a system that is complete in every respect without further cost to the Owner. Anything not shown on the drawings or indicated in the specifications, and required for complete operating systems, shall be included as part of this Work. This will also include all connections to new services.
- B. All parts of the plans and specifications fully apply when applicable to work of this Division. No attempt has been made to divide the work between the various trades or subcontractors.
- C. OPERATION: The entire Building Automation System (BAS) shall be comprised of a network of interoperable, stand-alone digital controls communicating on the Niagara AX open protocol communication network to a host computer communicating via the internet to the FUSD host computer. The BAS shall communicate to third party systems such as chillers, boilers, air handling systems, energy metering systems, other energy management systems, access control systems, fire-life safety systems and other building management related devices with open, interoperable communication capabilities.
- D. Work specified by others:
 - 1. HVAC Subcontractor:
 - a. Installation of automatic control dampers, smoke control dampers, and necessary blank off plates.
 - b. Access doors where required.
 - c. Installation of impression wells and pressure taps.
 - d. Installation of flow switches.
 - e. Installation of automatic control valves.
 - f. Installation of pressure taps and associated shut-off cocks. Pete's plugs shall be installed next to each temperature and pressure sensor.
 - 2. Electrical Subcontractor:
 - a. Electrical work shall, in general, comply with the following:
 - 1) Electrical work may include both line-voltage and low-voltage wiring, as required.
 - 2) All electrical work shall comply with the latest California Electrical Code and local electrical codes.

- 3) All safety devices shall be wired through both hand and auto positions of motor starting device to insure 100% safety shut-off.
- 4) All magnetic starters for mechanical equipment shall be furnished with integral 120V control transformers, sized to handle the additional VA needed for the controls - pilots, EP valves, etc. All motor starters to be NEMA rated; no IEC rated starters.
- 5) The motor starter supplier shall provide auxiliary contacts as required for interlock by BAS Contractor; the supplier shall estimate an allowance of at least one auxiliary contact per starter. All interlock and control wiring shown on the electrical prints is by the electrical subcontractor.

1.02 QUALITY ASSURANCE

A. Minimum Contractor Qualifications:

1. BAS Contractor; programs software and ensures network compatibility with all hardware as specified within, and the following requirements:
 - a. Hold a Niagara AX Framework Certification for at least two years, obtained from a Tridium certified training facility, no exceptions.
 - b. Shall have installed a minimum of three functioning networked systems.
 - c. Must provide a list of at least three projects of similar scope and cost, list to include:
 - 1) Project name / School District.
 - 2) Contact name and phone number.
2. Controls Contractor: Installs all hardware controls as specified within, and the following requirements:
 - a. A minimum of three installed and operational Building Automation Systems (BAS) with the Niagara AX Framework within the last five years.
 - b. A minimum of five years experience in servicing a networked BAS.
 - c. Must provide a list of at least three projects of similar scope and cost, list to include:
 - 1) Project name / School District.
 - 2) Contact name and phone number.

- ### B. Response Requirements:
- The BAS Contractor shall provide a 24-hour emergency response service with a dedicated telephone number. The BAS contractor shall guarantee a 2-hour maximum response time by a Niagara AX certified service technician. Fresno Unified reserves the right to obtain services and repairs from any BAS company when the 2-hour response time has been exceeded. The BAS contractor agrees by submittal of his/her bid to pay a late penalty to the District at a

rate of \$75 per every half-hour interval exceeding the 2-hour response limit. The District reserves the right to implement a late penalty on a call-by-call basis, depending on the nature of the emergency service call, at the District's discretion.

- C. Accountability: The District intends to document all service calls to ensure service provided has met the District's expectations as specified. Substandard service or conduct may result in the District certifying the Contractor as non-responsive and potentially eliminate the Contractor from bidding on future projects. During the warranty period, if the BAS is not fully functional and requires a service call, the District shall not be limited by any exclusivity arrangement between the BAS or Controls Contractor at any time.

1.03 CODES, STANDARDS, ORDINANCES AND REGULATIONS

- A. All work and materials shall be in full accordance with the latest rules and regulations of applicable codes as amended and adopted by any governmental agency which has jurisdiction over this work. Nothing in these Plans or Specifications is to be construed to permit work not conforming to these codes. Should the Plans or Specifications call for material, methods, or construction of a higher quality or standard than required by the above rules, the higher quality shall govern.
- B. When not contradicting the above, the manufacturers' recommendations along with applicable parts of the following documents shall be the basis for quality and technique of installation.
 - 1. Title 24, California Code of Regulations—California Administrative Code—Part 1.
 - 2. Applicable publications of the National Fire Protection Association (NFPA), and the National Electrical Code (NEC).
 - 3. Applicable publications of the American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE).

1.04 SITE CONDITIONS AND LOCATIONS

- A. The general location and arrangement of system hardware is shown on the drawings. Information on the drawings relative to existing services is approximate only. Minor adjustments required to conform to actual locations shall be made without additional cost to Owner. The Controls Contractor shall, as work progresses, verify the dimensions of the spaces available for the installation of the work and he shall assume full responsibility for the proper locations of each portion thereof.
- B. The construction documents are generally diagrammatic and the locations indicated may be approximate only. They do not show every offset, bend, or elbow required for installation in the space provided. The Controls Contractor, therefore, shall install all equipment, conduit runs and the like as follows:
 - 1. Adhere to the location indicated as near as possible.

2. Maintain ample head room and access in all passageways, clearance around all equipment and under conduit runs for unrestricted passage and for easy servicing of all apparatus, equipment, devices and the like.
3. Provide access for maintenance of all equipment.

1.05 SUBMITTALS

- A. Control Submittal: Within 30 calendar days after award of the contract, and before any materials of this Section are delivered to the job site, submit:
 1. The BAS Contractor shall submit description of operation and schematic drawings of the System to the Architect/Engineer for approval before starting work on-site. At least eight sets of submittals shall be sent through channels.
 2. Product data submittals must be complete and in a single bound document for all items supplied in this Division. Each document shall be bound with an index and marked with the equipment identification as specified in the Plans and Specifications.
 3. Provide complete control shop drawing including equipment, control devices, point to point connections with terminal numbers, and any details necessary for a complete control drawing.
 4. List of name plates to be engraved, showing each name plate wording and location.

1.06 REMOVAL AND SALVAGE

- A. Pre-Demolition conference: Contractor shall schedule a walk-through meeting with Energy Management Department to conduct an inventory on items to be removed and salvaged from the existing building under construction.
- B. Inventory List: The Contractor shall complete and submit an inventory list of items that have been removed and salvaged to the Energy Management Department and store items in a cool dry and protected area.
- C. Delivery: Delivery of the salvaged items shall be determined by the Energy Management Department and the Contractor.
- D. Remove and Reinstall: Detach items from existing location and store them for reinstallation in a strategic area of operation to be determined.
 1. Identify areas of occupancy to remain in-use and functional.
 2. If existing BAS is required to be removed, relocated, or abandoned, before proceeding with the demolition provide temporary power and communication that bypasses the area of demolition and that maintains the continuity of the BAS to other occupied parts of the site or building construction.

- E. Schedule of Demolition Activities: Indicate the following:
1. Detailed sequence of demolition and removal work, with starting and ending dates for each activity. Ensure on-site operations of the occupied areas of the BAS are not interrupted.
 2. If there is to be an interruption in the operation of the existing BAS, Contractor shall notify Architect & District Project Manager and indicate how long the services will be interrupted in writing.

1.07 CLOSE-OUT DOCUMENTS

- A. Record Documents:
1. At completion of project, BAS Contractor shall provide to the Architect/Engineer all As-Built drawings, communications and controller map, wiring diagrams, equipment specifications, Operations and Maintenance Manuals and other documentation as required to describe the system. At least four sets of operations and maintenance manuals with "as-built" drawings, parts lists, etc. shall be provided at job completion.
 - a. Hard copies shall be stamped with "Record Drawings".
 - b. Provide all Record Documents on a CD; including pdf files and CAD files using AutoCAD 2008 or latest version.
 2. During progress of the work, maintain an accurate record of all changes made in the systems from those shown on the drawings, specifications and submittals.
 3. Revise Shop Drawings and provide on reproducible media and in DWG format compatible Windows operating systems and Autocad 2008 or latest version.
- B. Communications and Controller Map: To include the following;
1. A detailed communication routing map showing entering and exiting locations
 2. A detailed list of controller locations by room number and location.
 3. Permanently attach the communication routing map and controller locations inside the NAC control panel.
- C. Operations and Maintenance Manuals: Upon completion of the work, a complete bound book containing the following information shall be submitted to the Architect/Engineer:
1. Complete catalog and performance data on all control devices, including all documents included in submittals.
 2. Complete manufacturers' operating and maintenance instructions on all control devices.
 3. Complete wiring and control diagrams for all equipment and systems, including list of materials, description of operation and system flow diagrams.

4. Manufacturers' warranty certificates on all equipment.
5. Contractor's warrantee letter.

1.08 GUARANTEE

- A. The Contractor shall warrantee in writing all work performed under this contract for a period of two years from the date of notice of completion.
- B. When notified of a system failure relating to the work performed under this contract, the Contractor will be responsible for all investigation, diagnoses, repair, revision or replacement necessary to correct the condition.

PART 2 - PRODUCTS

2.01 GENERAL PRODUCT DESCRIPTION

- A. The Building Automation System (BAS) shall be capable of integrating multiple building functions, including equipment supervision and control, alarm management, energy management, and trend data collection. System shall be Johnson Controls FX-60/70 Web based front end with Johnson Controls devices and controllers. BACnet, N2 must reside in controller and Open licensing shall be included in each FX60/70 device. Programming of the FX-60/70 and creating all required dynamic graphics shall be included in this section.
- B. The BAS shall consist of the following:
 1. Local Display Devices – PC Touchscreen.
 2. Portable Operator Terminals – Laptop with required software installed.
 3. Distributed User Interfaces.
 4. Network processing, data storage and communications equipment.
 5. DC Controllers (HVAC etc).
 6. Other components required for a complete and working BAS.
- C. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, ASCs, and operator devices. Controllers shall be provided a 10% spare point capacity for all necessary applications.
- D. System architectural design shall eliminate dependence upon any single device for alarm generation and control execution. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

E. Acceptable Systems:

1. Facility Explorer by Johnson Controls is the District Standard using the BACnet MSTP protocol to integrate into the District's existing server (JCI).
2. No substitutions allowed.

2.02 CONDUIT AND WIRING

A. Control Contractor shall provide and install all low voltage conduit and wiring for DDC system as required for a complete and operating system. Conduit and wiring shall conform to Division 16 requirements.

B. Wiring:

1. BACnet communications cable shall be Connect Air: W223C-2144FCBJC 22-3C (Blue Jacketed). Install per manufacturer's recommendations. No splices, Tee's, or cuts of any kind will be allowed. Identify both ends at terminal blocks, field devices, and sensors. All wiring that is routed below grade shall be W221P-1003PE (Outdoor Polyethylene BACnet-Black).
 - a. Communication Loop and sensors must be run in separate conduits and junction boxes.
 - b. The outside air sensor must be brought into the NAC I/O at all times. An outside air sensor brought into a controller is not acceptable.
2. Sensor wire shall be: Connectair Part # W181P-2040PRB 18-2 (Purple).
3. Analog Output shall be: W184C2059PINK 18-4 (Pink).
4. Thermostat wire shall be Connect Air: W224C-2020WHT 22-4C (White Jacketed).
5. Cable routed in accessible ceiling spaces shall comply with EIA/TIA standards for communications cabling. Communication bus wire shall be W223C-2144FCBJC 22 3C (Blue Jacketed) Connect Air, blue jacketed shielded cable.

C. Conduit: Conduit shall be minimum 1 inch diameter except that minimum conduit size for 120 volt power shall be 3/4-inch. For underground conduit, provide 100% spare capacity by installing a second conduit (empty) along all conduit routes. All conduits shall be sized as follows: Size per the CEC (NEC with California Amendments) and then oversize by one size. All conduits shall be RGSC (Rigid galvanized steel conduit) only. All fittings shall be steel/not malleable or aluminum.

2.03 BAS ARCHITECTURE

A. Automation Network

1. The automation network shall be configured as a Client/Server network with a web server operating on the Clients LAN/WAN. The web browser interface is

extended over the LAN/WAN. Monitoring and control of the BAS is available using the web browser interface.

2. The automation network shall include the option of a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards shall be standard "off the shelf" products available through normal PC vendor channels.
3. The BAS shall network multiple user interface clients, system controllers and systems supervisors(s) as required for systems operation.
4. The automation network option shall be capable of operating at a communication speed of at least 100 Mbps or more.
5. The automation network option will be compatible with other enterprise-wide networks. Where indicated, the automation network shall be connected to the enterprise network and share resources with it by way of standard networking devices and practices.

B. Control Network:

1. Control networks shall provide either "Peer-to-Peer," Master-Slave, or Supervised Token Passing communications, and shall operate at a minimum communication speed of 9600 to 76,800baud.
2. Digital Controllers shall reside on the control network via either BACnet MSTP or Zigbee wireless Smart Mesh.

C. Integration:

1. Hardwired
 - a. Analog and digital signal values shall be passed from one system to another via hardwired connections.
 - b. There will be one separate physical point on each system for each point to be integrated between the systems.
2. Direct Protocol (Integrator Panel)
 - a. The BAS system shall include appropriate hardware equipment and software to allow bi-directional data communications between the BAS system and 3rd party manufacturers' control panels. The BAS shall receive, react to, and return information from multiple building systems, including but not limited to the chillers, boilers, variable frequency drives, and power monitoring system.
 - b. All data required by the application shall be mapped into the BAS system, and shall be transparent to the operator.
 - c. Point inputs and outputs from the controllers shall have real-time interoperability with BAS software features such as: Control Software, Energy Management, Custom Process Programming, Alarm Management, Historical Data and Trend Analysis, Totalization, and Local Area Network Communications.

2.04 USER INTERFACE

A. Browser Based Interface

1. The system shall be capable of supporting an unlimited number of clients using standard Web browser such as Internet Explorer™, Google Chrome and Mozilla Firefox. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable.
2. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the Building Automation System (BAS), shall not be acceptable.
3. The Web browser client shall support at a minimum, the following functions:
 - a. User log-on identification and password shall be required. If an unauthorized user attempts access, notice of access failure shall be displayed. Security using authentication and encryption techniques to prevent unauthorized access shall be implemented.
 - b. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
 - c. Storage of the graphical screens shall be in the Network Area Controller (NAC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
 - d. Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page.
 - e. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
 - 1) Modify common application objects, such as schedules and setpoints in a graphical manner.
 - 2) Commands binary objects to start and stop.
 - 3) View logs and charts.
 - 4) View alarms.
 - f. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

4. Alarms

- a. Alarm feature shall allow user configuration of criteria to create, route, and manage alarms and events. It shall be possible for specific alarms from specific points to be routed to specific alarm recipients. The alarm management portion of the user interface shall, at the minimum, provide the following functions:
 - 1) Allow configuration to generate alarms on any numeric, binary, or data point in the system.
 - 2) Generate alarm records that contain a minimum of a timestamp, original state, acknowledged state, alarm class and priority.
 - 3) Allow the establishment of alarm classes that provide the routing of alarms with similar characteristics to common recipients.
 - 4) Allow a user, with the appropriate security level, to manage alarms - including sorting, acknowledging, and tagging alarms.

5. Reports and Summaries

- a. Reports and Summaries shall be generated and directed to the user interface displays, with subsequent assignment to printers, or disk. As a minimum, the system shall provide the following reports:
 - 1) All points in the BAS
 - 2) All points in each BAS application
 - 3) All points in a specific controller
 - 4) All points in a user-defined group of points
 - 5) All points currently in alarm
 - 6) All BAS schedules
 - 7) All user defined and adjustable variables, schedules, interlocks and the like.
- b. Reports shall be exportable to .pdf, .txt, or .csv formats.
- c. The system shall allow for the creation of custom reports and queries.

6. Schedules

- a. A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided:
 - 1) Regular schedules
 - 2) Repeating schedules
 - 3) Exception schedules
- b. Weekly schedules shall be provided for each group of equipment with a specific time use schedule.

- c. It shall be possible to define one or more exception schedules for each schedule including references to calendars.
- d. Monthly calendars shall be provided that allow for simplified scheduling of holidays and special days. Holidays and special days shall be user-selected with the pointing device or keyboard.

7. Password

- a. Multiple-level password access protection shall be provided to allow the user/manager to user interface control, display, and database manipulation capabilities deemed appropriate for each user, Based on an assigned password.
- b. Each user shall have the following: a user name, a password, and access levels.
- c. The system shall provide the capability to require a password of minimum length and require a combination of characters and numerical or special characters.
- d. When entering or editing passwords, the system shall not echo the actual characters for display on the monitor.
- e. The system shall provide unlimited flexibility with access rights. A minimum of four levels of access shall be provided along with the ability to customize the system to provide additional levels.
- f. A minimum of 100 unique passwords shall be supported.
- g. Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items defined for the access level of the password used to log-on.
- h. The system shall automatically generate a report of log-on/log-off and system activity for each user.
- i. All log data shall be available in .pdf, .txt, and .csv formats.

8. Historical Data Collection

- a. All numeric, binary or data points in the system database shall allow their values to be logged over time (trend log). Each historical record shall include the point's name, a time stamp including time zone, and the point's value.
- b. The Network Area Controller (NAC) shall have the ability to store its historical data records locally and periodically to a remote server on the network (archiving).
- c. The configuration of the historical data collection shall allow for recording data based on change of value or on a user-defined time interval.

- d. The configuration of the historical data collection shall allow for the collection process to stop or rollover when capacity has been reached.
 - e. A historical data viewing utility shall be provided with access to all history records. This utility shall allow historical data to be viewed in a table or chart format.
 - f. The history data table view shall allow the user to hide/show columns and to filter data based on time and date. The history data table shall allow exporting to .txt, .csv, or .pdf file formats.
 - g. The historical data chart view shall allow different point histories to be displayed simultaneously, and also provide panning and zooming capabilities.
9. Audit Log
- a. For each log entry, provide the following data:
 - 1) Time and date.
 - 2) User ID
 - 3) Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.
10. Database Backup and Storage
- a. The user shall have the ability to backup the System Controller databases.
11. Graphical User Interface Panel (**NIC**)
- a. On Site GUI - System shall also include a touchscreen PC or District approved equal. GUI shall include the following features.
 - b. Kiosk mode – Powers up directly to the Niagara AX Station serving PX pages.
 - c. USB backup/restore/upgrades
 - d. Touch alarm console
 - e. Touch platform management
 - f. kitTouch – specialized widgets for touch applications
 - g. Licensed for Niagara Network, Modbus TCP Slave, BACnet / MSTP.
 - h. Touchscreen shall be no smaller than 15", have a minimum native resolution of 1024 x 768 and shall be installed inside a panel. Panel shall be UL listed as a complete package located next to the NAC.
 - i. Mount the touch panel PC in NEMA 12 enclosure. Ventilate this enclosure with a low filtered ventilation inlet on one side and a high exhaust fan on the opposite side.

2.05 AUTOMATION NETWORK

A. Network Server **(NIC)**

1. F.U.S.D. District AX server is existing, BAS Contractor shall have the responsibility of bringing the firmware to current revisions. Any structures on the site with existing BAS that require this to match shall also be included in this project.
2. It shall be possible to provide access to all Network Area Controllers via a single connection to the server. In this configuration, each Network Area Controller can be accessed from the Graphical User Interface (GUI) or from a standard Web browser (WBI) by connecting to the server.
 - a. Distributed Control: The server shall provide the ability to execute global control strategies based on control and data objects in any NAC in the network, local or remote.
 - b. The server shall provide scheduling for all Network Area Controllers and their underlying field control devices.
 - c. The server shall implement the BACnet Command Prioritization scheme (16 levels) for safe and effective contention resolution of all commands issued to Network Area Controllers. Systems not employing this prioritization shall not be accepted.
 - d. Each Network Area Controller supported by the server shall have the ability to archive its log data, alarm data and database to the server, automatically. Archiving options shall be user-defined including archive time and archive frequency.
 - e. The server provides central alarm management for all Network Area Controllers supported by the server. Alarm management shall include:
 - 1) Routing of alarms to display, printer, email and email compatible pagers
 - 2) View and acknowledge of alarms
 - 3) Query alarm logs based on user-defined parameters
 - f. The server shall provide central management of log data for all Network Area Controllers supported by the server. Log data shall include process logs, runtime and event counter logs, audit logs and error logs.

B. Network Area Controller (NAC) or JACE

1. The NAC must provide the following hardware features as a minimum:
 - a. Communications
 - 1) One 10/100 Mb Ethernet Port – RJ-45 connection
 - 2) Digital controllers that are hardwired shall reside on the BACnet MSTP control network.

- 3) Wireless Digital Controllers shall also reside on the control network via either BACnet MSTP, Zigbee wireless Smart Mesh.
 - 4) Two RS-485 ports (up to 57,600 baud) shall be standard. Gateways or non-Johnson drivers not allowed.
 - 5) All required protocol drivers are included. BACnet, Modbus and N2 shall be resident as standard without additional costs, additional hardware External gateways shall not be acceptable.
 - 6) System shall also be capable of a Zigbee self-healing wireless mesh network. Antenna and driver shall reside in NAC controller as standard.
- b. Inputs/Outputs
- 1) Four form C SPDT relay outputs rated for 24 VAC/DC @ 2Amps resistive each with individual LED indicators
 - 2) Six Universal Inputs for 10K NYC, 4-20 mA, 1-10 V, Dry contact
 - 3) Additional I/O modules shall be allowed if needed
- c. Battery Backup
- 1) Battery backup provided for all on board functions including I/O
 - 2) Battery is monitored and trickle charged
 - 3) Battery maintains processor operation through power failures for a pre-determined interval, and then writes all data to flash memory, shuts the processor down, and maintains the clock for five years.
- d. Environment
- 1) Must be capable of operation over a temperature range of 0°F to 122°F.
 - 2) Must be capable of withstanding storage temperatures of between 0°F and 150°F.
 - 3) Must be capable of operation over a humidity range of 5% to 95% RH, non-condensing.
- e. Performance
- 1) FX20 supports up to 15 devices per Supervisory controller
 - 2) FX60 supports up to 50 devices per Supervisory controller
 - 3) FX70 supports up to 100 devices per Supervisory controller
2. The Network Area Controller (NAC) shall be a fully user-programmable device capable of providing all of the capability described in Section 2.3 Part A.

3. Automation network – The Network Area Controller (NAC) shall reside on the automation network. Each NAC shall support one or more sub-networks of controllers.
 4. User Interface – Each Network Area Controller (NAC) shall have the ability to deliver a web based user interface as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.
 5. Power Failure – In the event of the loss of normal power, The Network Area Controller (NAC) shall continue to operate for a defined period after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software. Flash memory shall be incorporated for all critical controller configuration data.
 - a. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.
 - b. Certification – All controllers shall be listed by Underwriters Laboratories (UL).
- C. Application Specific Controllers (ACS's)
1. The ASC devices must provide the following hardware features as a minimum:
 - a. Communications:
 - 1) Zigbee Wireless Mesh by Johnson controls Model# FX-ZFR1810, shall be installed where specified and shown on portable classroom installations.
 - 2) Wireless Repeaters; Johnson Model#FX-ZFR1811 to be used in area as needed.
 - b. Environment:
 - 1) Must be capable of operation over a temperature range of 0°F to 122°F.
 - 2) Must be capable of withstanding storage temperatures of between 0°F and 158°F.
 - 3) Must be capable of operation over a humidity range of 5% to 95% RH, non-condensing.

2.06 SOFTWARE PROGRAMMING/TOOLS

A. Network Area Controller Toolset

1. Device embedded toolset shall provide the following capabilities in a graphical environment using a standard Web browser:
 - a. Device and point management

- b. Scheduling, alarming and trending setup
 - c. Creation and binding of graphics
 - d. Time management
 - e. User management
 - 2. Toolset provides additional engineering capabilities including:
 - a. Editable table based point listings.
 - b. Automatically generated graphics for standard applications.
- B. Device Program Editor
- 1. Definition of application and logic and display operation shall be available in a completely graphic environment.
 - 2. Definition of operator device characteristics, Digital Controllers (DC) panels, individual points, applications, and control sequences shall be performed in a drag and drop programming environment.
 - 3. All temperature and equipment control strategies, energy management routines, scheduled operations and local device status indicators shall be definable by the operator. User password access and language options shall be definable by the operator.
 - 4. Event definition, prioritization, logging and reporting options are definable by the operator.
 - 5. Application logic shall provide for stand-alone applications as well as distributed applications that are automatically downloaded from master controllers to a network of controllers.
 - 6. The programming environment shall provide help menus and instructions for each operation and/or application performed, for all programming library functions, and for the programming language itself.
 - 7. Libraries of standard application modules shall be provided, such as temperature, humidity, and flow control. These modules may be used as "building blocks" in defining or creating new control sequences. In addition, the user shall have the capability to easily create and archive new modules and control sequences.

2.07 LOCAL CONTROL PANELS

- A. All control panels shall be factory constructed, incorporating the BAS manufacturer's standard designs and layouts. All control components shall be UL inspected and listed. Control panels shall be fully enclosed, with sub-panel, hinged door, and slotted flush latch. Control panels shall exist on all equipment specified and shall be UL listed as a complete fabricated system. UL listings shall be shown on final drawings.

- B. In general, the control panels shall consist of the DDC controller(s), display module as specified and indicated on the plans, and I/O devices—such as relays, transducers, and so forth—that are not required to be located external to the control panel due to function. Where specified the display module shall be flush mounted in the panel face unless otherwise noted.
- C. All I/O connections on the DDC controller shall be provide via removable or fixed screw terminals.
- D. Low and line voltage wiring shall be segregated. All provided terminal strips and wiring shall be UL listed, 300-volt service and provide adequate clearance for field wiring.
- E. All wiring shall be neatly installed in plastic trays or tie-wrapped.
- F. A convenience 120 VAC duplex receptacle shall be provided in each enclosure, fused on/off power switch, and required transformers.

PART 3 – EXECUTION

3.01 PREPARATIONS

- A. Prior to Installation: Inspect the installed work executed under other Sections which affect the installation of the controls. Report unacceptable conditions to the Engineer. Do not begin work until unacceptable conditions have been corrected. Installation of the controls shall constitute acceptance of existing conditions.
- B. Coordination: Coordinate work with work specified under other Sections to ensure proper and adequate interface of work. Equipment and systems drawings are generally diagrammatic unless dimensions are indicated. Drawings and details shall be checked for interference's with structural and other conditions prior to performing work.
- C. The Contractor shall be responsible for safety and good condition of his materials and equipment until final acceptance by the Owner. He shall erect and maintain suitable barriers, protective devices, lights and warning signs where required.

3.02 INSTALLATION

- A. General:
 - 1. When applicable installation procedures are shown or specified in other sections, those procedures shall be followed.
 - 2. Provide all supports and hangers, etc., as required to install the equipment as specified or shown on the drawings. All equipment shall be supported, braced and cross-braced to comply with current CBC and CMC.
 - 3. Sealing: Wherever any part of the control system has to pierce the roofing, openings through the roof shall be flashed absolutely watertight.

4. Arrange and support piping and equipment so that vibration is at a minimum and is not transmitted to or through building structure.

3.03 CONDUIT AND WIRING

- A. Control wiring and conduit shall be the responsibility of this section and be installed as follows:
 1. In equipment rooms/attics – Conductors shall be run in conduit. Final connection to equipment shall be flexible conduit.
 2. Concealed in new building construction (wall/inaccessible ceilings) - Conductors shall be run in conduit.
 3. Roof mounted/exterior equipment yards - Conductors shall be in conduit. All flexible conduit shall be seal-tite with weatherproof connections. Equipment on grade and detached from the building a distance greater than 36" shall have underground control conduit routed to equipment.
 4. Above accessible ceiling spaces - Control cable will be allowed to be installed without conduit in accessible areas above ceilings as follows:
 - a. Plenum rated cable is an approved type for the application.
 - b. Cable is bundled/organized in management devices routed square with building lines (no diagonals) and kept clear of electrical devices (i.e., ballasts, transformers, etc.) that could cause interference.
 - c. Conduit sleeves are provided between accessible ceiling spaces (i.e., across soffits, gypboard ceilings, etc.) as required to maintain future access to cable.

3.04 CONTROL PANELS AND DEVICE LOCATIONS

- A. All controllers, relays, switches, etc., for equipment located within equipment rooms shall be mounted in enclosed UL listed control panels with hinged locking doors. All control devices equipment located in exposed areas subject to outside weather conditions shall be mounted inside weatherproof enclosures.
- B. Location of each panel is to be convenient for adjustment and service. Submit locations of all panels to the engineer with shop drawings.

3.05 IDENTIFICATION

- A. The label wording shall match that used on the drawings and provide clearly readable printed labels for each control component inside a panel. When applicable, additional identification needed shall be documented on the Shop Drawings.
- B. Engraved nameplates shall be provided on the face of each panel and beneath each actuator and control device not in a panel describing its use.

- C. All electrical devices within the panel shall be wired to a terminal strip within the panel. An "electric terminal" numbering system shall be applied to all terminals with aforementioned numbers matching terminals shown on Shop Drawings.

3.06 CLOSING-IN OF UNINSPECTED WORK

- A. General: Do not allow or cause any of the Work of this Section to be covered up or enclosed until it has been inspected, tested, and approved by the Mechanical Engineer and by all other authorities having jurisdiction.
- B. Uncovering: Should any of the Work of this Section be covered up or enclosed before it has been completely inspected, tested, or approved, do all things necessary to uncover all such work. After the Work has been completely inspected, tested, and approved, provide all materials and labor necessary and make all repairs necessary to restore the Work to its original and proper condition at no additional cost to the Owner.

3.07 PROGRAMMING

- A. The Direct Digital Control (DDC) operational program will be provided by the BAS Contractor. The Contractor shall provide any testing program he feels necessary to fully test the operation of the various components.

3.08 SYSTEM INSTRUCTION AND RECORD DRAWINGS

- A. The BAS Contractor shall schedule a minimum of 40 hours of training to train the District's Energy Management Department in the use and care of the system. This training shall occur after all commissioning of the control system is completed.
- B. Instruction period shall be started after instruction books, service manuals and record drawings have been submitted to and approved by the Architect/Engineer and shall be at hours (regular and non-regular) arranged by the Architect/Engineer.
- C. Service manuals shall include oiling, cleaning and servicing data, compiled in clearly and easily understood form and in a durable binder. Data shall show all serial numbers of every piece of equipment and complete list of replacement parts.

3.09 TESTING AND ACCEPTANCE

- A. The commissioning period starts when the following conditions are met:
 - 1. The BAS system and all involved HVAC equipment have been installed, connected to the EMS system and ready to operate.
 - 2. A commissioning meeting has been conducted with representatives of contractors involved, Fresno Unified School District Energy Management Department Technician & HVAC Supervisor/Mechanic, General Contractor, Mechanical Contractor, and the Control System Contractor.

3. Consensus is reached, by the representatives at the above referenced meeting that it is appropriate for the commissioning process to start. The operational program shall be loaded into the DDC system by the Control Systems Contractor.
- B. During the commissioning period, the Control System Contractor will maintain a commissioning file of the printed reports from the building. The District shall verify all commissioning tests.
- C. During the commissioning period all mechanical equipment with filters shall have new filters installed. The static pressure across the fan shall be accurately measured and documented if installed. System balance, if required, shall have been completed.
- D. The Contractor shall furnish a complete and operating system. The Contractor shall also verify, in the presence of the District, the system accuracy and proper function of each controlled device and sensor. The following items shall be successfully demonstrated prior to acceptance by the District:
 1. All system outputs, including controllers, relays and other control devices, shall be addressed and start/stop functions demonstrated.
 2. All inputs shall be displayed and all event-initiated functions shall be demonstrated.
 3. Demonstrate program integrity and power restore sequence during and after a power failure and restoration.
 4. Deliver all As-Built drawings, wiring diagrams, equipment specifications, As-Built communications routing map, Operation and Maintenance Manuals and other documentation as required to describe the system.
 5. A wiring schematic shall be permanently attached to the inside door panel of each control device.
 6. A detailed As-Built communications wiring loop routing map shall be permanently attached to the front end door panel and a copy shall be provided to the Maintenance Department.
 7. Complete operator training in the use, programming and operation of the system.
 8. The system will not be considered complete until all system graphics are operational and accurate.

3.10 COMMISSIONING THE SYSTEM

- A. The District reserves the right to employ a third party commissioner at the District's expense.
- B. During the commissioning period all mechanical equipment with filters shall have new filters installed. The static pressure across the fan shall be accurately measured and documented if installed.

- C. The commissioning process will be completed and the training process shall start when the following conditions are met:
 - 1. No "alarm" or "condition reports" are being generated by the DDC system for seven (7) calendar days (168 hours) due to incomplete or inaccurate installation, program, or programming.
 - 2. All adjustments and "fine tuning" of the system shall also be included in the training process.
 - 3. The system has been approved by the General Contractor, and accepted by the Mechanical Engineer and District.
- D. The Training Process: Shall consist of the following:
 - 1. System use, operation and field trouble shooting to be provided to the District's Energy Management Department's personnel. Training must be a total of 40 hours of hands on, as well as phone support when needed. The 40 hour training can be used in any time allotment agreed upon by the Controls Contractor and the District EMS Control Center until hours are depleted.
 - 2. The District reserves the right to stop the clock at any time during the training process if there has been a discovery that impedes the complete full and and accurate operation of the BAS installed. This includes the software programming, hardware components, sensors, or mechanical equipment and issues therein until they have been resolved.

END OF SECTION

SECTION 15980
BUILDING AUTOMATION SYSTEM (BAS)
SUPPLEMENTAL REQUIREMENTS
(based on FUSD BAS Rev 12-19-13)

PART 1 - GENERAL

1.1 GENERAL MECHANICAL PROVISIONS

- A. The preceding General Mechanical Provisions shall form a part of this Section with the same force and effect as though repeated here.

1.2 SCOPE

- A. General: This section adds supplemental requirements to Section 15975.
- B. Wireless Communications: Wireless communication shall not be used unless specifically noted.

PART 2 - PRODUCTS

2.1 MISCELLANEOUS DEVICES

- A. Thermostats: Concealed, adjustable, dual setpoints with fan AUTO-ON and AUTO-OFF function selectors. Locking cover with temperature indicator. Honeywell PRO 5000 Model# TH5220D1003. Wall-mounted thermostat shall be mounted with top of thermostat at 48" maximum above finish floor. (Applicable where HC units not controlled by DDC).
- B. Outside Air Temperature Sensor: Provide one ACI/34-Outside per NAC. Install on north wall of buildings with NAC. Mount 3 feet below overhang, typical, unless directed otherwise by district. Specific locations shall be as directed by District.
- C. Photocell: Wattstopper EM-24 A 2. Combine with outside air temperature sensor.
- D. Status Sensor: Current sensing status sensor with sensitivity adjustment, Siebe E112-800, Functional Devices RIBXGTA or RIBXKTA. Current sensor must be installed on the load side of the magnetic starter.
- E. Duct Smoke Detectors: Photoelectric type, 115 VAC. A visual indication of alarm and power shall be provided on detector front. Manual test and reset switch on the front of the detector. Minimum of two sets of alarm contacts. UL listed. California State Fire Marshal listed. Air Products and Controls, SM-501 Series.
- F. Control Valves:
 - 1. General: Control valves and valve piping shall be sized at 6 ft./second or less. Submit all valve sizes and Cv selections. Equal percentage or linear flow characteristics. Unless otherwise noted, select for 2-4 PSI pressure drop across the valve at the specified flow. 2-inch and smaller: Screwed connections, globe or ball valve. 2-1/2-inch and larger: Flanged connections, globe or butterfly valve.
 - 2. Ball Valve: Chromium plated bronze ball, bronze stem, replaceable teflon seat and O-rings. 400 psi WOG. Packing shall be reinforced teflon seal washer and stuffing box ring. Stem packing gland screw shall be adjustable for wear. Factory flow characterizing disk. Johnson Controls VG1000 series only.

3. Globe Valve: Contoured plugs for linear control. 316 stainless steel stem, replaceable seat and adjustable operating range. Packing shall be molded BUNA-N. Valves controlling terminal units or above ceilings shall be of the packless type with bellow seal, or spring loaded teflon requiring no packing maintenance. 2-inch and smaller: Bronze body, 250 psi WOG. 35 psi maximum working pressure differential. 2-1/2 inch and larger: Cast iron body, 125 psi WOG. 25 psi maximum working pressure differential. Belimo.
 4. Butterfly Valve: Cast iron body, full lug style (with lugs drilled and tapped for isolation and removal of downstream piping), one-piece 416 stainless steel stem, aluminum bronze disc and EPDM or BUNA-N seat to match application. 175 psi WOG. Packing shall be molded BUNA-N. Belimo.
- G. Electric Actuators:
1. General: Fully modulating, unless otherwise noted. UL listed. Visual position indicator, manual override, spring return. ZS-BFV weather guard where exposed to weather. Belimo.
 2. Valve Actuators: Provide with factory mounting brackets and linkage to the control valve. Capable of shutting off against a 50 psi differential.
 3. Damper Actuators: Actuators shall be direct-mounted onto the damper control shaft without linkage. Damper actuators shall be sized to provide a minimum of 5 inch pounds of torque per square foot of damper face area.
- H. Controls Transformers: 120VAC/24VAC, 50VA with white common wire. UL listed Split Bobbin transformers.
- I. Relays: General purpose relays shall be IDEC RH2B-UL with SH2B-05 base. Motor rated relays (PRD) shall be Functional Devices RIB.
- J. Circuit Breaker: Enclosures receiving 120 volt power shall have a combination circuit breaker/dual receptacle. Functional Devices PSPT2RB4. Enclosures receiving 60 volt (or less) power shall have a circuit breaker, IDEC NRAS 1100.
- K. Enclosures:
1. General: UL508A approved as a fabricated panel assembly. A hinged, lockable front panel shall be used. Provide hasp where padlocks are required. The front of the panel shall be identified with an engraved plastic label with 1/4" high lettering, white on black background. Coordinate label names with District. No conduit or other penetration of any kind shall be made on top of any enclosure. If any such entry is made, a plug will not be acceptable, replace the enclosure. All panels shall incorporate Panduit H100X034F1T-B heat shrink markers at both ends of all internal wires and both ends of all field wires. Apply the labels adjacent to the terminal connections.
 2. Pull can for wires only (no relays): Hoffman. For indoor location - NEMA 1 with National cam lock C8051, bright nickel finish, keyed for C346A. For outdoor location - NEMA 3R with Master padlock, keyed for P605.
 3. For field control devices, unless otherwise noted: Hoffman A 242406LP (minimum size-larger if required) with full size metal back panel. For indoor location - NEMA 1 with National cam lock C8051, bright nickel finish, keyed for C346A. For outdoor location - NEMA 3R with Master padlock, keyed for P605. Panel shall be a UL508A fabricated panel.

- 4. For supervisory control panel: Hoffman A 363608LP (minimum size-larger if required) with full size metal back panel. For indoor location – NEMA 12 with National cam lock C8051, bright nickel finish, keyed for C346A. For outdoor location - NEMA 3R with Master padlock, keyed for P605. Panel shall be a UL508A fabricated panel.
- L. Conduit: All conduit shall be rigid galvanized or EMT – refer to paragraph 3.2, B. Conduit shall be minimum 1 inch diameter for communication cable. For underground conduit, provide 100% spare capacity by installing a second conduit (empty) along all conduit routes. All fittings and boxes shall be steel - not malleable, aluminum or plastic.
- M. Labels and Signs: All labels, signs, etc., shall be engraved, laminated plastic, white on black background, 1/8-inch high lettering, minimum, unless otherwise noted.
- N. Wiring Labels: Panduit H100X034F1T-B heat shrink markers.
- O. Wall Plates: Brushed stainless steel. Hubbell.

2.2 REFER TO SPECIFICATION SECTION 15975 – CHANGE THE FOLLOWING:

Page 2: Change Niagara AX to Niagara AX/N4.

Page 2: At paragraph 2.a. – Change to Niagara N4.

Page 6: Change FX60/70 to FX80.

Page 6: Delete the requirement for Portable Operator Terminals (laptops).

Page 12: Delete "(NIC)" – Provide a Graphical User Interface – program the device for read only. Locate in existing control panels.

Page 13: Clarification – the Network Server is not in the contract.

Page 14: Change sub-paragraph b. to the following:

- 1) IO-16/34-REM-H Input/Output modules shall be utilized for additional control devices.

Change sub-paragraph c. to the following:

- 1) Provide Micro-SD card with 4GB flash total storage/2GB user storage backup for all on board functions including I/O.

Change sub-paragraph e. to the following:

- 1) FX80 shall be licensed for sufficient devices for this project, plus all existing devices, and an additional 15% (minimum) licenses for the future, unless otherwise noted.
- 2) FX80 shall be licensed with a 1-year Software Maintenance Agreement.
- 3) If the existing District server is licensed for AX, then FX80 shall be downgraded to AX.

Page 15: Add the following to sub-paragraph C. 1. a

- 3) All other controllers shall be BACnet communicating PCG, PCV or PCA Johnson devices.

2.3 VARIABLE SPEED DRIVE

- A. General: The variable frequency drive (VFD) shall be a completely adjustable frequency motor drive system consisting of a pulse width modulated inverter for speed control of NEMA Design B induction motors. Variable frequency drives shall be manufactured by a single source. The VFD manufacturer shall have a minimum of five years experience in VFD design. Allen Bradley Model 525, without substitution. Provide factory start-up.
- B. Standards: VFD shall be in accordance with the latest revisions of the following:
 - 1. UL Standard 508, Electrical Industrial Control Equipment
 - 2. VFD shall be UL listed and bear the UL label.
- C. Design Requirements: The VFD shall be capable of operating in the following conditions: ambient temperature 0 to 40 degrees C and relative humidity 0 to 95%, noncondensing. The power section shall allow the following faults to occur without damage to the VFD: single-phase fault, three-phase short circuit, or phase to ground short circuit. VFD shall include the following features: overcurrent protection, overspeed protection, over temperature protection, electronic thermal motor protection. Enclosures per paragraph 2.1, K. Provide line reactors, 3% impedance. Provide filters for load side circuit length in excess of 200 feet.
- D. Adjustments: VFD adjustments shall be set via menu driven selections accessible from the front panel. The VFD shall operate in the auto or manual mode and shall include the following front panel mounted switches and indicators:
 - 1. 2 line x 14 character alphanumeric display
 - 2. Local/ remote switch.
 - 3. Digital indicator of frequency, current, volts, torque, HP, KW, KWhrs and run hrs.
 - 4. Manual speed control
 - 5. Run / stop switch.
 - 6. Power on and run indicator
 - 7. Fault indication including: current limit, overvoltage, undervoltage, overload or thermal motor protection.

PART 3 - EXECUTION

3.1 GENERAL ITEMS

- A. Graphical User Interface Panel: Refer to Section 15975, paragraph 2.04, A, 11. Delete "(NIC)". Clarification – the Graphical User Interface Panel is to be included in the Contract. Mount the touch panel PC in a NEMA 12 enclosure. Ventilate this enclosure with a low filtered ventilation inlet on one side and a high exhaust fan on the opposite side.
- B. Existing Devices: Remove all unused control devices and related conduit and wire.
- C. Existing Thermostat Guards: Where possible, re-use existing thermostat guards.

- D. Multiple Equipment Items in Same Space: Where multiple equipment items serve the same space, one temperature sensor shall be used to control the multiple units.
- E. Refer to specification Section 15975, paragraph 2.02, C: EMT conduit is also allowed as noted in this Section.
- F. Exhaust Fan Points List: For exhaust fans that are switched with lighting, replace the light switch with a Smart Exhaust SPSE1-w switch (with time delay).
- G. Lighting Points List: Control power for lighting shall be via a dedicated transformer. Do not power lighting controls from any equipment control transformer.
- H. Refer to Specification Section 15975: At paragraph 2.01, A – delete the reference to “N2”.
- I. Room Sensors and other operable devices: Mount all room temperature sensors and other operable devices at +48” to the highest operable part.

3.2 INSTALLATION

- A. General: All electrical work shall be in accordance with the California Electrical Code, Fresno Unified School District Standards and the Electrical Specifications. Wiring shall be concealed in walls; above the ceilings, or below grade unless otherwise noted. Exposed wiring shall run parallel to room surfaces; location shall be approved by Fresno Unified School District Project Manager. No structural member shall be weakened by cutting, notching, boring or otherwise. Provide electric power for each device requiring external power. Dedicated circuits shall be provided for all network area controllers, field control devices and elsewhere, as required. Identify the power circuit and wiring at both ends. Any devices or wiring exposed to the weather shall be protected in weatherproof enclosures as specified and weatherproof conduit. Set, test and adjust the system for proper operation. All device locations noted in O&M's, programming, graphics, etc. shall refer to room numbers noted in the District's "Key Plans". Provide wiring diagram encased in plastic in all control panels. Provide 500VA control power panels as required, a minimum of one per floor. 120/24 volt transformer, 5 individual fused 100 VA circuits. NEMA 1 enclosure. Provide 120 volt, 20 amp dedicated power circuit. Locate in electrical rooms.
- B. Wiring and Conduit: Wiring in walls or in mechanical rooms, janitor rooms or storage rooms shall be in conduit. All wiring exposed to view, below 8 ft., shall be run in rigid galvanized steel conduit. Above 8 ft. may be EMT. All conduits shall include a pull wire (#12 stranded purple). Wiring in accessible attics may be run without conduit – use plenum-rated wiring. This wiring shall be strapped to structure at 48 inches on center and shall not lie on the ceiling. Inside classrooms, wiring may be run in Panduit for remodel projects. Panduit shall be Series LDPH51W10-A. All wiring (field and inside enclosures) shall be labeled at both ends as specified. All wire or cable shields shall be bonded together. Wiring and wire rolls shall be secured to the interior walls of enclosures or equipment. Use industry standard wire ties and support loops. Do not route communication wiring through room sensors, or any other device that is not secured in a locked enclosure. All communication wiring shall be new.
- C. Existing Controls (remodel projects): Remove all unused control devices and related conduit and wire. Return all unused devices that the District desires to retain. Refer to the Removal and Salvage paragraph in the previous specification section. Where possible, re-use all existing thermostat guards. Existing rigid and EMT conduit may be re-used. Replace all existing flex conduit and fittings.

3.3 SEQUENCE OF OPERATION

- A. General: Equipment shall start by normally open relay and signal from BAS. Provide heat/auto/cool selection through the BAS. Auto places heating/cooling selection under control of BAS, based on outside air temperature. Heat/cool changeover setpoint shall be 65 degrees F (adjustable through BAS). Wireless communication is not acceptable. All BAS communication shall be via BACnet. Locations of all control panels and sensors shall be coordinated with, and as directed by, the District.
- B. Set Point Adjustment: Supply temperature set points shall not be set outside the range specified by the equipment manufacturer.
- C. Central Plant Equipment:

The circulation pumps shall be started/stopped by the BAS or manually. The pump speed shall be modulated to maintain a minimum pressure as reported by the pressure transmitters. The lead pump shall be cycled to 80% of capacity. When the system demand exceeds this set point the lag pump shall be started and the pumps track in unison to maintain system pressure. Ramp down sequence shall be in reverse order. The lead/lag pumps shall be alternated on a run time basis (adjustable) by the BAS, or by manual selector switch. At the differential pressure sensor locations for the chilled and hot water piping, provide an engraved plastic tag indicating "PRESSURE SENSOR". On the pressure sensor, provide a brass tag indicating "PRESSURE SENSOR FOR DISTRIBUTION PUMP CONTROL".

- 1. Boiler: The boiler pump and boiler are started by a signal from the BAS and operate continually until BAS shut-down by either time schedule or by outside air temperature rise to 65 degrees F (adjustable). Boiler pump shall continue to run for 15 minutes (adjustable) after boiler shut down.
- 2. The boiler shall be interlocked with a flow switch to insure flow. The boiler temperature is controlled by the boiler thermostat.
- 3. Heating hot water reset control: Main loop water temperature shall be BAS controlled. The main loop reset temperatures as controlled by BAS shall be adjustable. Reset temperatures are site specific. Coordinate with the District.
- 4. Chiller: Chiller is started by BAS and upon proof of flow the chiller is allowed to operate on its internal controls to maintain chilled water temperature. Provide control boards, wiring and programming for the chillers to allow the District maintenance and EMS departments to monitor the chiller operations through the micro-processor that is built into each chiller. Provide front end control boards and dedicated communication / control wiring as required.
- 5. The chilled water pump starts by BAS signal and operates continually until BAS shut down. Chilled water pump to run for 15 minutes (adjustable) after chiller shut down.

D. Air Handler - VAV:

- 1. General: The unit shall be activated by the BAS. The unit shall be capable of an economizer cycle. A static pressure sensor located 2/3 of the distance down the supply ductwork shall cause the VFD to vary the air volume of the supply fan to maintain a constant duct pressure. A static pressure sensor located in the return ductwork 2/3 of the distance from the most remote return grille towards the return/exhaust fan shall cause the VFD to vary the air volume of the return/exhaust fan to maintain a constant return duct pressure.

2. Minimum Outside Air Control: The DDC shall modulate the outside air and relief dampers to maintain the required minimum outside air (except in economizer mode), proportional to the signal used to control the supply fan speed. The outside air damper positions shall be developed in coordination with the Balancing Contractor. One setpoint shall be with the supply fan VFD setting for maximum scheduled air flow. The outside air dampers shall be adjusted to provide the minimum scheduled air flow with the VFD at this position. The second setpoint shall be with the supply fan VFD setting for minimum scheduled air flow (30% of maximum air flow). The outside air dampers shall be adjusted to provide the required minimum air flow with the VFD at this position. The relief dampers shall also be set using this procedure. See notes at drawing schedule regarding demand control ventilation with CO2 sensors. For air handlers noted with demand control ventilation, outside air dampers shall be modulated by signal from the CO2 sensors to maintain baseline CO2 levels.
 3. Heating: On system startup, if the temperature sensors for all VAV/VVH boxes on an air conditioning system call for heating, the outside air (OSA) damper is closed, the relief damper is closed and the control valve is fully open. As the space temperature approaches setpoint, the OSA and relief dampers open and modulate to provide minimum outside air.
 4. Cooling and Ventilation: A temperature sensor downstream of the cooling coil shall modulate the system to maintain a downstream supply air temperature of 55F (adj.). This temperature shall be reset by the warmest representative VAV/VVH box temperature sensor. If the outside air is less than the space temperature, the outside air damper and relief damper shall modulate to maintain the supply air at the set temperature. When the outside air temperature is greater than the space temperature, the outside air damper and relief damper modulate to minimum outside air position.
 5. Purge Cycle: At 4:00 a.m. during the cooling season between April 15 and October 15, if the room temperature exceeds the outside air temperature, the unit shall run with the outside air and relief dampers 100% open. The unit shall stop and the OSA and relief dampers shall close when the room temperature is within 2 degrees of the OSA temperature.
 6. Off Cycle: The outside air and relief dampers go to the closed position and the fans shut off.
- E. Exhaust Fans: Refer to schedules. For exhaust fans that are to be switched with lighting, replace the light switch with a Smart Exhaust SPSE1-w switch (with time delay).
- F. Equipment Shut Down: As required by Code, smoke detectors shall immediately shut down equipment when smoke is detected and shall signal the fire alarm system. Shut down of the equipment shall be accomplished through U.L. listed devices.
- G. Fire/Smoke Dampers: Fire/smoke dampers shall be closed on smoke alarm. Damper shut down shall be accomplished through U.L. listed devices. The air moving equipment serving the damper shall be shut down through U.L. listed devices. The fire alarm system shall be signaled.

END OF SECTION

**SECTION 16010
GENERAL ELECTRICAL**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

Contract requirements of the foregoing General Conditions, General Requirements and supplements thereto and all requirements of these Specifications shall form a part of this Section with the same force and effect as though repeated herein. The provisions of this Section shall apply to all of the following Sections of Division 16 of these Specifications. All applicable portions of the work under Division 16 shall conform fully to all provisions of all other Division 16 Sections.

1.02 SUMMARY OF WORK:

The Contractor shall provide all materials, tools, equipment, labor and services necessary to furnish and install complete working electrical systems as shown on the plans and described within these Specifications. All systems, at project completion and before final acceptance, shall be demonstrated to have a complete and working functional operation. The work includes but is not specifically limited to items indicated on Drawings and specified herein.

1.03 DESCRIPTION AND INSTALLATION OF SYSTEMS:

- A. The electrical drawings are diagrammatic and do not necessarily show all raceway, wiring, number or types of fittings, offsets, bends or exact locations of items required by the electrical systems. Items not shown or indicated which are clearly necessary for proper operation, payment or installation of systems shown shall be provided at no-increase in contract price.
- B. The exact routing of systems and location of devices and equipment shall be governed by coordination with other trades, structural and architectural conditions. The Electrical Engineer reserves the right, at no increase in contract price, to make reasonable changes in location of electrical equipment or wiring systems; so as to coordinate with other systems, group them into orderly relationships, or to increase their utility. Contractor shall verify requirements in this regard prior to roughing in.
- C. Install electrical work in cooperation with other trades and make proper provisions to avoid interferences and coordinate with structural and architectural features, in a manner approved by the Electrical Engineer. All changes caused by neglect to make such provisions shall be at Contractor's expense. Provide offsets and special fittings, as required to facilitate installation of the work.
- D. When a particular product or type of product is specified with a manufacturer's designation, the latest published specifications, installation, and construction information of the manufacturer shall constitute the minimum acceptable standard. Any substitutions shall be made in accordance with Section 1.09 SUBSTITUTIONS.

1.04 RELATED DOCUMENTS:

- A. Codes and Regulations: All electrical equipment and material and its installation shall conform to the current requirements of the following authorities, codes and standards:
 - 1. Occupational Safety and Health Act (OSHA).
 - 2. California Electric Code CEC.

3. California Code of Regulations CCR.
 - a. Title 8, Safety Orders.
 - b. Title 19, Fire and Panic Safety Standard.
 - c. Title 24, Part 1, Administrative Regulations.
4. California Fire Code CFC.
5. California Building Code CBC.

NOTE: Where two or more codes or designs conflict, the most restrictive shall apply. Nothing in these Drawings and Specifications shall be construed to permit work not conforming to applicable codes.

- B. Tests and Standards: The tests, standards, or recommended procedures of the following agencies shall relate to all parts of these Specifications and shall be considered a minimum:

1. American National Standards Institute (ANSI).
2. Underwriters Laboratories, Inc. (UL).
3. National Electric Manufacturers Association (NEMA).
4. Electrical Testing Laboratories (ETL).
5. National Fire Protection Association (NFPA 72).
6. Insulated Power Cable Engineers Association (IPCEA).
7. Institute of Electrical and Electronic Engineers (IEEE).
8. Illumination Engineering Society (IES).

1.05 EXAMINATION OF DOCUMENTS AND SITE:

Before submitting a proposal, each bidder shall carefully examine the electrical, mechanical, architectural, and structural drawings and specifications. He shall also visit the site and fully inform himself as to all existing conditions and limitations applying to the work. If, after such examination and study, it appears that any change from the drawings and specifications should be allowed, the bidder shall so state in writing together with any change in cost involved.

By the act of submitting a proposal, each bidder shall be deemed to have made such examinations of the drawings and specifications and premises, and it will be assumed that he is therefore familiar with the entire scope of the project and has based his proposal upon the work described in the Drawings and Specifications and upon all existing conditions and limitations applying to his work.

1.06 EXECUTION:

- A. Workmanship: The work shall be performed by competent workmen, skilled in the particular phase of the work entailed. The work shall be first class throughout, neat, accurate and in full accordance with the intent of these Specifications and the satisfaction of the Electrical Engineer.
- B. Safety: All standard safety procedures as set forth by OSHA, CCR, and California Division of Industrial Safety shall be strictly adhered to.
- C. Coordination: The Contractor shall familiarize himself with the work of other crafts so as to be able to provide electrical service of correct size and voltage and other requirements to any equipment to be installed. The installations shall be coordinated as to location and time, and interference causing delays and non-acceptable construction shall be avoided.

Prior to commencing construction the Electrical Contractor shall arrange a conference with the general and sub-contractors as well as equipment suppliers and shall verify types, sizes, locations, requirements, controls, and diagrams of all equipment furnished by them.

Exact equipment rough-in locations shall be verified from shop drawings.

- D. Cutting and Repairing: The Electrical Contractor shall do all cutting necessary for the proper installation of his work, repair any damage done by himself or his workmen, and coordinate his work with that of others. Do no cutting or patching without approval of the Electrical Engineer. Round holes through concrete slabs or walls shall be core drilled with a diamond drill, rectangular openings shall be cut with a diamond saw. In no case shall any concrete beam or column be cut.
- E. Sleeves and Openings: Electrical Contractor shall be responsible for all sleeves and openings through walls and floors required by electrical work. All openings around conduits in sleeves shall be sealed with a material of equal fire rating as the surface penetrated. Openings not utilized shall be temporarily sealed in a similar manner. All required sleeves shall be furnished to and coordinated with the General Contractor.
- F. Cleaning and Painting: All exposed work shall be thoroughly cleaned upon completion of work. All panelboards and equipment not located in electrical or mechanical rooms or closets shall be field painted per painting specifications, color as selected by Owner. Panelboard enclosures, fixtures, and equipment, where finish has been marred in shipment or installation, shall be completely refinished. Minor finish damage shall be rectified as indicated by the Electrical Engineer. Contractor shall remove all waste and rubbish resulting from his work from the site.

1.07 QUALITY CONTROL:

- A. Supervision: The Contractor shall personally, or through a competent representative, constantly supervise the work from beginning to completion and final acceptance. He shall cooperate fully with the inspection authorities in the provision of information and access to the work. He shall, to the best of his ability, maintain the same job foreman throughout the life of the project unless a replacement is requested or authorized by the Electrical Engineer.
- B. Inspection and Tests: The Contractor shall furnish all labor and test equipment required to fully test and adjust the equipment installed under this specification and demonstrate its proper operation.
 - 1. Arrange for all tests and inspections and provide minimum 48 hours notice to the Electrical Engineer.
 - 2. A test must demonstrate that each piece of equipment, outlet, fixture, device, and appurtenance is in sound operating condition and in proper cooperative relation to associated equipment.
 - 3. All tests shall be conducted under supervision of the Electrical Engineer, and any defects of any nature which are apparent as a result of such test shall be made correct to the satisfaction of the Electrical Engineer before final acceptance is made.
 - 4. No equipment shall be tested, or operated for any other purpose, such as checking motor rotation, until it has been fully checked in accordance with the manufacturer's instructions.
- C. Warranty: The Contractor agrees to replace or repair, to the satisfaction of the Owner, any part of the installation which may fail due to defective material and/or workmanship or failure to follow Drawings and Specifications, for a period of one year after final acceptance. Any damage to other work resulting from such failure or the correction thereof shall be remedied at the Contractor's expense. The Contractor shall, further, secure from the manufacturers of special equipment, such as signal systems, their respective guarantees

and deliver same to Owner. Guarantees between Contractor and his suppliers shall not affect warranties between Contractor and Owner.

1.08 GROUNDING:

- A. The conduit system supports, cabinets, switchboards, etc., and neutral conductors must be permanently and effectively grounded by means of approved ground clamp, in accordance with the electrical safety orders of the Department of Industrial Relations of the State of California.
- B. This Contractor shall exercise every precaution to obtain good contacts at all panel boxes, pull boxes, etc. Where it is not possible to obtain good contacts, the conduit shall be bonded around the boxes with a #6B&S gauge, rubber covered, double braided wire with ground clamps.
- C. Equipment and raceway bonding procedures shall be rigidly maintained and meet all jurisdictional requirements of codes and regulations.
- D. A separate grounding conductor shall be run in all receptacle circuits.

1.09 SUBSTITUTIONS:

- A. The Specifications or Drawings are in no way to be construed as being proprietary toward one product. Those products, or types of products, listed are intended to set the standard for quality, design, and installation procedure. However, no right is implied upon the part of the Contractor to substitute other materials, products or systems without the written approval of the Engineer.
- B. All requests for substitution shall be made in accordance with the General Requirements.
- C. All requests for substitutions shall be in writing and shall indicate all information required including differences from the specified item. The request for substitution shall be accompanied by cuts, product literature, performance data, specifications, drawings, samples or other means as may be required for proper evaluation by the Electrical Engineer.
- D. All proposed substitutions shall be standard product of the firm under current manufacture and be a catalog item at time of bid.
- E. Acceptance of substitution shall not relieve the Contractor from responsibility for complying with requirements of the Contract Documents. The Contractor shall be responsible for changes in other parts of the work occasioned by his substitutions and shall bear their expense.
- F. Representative samples may be required for determination of equality.

1.10 SUBMITTAL:

- A. Make submittal for all material to be used on the project, whether as specified or substitutions, within thirty-five (35) days after award of Contract by the Owner, in accordance with SUBMITTAL section, and the following:
 - 1. All submittal shall be neat and bound in a suitable folder or binder.
 - 2. Identify each item by manufacturer, brand, trade, name, number, size, rating, and whatever other data is necessary to properly identify and check materials and

- equipment. Words "as specified" are not sufficient identification.
3. Identify each submittal item by reference to specifications section paragraph in which item is specified, or Drawings and Detail Number.
 4. All submittal shall be submitted in coherent groups, e.g. all light fixtures at one time. No partial, or incomplete submittal will be accepted.
 5. Organize submittal in same sequence as they appear in specification sections, articles or paragraphs.

B. Product Data: Submit eight copies, in groups, as follows:

1. Boxes, conduits, and raceway types required, including fittings
2. Electric Wire, cable, junctions, certifications, and connectors
3. Lighting Fixtures
4. Switchboards, Panelboards, Transformers, and disconnects
5. Fire Alarm Equipment

C. Shop Drawings: Shop drawings shall show physical arrangement, wiring diagram, construction details, finishes, materials used in fabrication, provisions for conduit entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, weight, power sources, circuit numbers, and shall be compatible with the Contract Drawings and Specifications.

Show wiring as actually installed, connected, and identified for this specific project. Include identification of cables and cable conductors.

Shop and instruction drawings shall cover the equipment or device to be installed and not merely the general class of such equipment or device.

1.11 DOCUMENTATION:

- A. Construction Record Drawings: The Contractor shall furnish to the Engineer, in accordance with the GENERAL REQUIREMENTS, a complete set of "as constructed" drawings which clearly indicate all deviations from the basic contract drawings, including exact dimension locations and depths for all stubbed conduits, location and size of spare conduits, & conductors, all new and uncovered existing work outside the buildings, power feeder runs, and communications "primary" conduit runs. Corrections and changes shall be kept up to date at all times.
- B. All submittal and shop drawings will be resubmitted with record drawings showing all revisions and changes made, clearly marked with field termination wire so as to reflect actual construction record conditions. Revisions and changes will be enumerated and new dates of drawings shown.

1.12 PORTABLE OR DETACHABLE PARTS:

The Contractor shall retain in his possession and shall be responsible for all portable and detachable parts or portions of the installation such as fuses, keys, locks, adapters, locking clips, and inserts until final completion of his work. These parts shall be itemized and delivered to the Owner at Project Closeout.

END OF SECTION

SECTION 16100
BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SCOPE:

Furnish and install material and equipment as indicated on the drawings and as specified.

1.02 MATERIALS AND EQUIPMENT:

Shall be new and of the best quality used for the purpose in good commercial practice.

1.03 UL APPROVAL:

All material and equipment within the scope of the UL re-examination service shall be approved by the Underwriters' Laboratories for the purpose for which they are used and shall bear their label.

1.04 STORAGE:

All material and equipment shall be stored in a manner to prevent damage or corrosion. Equipment with components which can be damaged due to moisture shall be placed in special heated storage facilities.

1.05 DRAWINGS:

Drawings for all equipment are intended to be diagrammatic only. Any location not actual dimension is not to be considered as necessarily final or accurate. Exact locations must be determined in the field from the requirements of the equipment that is to be installed.

1.06 COORDINATION:

Before rough-in of any utility lines, services, and feeders, or of any equipment, this Contractor must coordinate his work with that of other crafts and trades so that these services shall be installed in their proper locations and without interference to the equipment or building structure. This will require cooperation among all crafts and trades, the inspector, and General Contractor, along with study of shop drawings and the building drawings.

1.07 ELECTRICAL WORK EXPOSED TO WEATHER:

- A. All electrical devices and equipment installed in exposed locations shall be protected by suitable NEMA type 3R enclosures, cast boxes with gasketed covers, or other Engineer approved methods.
- B. All ferrous metal portions of electrical work exposed to weather including conduits, clamps, supports, etc. shall be hot-dip galvanized.

1.08 SEISMIC ANCHORAGE:

- A. Provide complete seismic anchorage and bracing for the lateral and vertical support of conduit and electrical equipment, as required by the California Building Code, and the following.
- B. Anchorage of Equipment: All mechanical and electrical equipment shall be braced or anchored to resist a horizontal force acting in any direction using the following criteria:
Fixed equipment on grade - - - 33% of operating weight
Fixed equipment on structure - - 50% of operating weight

Emergency power and communication
equipment on grade - - - - - 50% of operating weight
Emergency power and communication
equipment on structure - - - - 75% of operating weight
For flexibly mounted equipment use 2 x the above values.
Simultaneous vertical force - use 1/3 horizontal force.

- C. Where requested, submit calculations prepared and signed by a Structural Engineer licensed in the State of California, showing compliance with the above for all electrical equipment weighing more than 50 pounds, excepting items corresponding exactly in configuration and weight to those specified and detailed. Where anchorage details are not shown on drawings, the field installation shall be subject to the approval of the Electrical Engineer.
- D. Conduit that crosses structural separation between buildings or building units shall be installed with flexible connections, suitable to accommodate longitudinal and transverse displacements.

1.09 SUBMITTAL:

- A. Product Data: Submit manufacturer's data including specifications, installation instruction and general recommendations for each item submitted under Submittal, Section 16010, 1.10. Submit calculations in accordance with Section 1.08.

PART 2 - PRODUCTS

2.01 CONDUIT MATERIALS AND COMPONENTS:

- A. Rigid Metal: All exposed exterior damp locations, in concrete walls and slabs, in concrete block walls, interior exposed locations up to +8 feet, or elsewhere shown on plans. Rigid metal conduit shall be new galvanized thickwall threaded, furnished in 10 foot lengths.
- B. Thin Wall E.M.T.: Interior dry locations above ground and above +8 feet, exposed only in non-finished areas. E.M.T. shall be new galvanized, furnished in 10 foot lengths. E.M.T. shall be coupled with steel screw type connectors in concealed locations, and plastic bushed sealing type couplings in exposed locations. Crimp and die cast type connectors are not acceptable.
- C. Flexible Metallic Conduit: Fixture whip connections from junction boxes to lay-in fluorescent fixtures to 6 feet or less in accessible ceilings, maximum 36 inches all other locations. conduits shall be flexible interlocking single strip zinc coated, or aluminum steel with copper ground wire.
- D. Flexible Liquidtight Metallic Conduit: Connections to machinery. Conduit shall be flexible interlocking single strip steel conduit with liquidtight exterior cover, with all connections made with plastic bushed fittings and with copper ground wire (maximum length 36").
- E. Plastic P.V.C., Schedule 40: Underground locations and below vapor barrier of slabs, and in solid grouted masonry walls where wall entry and exit points are made with rigid galvanized steel. No plastic conduit shall be installed in slab floors or in exposed locations. P.V.C. conduit shall be Type 40 heavy thickwall polyvinyl chloride conduit, minimum 3/4" size, Underwriters' Laboratories tested, furnished in 10 foot lengths.

2.02 OUTLET AND SWITCH BOXES:

- A. Boxes shall be one piece die formed galvanized steel of shape and with fittings necessary to suit location and use. Boxes shall be of sufficient size to contain all wires, devices, and

connection fittings required without crowding. Ceiling and surface mounted boxes shall be minimum 4" square or octagonal. Plaster rings shall be provided where required.

- B. Exposed boxes shall be cast type with gasketed weatherproof cover.

2.03 WIRING DEVICES:

- A. Wall Switches: 120/277 Volt Switches: Quiet slow make, slow break design, toggle handle, with totally enclosed case, rated 20 ampere, specification grade. Provide matching two pole, 3 way, and 4 way switches.
- B. Receptacles: Standard Duplex Receptacles: Full gang size, polarized duplex, parallel blade, U-grounding slot, specification grade, rated at 15 amperes, 125 volts, designed for split feed service.

2.04 WALL PLATES:

- A. Weatherproof Plates: Cast metal, gasketed; for receptacles, provide spring loaded gasketed doors. Provide at all weatherproof locations.

2.05 WIRE:

- A. Low Voltage - (Under 600 Volt): Branch circuit wire shall be copper type THWN/THHN, 600 volt, from new fresh stock, bearing U.L. label, delivered to site in unbroken packages; minimum power size 12 AWG. All 20/1 home runs over 150 feet from panel shall be increased to next larger size. Conductors #8 or larger, shall be stranded copper, #10 AWG and smaller shall be solid copper or as shown on plans. All control wires shall be stranded.

PART 3 - EXECUTION

3.01 INSTALLATION OF CONDUIT RACEWAYS:

- A. General: Install conduits in a neat manner, concealed except as noted. Mount conduits directly to building structure with clamps or one hole straps where possible. Secure straps with cadmium plated wood screws into wood, and machine screws into metal or inserts preset in concrete. Where impractical to secure directly to structure, suspend on conduit hangers. Wherever possible, group and rack multiple conduit runs.
- B. Installation and Cleaning: Install free from dents, kinks and bruises. Red lead all threaded conduit joints before coupling. Plug ends at time of installation to prevent entry of dirt or moisture. Thoroughly clean out conduits before installing conductors. Thoroughly clean all exposed conduit exteriors.
- C. Provide tagged pullwire in all empty conduits. Pullwire shall be 1/8" stranded nylon, leave 36" free coiled each end.
- D. Plastic conduit shall be installed in accordance with manufacturer's recommendations and accepted trade practice. Where plastic conduit rises above ground in exposed locations the riser bend and riser shall be of rigid metal conduit installed according to rigid metal portion of this specification item.
- E. All plastic, flexible, feeder and receptacle branch conduits shall carry a grounding bond wire with the size as shown, or where not shown, as determined by applicable codes for the ampacity of the circuit being carried.
- F. Protective Coating: All metallic conduits installed in contact with earth or in concrete on

contact with earth shall be coated with a minimum 40 mil P.V.C. coating on all conduit lengths and fittings. The coating shall correspond to ATSM D638-68, D1706, D140-64, and D746-64T specifications and Federal test standard 141, method 615z. Coating shall be continuous without flaws showing exposed metal. Coating shall extend to the device conduit is terminated to in exposed locations and 12" above grade in unexposed locations.

- G. Conduits which stub-up through floor shall be installed so that none of the curved portions of the elbow is exposed. Conduit bends and risers terminating below-grade runs shall be 40 mil PVC coated galvanized rigid steel.
- H. Conduit Routing: Route exposed conduits parallel or perpendicular to walls or floors. Install conduits in masonry walls at time of wall construction. No conduits will run under heavy equipment, footing or other structural elements. Where runs must cross footings, install in sleeves per structural details.
- J. Conduits Penetrating Membranes: Where conduits penetrate wall or slab membrane moisture barriers, penetration shall be sealed in accordance with the requirements of applicable sections of these Specifications for "Thermal and Moisture Protection".
- K. Conduits Penetrating Roof: Provide flashing and counter flashing making watertight joints where conduits pass through roof or waterproofing membranes, in accordance with existing roofing manufacturer's warranty requirements.
- L. Escutcheons: Conduits penetrating wall, floors, or ceiling in exposed locations shall be installed with appropriate escutcheon plates.
- M. Separations: Coordinate with all other crafts to allow minimum of 12" running and 6 inches crossing clearance at flues, hot water pipes, steam pipes, and heat sources. Keep electrical conduits free from contact with all other piping runs of other systems or of dissimilar metals.
- N. Conduits Crossing Building Joints: Conduits shall not be run in concrete slab or wall construction where passing through an earthquake or expansion joint. At such condition, conduit shall be run exposed or in furred ceiling space with 24" length of flexible conduit crossing joints.
- O. Conduits Penetrating Floors and Walls: Provide grouting around raceways where penetrating floor slabs, concrete or masonry walls. At fire separation walls or floors, use Engineer approved expanding type putty, Nelson Flameseal or equal, to maintain the fire rating of the surface penetrated.
- P. Conduit Support: Support of conduit and tubing in steel stud walls shall be by #18 gauge steel wire, secured to steel bars or straps attached to steel studs. Conduits rising vertically between wall studs shall be tied to a horizontal cross support attached tightly to eliminate any movement.

3.02 INSTALLATION OF EXTERIOR PULL BOXES AND MANHOLES:

- A. Where pull boxes are used without bottoms they shall be set on six inches of 3/4" crushed rock of a volume equal to that of the pull box used.
- B. Where pre-case units are used all joints are to be tongue and groove, sealed with a suitable sealer.

3.03 INSTALLATION OF JUNCTION BOXES AND INTERIOR PULL BOXES:

Locate pull boxes and junction boxes above removable ceilings or in electrical rooms, utility rooms,

or storage areas. No junction box will be installed in an inaccessible area.

3.04 INSTALLATION OF WIRE:

- A. Scope: Provide all wiring for complete electrical work, installed in code conforming raceway. Branch circuit wiring shall be #12 AWG minimum, unless noted otherwise.
- B. Home Runs: Branch circuit conductors shall be home run to panelboards or motor control centers in groupings shown on the drawings. Combining branch circuit home run conductors in single conduits other than that shown shall not be permitted.
- C. Color coding shall be strictly adhered to and shall be as follows:
 - 1. Color coding shall be:

120/240 Volt	277/480 Volt
A Phase - Black	A Phase - Brown
B Phase - Red	B Phase - Orange
C Phase - Blue	C Phase - Yellow
Neutral - White	Neutral - Grey
Ground - Green	
Travelers - Pink	
 - 2. Color coding utilized shall be noted on electrical "as constructed" drawings and shop drawings.
 - 3. The wires shall be of solid colors in size #6 and smaller. In sizes #4 and larger the wires shall be black and 3" width of the appropriate color tape shall be applied around the wire at 12" intervals starting 2" from the termination of the end of the wire.
 - 4. The color coding for control circuit wires will be as noted on the plans or as agreed upon with the Electrical Engineer and will be of a color other than that designated for the phase wires. Where control wires are installed and various colors are used, they shall be noted on the "as constructed" drawings and shop drawings turned in at the completion of the job.
- D. Pulling: Use approved wire pulling lubricant for pulling #4 AWG and larger wire. Oil or grease is prohibited as a conductor pulling lubricant. All conductors #8 and smaller shall only be pulled by hand. Pulling lubricant for conductors over 600 V will be approved by the conductor manufacturer and the Electrical Engineer.
- E. Splices: Join the conductors securely, both mechanically and electrically using crimp, compression, or pressure type connectors, except that screw-on type connectors shall not be used for wires larger than #10 AWG. The splice area shall be taped to provide equal or greater insulation than the original. Tape run-back over the original insulation shall extend 3 to 5 overall diameters of the insulated wire. No splices in conductors over 600 V or feeders over #6 AWG is permitted.
- F. Splice only in accessible junction or outlet boxes.
- G. Wiring in panelboards, switchboards, and cabinets shall be neatly installed. Wiring shall be grouped, laced or clipped, and fanned out to wiring terminals.
- H. Identification and Markings: In addition to all other requirements for identification and marking of wires, cables, panelboards, and junction boxes, the following shall be strictly adhered to:
 - 1. The identification of individual wires terminating in either junction boxes, circuit breakers, terminal strips, or on control devices shall be done by means of

- appropriate tape marker.
2. Where subdistribution wires terminate they shall be marked with the point of origination or point of destination, phase, and voltage to ground. This will include all subdistribution circuits originating from 480/277 volt or 240/120 volt distribution panels serving lighting circuits, receptacle circuits, small power equipment, and small mechanical equipment.
 3. Thus each end of a particular feeder or subdistribution class circuit shall be marked as to its phase and point of origination or destination and either voltage line to line in distribution class circuits or voltage to ground in subdistribution class circuits.
 4. All control circuits will be marked at each control panel as to their function and where they terminate.
Where control wires terminate into relays or enclosures or terminal cans remote from the main point of control, the wires will be marked as to their function and where they originate.
 5. All associated wiring integral within a control cabinet may be marked with the printed circular wire wrapping at each end.
 6. Where wires are pulled through or looped through a junction box, they shall be marked as to the point of origin and the point of destination. All markings in above ground junction boxes will be via linen tags with indelible ink and all markings on junction boxes or pull boxes below ground level will be by means of 1/4" plastic tape with embossed letters. This plastic tag will circle the wire and both ends stapled together.
- J. Testing: All conductors of 125 amps or higher and under 600 volt potential shall be tested with a 600 volt megohm prior to energization and the readings shall be recorded and handed in with the record drawings at the completion of the project. The tests shall be conducted from phase to phase and from each phase to ground.

3.05 INSTALLATION OF MECHANICAL AND OWNER'S EQUIPMENT WIRING:

- A. Furnish all power supplies for other Divisions equipment as shown on the mechanical and civil plans.
- B. Make all connections of power to all mechanical and Owner's equipment along with installation of required disconnection means. This Contractor shall make all connections to other miscellaneous equipment which required line or low voltage power. Verify accessibility of all outlets and re-adjust outlets if necessary to meet the Code. Verify sizes and current characteristics of all equipment before installation of wiring and adjust wiring properly as required.
- C. Supply all electrical junction boxes for mechanical equipment.
- D. After all wiring to each unit is complete, Electrical Contractor shall cooperate with Mechanical or Equipment Contractors in testing equipment for proper operation and shall correct wiring as required for proper operation.

END OF SECTION

SECTION 16400
DISTRIBUTION AND GROUNDING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General Conditions, General Requirements and Division 1 Specification sections, apply to work of this section.
- B. Section 16010 - General Electrical, and Section 16100 - Basic Materials and Methods sections apply to work specified in this section.

1.02 SCOPE:

- A. Work included: Furnishing and installation of a complete electrical distribution and grounding system. Conditions of this section apply to all other 16400 series sections included.
- B. Related Work: Refer to other sections, particularly those listed below, so as to properly coordinate work specified herein with that specified elsewhere to produce a finished, workmanlike, fully functioning installation. All other Electrical Sections: Division 16

1.03 QUALITY ASSURANCE:

Codes and Regulations, Reference Standards: See Section 16010.

1.04 NAMEPLATES:

Laminated phenolic plastic, color coded black for equipment, with white letters. Provide for identification of each transformer, panelboard and motor control center, secure to face with two (2) chrome plated screws each. A schedule of nameplates shall be included with the shop drawings for approval.

1.05 SUBMITTAL:

- A. Product Data: Submit manufacturer's data on service entrance equipment, switchboards, motor control centers and/or individual starters, transformers, panelboards, disconnect switches and grounding components.
- B. Trip Curves: When requested, submit trip timing curves for all circuit interrupting devices.
- C. Nameplate Schedule: Submit nameplate schedule for approval.

1.06 COMPONENT COORDINATION:

In order to maintain close control and coordinate the various components of the distribution systems, the number of manufacturers shall be kept to a minimum. Equipment manufacturer shall be General Electric, Square D, or equal. It shall be the manufacturer's responsibility though the Electrical Contractor to coordinate all components of the system in order to ensure systems that will provide maximum protection of equipment and reliable safe operation.

1.07 FEEDER CONNECTIONS:

Provide cast, saddle type bolted lugs or hydraulically set compression lugs for all bus connections. Manufacturer shall be Thomas and Betts, Burndy, O.Z. or approved equal. Lugs in which the set of screw embeds directly into feeder conductor shall not be used.

1.08 MISCELLANEOUS:

- A. Equipment Bases: Provide appropriately sized concrete housekeeping bases for all floor-mounted equipment.
- B. Hoisting Lifting Lugs: Provide on all heavy equipment as required to ensure safe hoisting.
- C. Space for Future Protective Device: Provide as indicated on drawings; shall be completely equipped for the future addition of a circuit breaker or fused switch, including all connections.

PART 2 - PRODUCTS

2.01 PANELBOARDS:

- A. Panelboards shall be Air Circuit Breaker bolted type, with voltage, phase, and breakers as specified in panelboard schedules. Panelboards shall be installed flush or surface or specified, at locations as indicated on plans. Panelboards shall be installed in code gauge rust proof steel cabinets with flush door having flush locks all keyed alike and with trim cut square and true. Panelboards: Square D, type NQOB, General Electric, or equal.
- B. All panelboards and breakers shall meet the requirements of the indicated available symmetrical short circuit current or have a minimum bus bracing to meet figure shown.
- C. All interiors shall be completely factory assembled. They shall be so designed that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors, so that circuits may be changed without machining, drilling or tapping.
- D. Branch circuits shall be arranged using double row construction except when narrow column panels are indicated. A nameplate shall be provided listing panel type and ratings.
- E. Unless otherwise noted, full size insulated neutral bars shall be included. Bus bar taps for panels with single pole branches shall be arranged for sequence phasing of the branch circuit devices. Neutral bussing shall have a suitable lug or each outgoing feeder requiring a neutral connection. A ground bus will be included in all panels.
- F. Boxes shall be at least 20 inches wide made from galvanized steel. Provided minimum gutter space in accordance with California Electric Code. Where feeder cables supplying the mains of a panel are carried through its box to supply other electrical equipment, the box shall be sized to include the additional required wiring space. At least four interior mounting studs with adjustable nuts shall be provided.
- G. Door hinges shall be concealed. All locks shall be flush, stainless steel, cylinder tumbler type locks with catches and spring loaded door pulls, keyed alike and directory frame and card having a transparent cover shall be furnished with each door.
- H. All exterior and interior steel surfaces of the trim shall be properly cleaned, primed with a rust inhibiting phosphatized coating and finish with a gray ANSI 61 paint. Trims for flush panels shall overlap the box for at least 3/4 inch all around. Surface trims shall have the same width and height as the box. Trims shall be mountable by a screwdriver without the need for special tools. After installation, trim clamps shall not be accessible when the panel door is closed and locked.
- I. All main bus bars shall be copper sized in accordance with UL standards to limit the temperature rise on any current carrying part to a maximum of 50 degrees C above an

ambient of 40 degrees C maximum.

- J. Circuit breakers shall be quick-make, quick-break, thermal-magnetic, trip indicating, and have common trip on all multipole breakers. (Trip indication shall be clearly shown by the breaker handle taking position between ON and OFF when the breaker is tripped). Branch circuit breakers feeding convenience outlets shall have sensitive instantaneous trip settings of not more than 10 times the trip rating of the breaker to prevent repeated arcing shorts resulting from frayed appliance cords. Single pole 15 and 20 ampere circuit breakers shall be UL listed as "Switching Breakers" and carry the SWD marking. UL Class A (5 milliamperes sensitivity) ground fault circuit protection shall be provided on 120V ac branch circuits as specified on the plans or panel board schedule. This protection shall be an integral part of the branch circuit breaker which also provided overload and short circuit protection for branch circuit wiring. Tripping of a branch circuit breaker containing ground fault circuit interruption shall not disturb the feeder circuit to the panelboard. A single pole breaker containing ground fault circuit interruption shall not disturb the feeder circuit to the panelboard. A single pole circuit breaker with integral ground fault circuit interruption shall require no more panelboard branch circuit space than a conventional single pole circuit breaker. Connections to the bus shall be bolt on.

2.02 DISCONNECTS:

- A. Motor and circuit disconnects shall have an Underwriters' Laboratory label.
- B. Disconnect switches shall be suitable for area where they are installed, i.e., weatherproof, and shall be rated heavy duty. Use only 600 volt class with proper number of poles. Switches shall be fused unless indicated on plans. Fuses shall be of type specified on plans.
- C. When the disconnect is not clearly visible from the control location, provide it with an operating handle which is lockable in the open position.

2.03 GROUNDING:

- A. Clamps, bonds, etc. suitable and as necessary to provide continuous ground system.
- B. All grounding conductors shall be copper, sizes not less than that required under CEC requirements.

2.06 SWITCHBOARDS:

- A. Manufacturer's: Subject to compliance with requirements, provide switchboards of one of the following: General Electric, Square D, or equal.
- B. General: Except as otherwise indicated, provide switchboards of types, sizes, characteristics, and ratings indicated, which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information, and as required for complete installation. Service entrance switchboards shall comply with serving utility requirements.
- C. AC Dead-Front Distribution Switchboards: Provide factory assembled, dead-front, metal enclosed, self-supporting secondary power switchboards, of types, sizes and electrical ratings and characteristics indicated; consisting of panel (vertical) units, and containing circuit breakers of quantities, ratings and types indicated. Provide copper or tin plated aluminum main bus and connections to switching devices of sufficient capacity to limit rated continuous operating temperature rise to 54 degrees F, and 90 degrees F for circuit breaker branches; with main bus and tap connections silver-surfaced and tightly bolted for maximum conductivity. Brace bus for short circuit stresses up to maximum interrupting

capacity. Prime and paint switchboard with manufacturer's finish and color. Construct units for outdoor, NEMA Type 3R.

- D. Enclosures: Construct dead-front switchboards, suitable for floor mounting, with front cable/wire and conduit accessibility as indicated. Provide welded steel channel framework, hinge wireway front covers to permit ready access to branch circuit breaker load slide terminals. Coat enclosures with manufacturer's standard corrosive resistant finish.
- E. Bussing: Provide switchboard with sufficient cross-sectional area to fulfill U.L. Standard 891 pertaining to temperature rise.

2.07 DRY TYPE TRANSFORMERS

- A. Transformers shall be compartment type, self-cooled, tamper resistant and weather resistant for mounting on a pad and shall comply with the latest applicable standards. The coils shall be wound with copper conductors.
- C. Transformers shall be TP-1, K4, or K13 rated as indicated and have a maximum temperature rise of 80C above a 40C ambient.
- D. Primary taps shall be full capacity, with a minimum of two 2 1/2% above and below rated voltage.
- E. KVA sizes and voltages shall be as shown on the drawings.

2.08 MANHOLES AND PULLBOXES:

- A. Precast manholes and pullboxes shall have an ultimate 28-day compressive strength of not less than 3000 psi.
- B. Metal frames and covers shall be made of steel. Covers shall be rated AASHTO H20
- C. Pulling irons shall be bars bent in form and cast in walls and floor.
- D. Cable racks, rack arms, and insulators shall be sufficient to accommodate cable. Wall brackets shall be channel steel. Slots for mounting cable racks shall be at 8 inch intervals. Cable rack arms shall be steel and removable. Insulators shall be dry process glazed porcelain.

2.09 WARNING TAPE:

Warning tape shall be acid and alkali-resistant polyethylene film, 6 inches wide with minimum thickness of 0.004 inch. Tape shall have a minimum strength of 1750 psi lengthwise and 1500 psi crosswise. The tape shall be manufactured with integral wires, foil backing or other means to enable detection by a metal detector when the tape is buried up to 3 feet deep and no more than 1 foot above utility line. The metallic core of the tape shall be encased in a protective jacket or provided with other means to protect it from corrosion.

2.10 MOTOR STARTERS:

- A. Manual motor starters to be quick-make, quick break, with overload protection. General Electric or 101 for 120/240 volt 1 hp or less.
- B. Magnetic motor starters shall be full voltage non-reversing unless indicated with control power transformer (120 volt coil) and with overload relay protection. Reduced voltage type starters shall have starting timing relays and multi-tap autotransformers. Combination type shall have integral fused switch, motor circuit protector, or circuit breaker as indicated. Provide Hand-Off-Auto selector switches, pushbuttons, pilot lights, control circuit

disconnect, elapsed time meters, interlocks, and other control devices as required or indicated. Provide spare 2 normally open and 2 normally closed auxiliary contacts.

PART 3 - EXECUTION

3.01 INSTALLATION OF SWITCHGEAR AND SWITCHBOARDS:

- A. Install switchgear and switchboards as indicated, in accordance with manufacturer's written instruction, and with recognized industry practices to ensure that switchboards comply with requirements of NEMA and NEC standards, and applicable portions of NECA's "Standard of Installation".
- B. Prior to energization of circuitry, check all accessible connections to manufacturer's torque specifications. Subsequent to wire and cable hook-ups, energize switchboards and demonstrate functioning in accordance with requirements.

3.02 INSTALLATION OF PANELBOARDS:

- A. Provide mounting brackets, busbar drilling, and filler pieces for unused spaces.
- B. Branch circuits shall be connected as shown in line diagrams and/or panelboard schedules, with wires neatly tie wrapped in panel.
- C. All distribution panelboards shall have all sub feeders and main breakers marked with 1" x 3" plastic name tags secured with two self tapping screws.
- D. All panelboards shall be provided with a 2" x 3-1/2" plastic name tag on the front of the panel door or on the trim, indicating panel designation and distribution panel and circuit feeding above panel, secured with two self tapping screws.
- E. Branch circuit panelboards shall have a plastic covered circuit directory card on the inside of each door with all circuit destinations neatly typed.
- F. Contractor shall check and tighten all factory made wire or lug connections. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standard 486A.
- G. Install four (4) spare 3/4" conduits from all panelboards to accessible ceiling space.

3.03 INSTALLATION OF DISCONNECTS:

Install disconnects for all equipment and motors of the size required and as recommended by manufacturer.

3.04 INSTALLATION OF GROUNDING:

- A. Scope: Provide grounding system complying with the codes and ordinances specified. Grounding system shall provide continuity through the entire electrical system.
 - 1. Panelboard ground buses.
 - 2. PVC conduit or other raceways.
 - 3. All motors.
 - 4. All lighting fixtures.

- 5. Grounding terminals of all receptacles.
 - 6. Miscellaneous grounds required by code.
- B. Equipment and raceway bonding procedures shall be rigidly maintained and meet all jurisdictional requirements of codes and regulations.
 - C. Good, electrically continuous, metal to metal contacts shall be made wherever possible at all panel boxes, pull boxes, etc. Where it is not possible to obtain good contacts, the conduit shall be bonded round the boxes with a 6 BS gauge, rubber covered, double braided wire with ground clamps.
 - D. A separate grounding conductor shall be run in all conduit runs from distribution, lighting, and power, etc. panelboards, motor control outlets, etc., back to their respective service or distribution panelboards.
 - E. Flexible Conduit Grounding: Provide a separate grounding conductor in all flexible conduit runs to include watertight flexible conduit with integral grounding straps. Install ground conductors inside conduit with ungrounded conductors. Extend from nearest panel to device being connected.
 - F. Receptacle Circuits: Provide a separate grounding conductor in all receptacle circuit conduit runs, back to serving panelboard.
 - G. Fence grounding: Fence shall be grounded with a ground rod at each fixed gate post and at each corner post. Drive ground rods until the top is 12 inches below grade. Attach a No.4 AWG copper conductor, by fusion weld process, to the ground rods and extend underground to the immediate vicinity of fence post. Lace the conductor vertically into 12 inches of fence mesh and fasten by two approved bronze compression fittings, one to bond wire to post and the other to bond wire to fence. Each gate section shall be bonded to its gatepost by a 1/8 - inch by 1 - inch flexible braided copper strap and ground post clamps. Clamps shall be of the anti-electrolysis type.

3.05 INSTALLATION OF EXTERIOR PULL BOXES AND MANHOLES:

- A. Precast manholes shall be set on 12 inches of level, 90 percent compacted granular fill, 3/4-inch to 1-inch size, extending 12 inches beyond all sides. Granular fill shall be compacted by a minimum of four passes with a plate vibrator. Provide 3/4-inch by 12-foot driven copper ground rod and #2 copper ground wire in each manhole.
- B. Where pull boxes are used without bottoms they shall be set on twelve inches of 3/4" crushed rock of a volume equal to that of the pull box used.
- C. Where pre-case units are used all joints are to be tongue and groove, sealed with a suitable sealer.
- D. Where conduits enter horizontally, they shall be bushed with belled ends and terminate flush with the inside of wall. All cracks and openings shall be grouted smooth.
- E. Where conduits enter, other than from horizontal runs, they shall be properly bushed and extended a minimum 1/2" from inside of wall or bottom into pull box. They shall be at no more than 45 degrees rise from the horizontal runs.

3.06 THIRD PARTY INDEPENDENT TESTING

- A. Provide testing for new and re-used circuit breakers of 100 amp trip ratings and above. Testing shall be performed by an independent testing laboratory. Testing shall include testing handle on/off operation, thermal overload pick up trip testing, and magnetic

instantaneous trip testing at AIC rating of the circuit breaker.

- B. All testing must be witnessed by the DSA Inspector of Record.

END OF SECTION