SECTION 15000 MECHANICAL

PART 1 – GENERAL

1.01 The General Conditions apply to this section.

1.02 Scope of Work

A. This section applies for all mechanical sections. All conditions and materials are pertinent to the other sections as if repeated in those sections.

B. Furnish and install any incidental work not shown or specified which is necessary to provide a complete and workable system.

C. The intent of the drawings and specifications is to replace the hot water boilers, add a plate frame water source economizer, and replace pneumatic temperature controls as shown on the drawings in accordance with the latest edition California Building Code (CBC). Should any conditions develop not covered by the contract documents wherein the finished work will not comply with said California Building Code (CBC), a change order detailing and specifying the required work shall be submitted to and approved by the City of Stockton before proceeding with the work.

D. All equipment and materials shall be made in **USA.**

E. All work shall be coordinated with the Stockton Police Department.

F. If any areas that require abatement are encountered, notify the City of Stockton personnel at once.

1.03 The work in this contract shall include but not limited to the following.

1.03.1 Base Bid

A. Removal of two (2) Bryan Hot Water Boilers. Boilers will have to be dismantled before removal from Boiler Room.

1. Provide rental boiler and pump during boiler replacement.

B. Removal of associated piping flue and breeching as shown on the Drawings or as required for boiler removal.

C. Install new boilers as scheduled on the Drawings. Manufacturer shall remove front section of boiler, for shipping, if required to fit in elevator to basement.

D. Connect new piping between existing piping and new boilers as required and shown and detailed on the Drawings.

E. Install two (2) new hot water circulating (primary) pumps with motor starters as required, and as scheduled on the Drawings.

F. Replace 7.5 HP 1760 RPM motor on HWP-E with new 5 HP Premium Duty 1760 RPM motor. Align motor with pump shaft, shim as required.

G. Replace HWP-E motor starter with new VFD (Variable Frequency Drive).

H. Install differential pressure sensors in existing hot water piping where shown on the Drawings. Pressure sensors furnished by Siemens.

I. Insulate (N) hot water piping and un-insulated hot water piping at the air handling units.

J. Install (N) breeching and flue. The flue stack vendor shall provide a draft calculation at the time of submittal showing that the proposed stack material meets the boiler manufacturers draft requirements. Failure to provide a draft calculation providing adequate draft range will cause direct rejection of the submitted product.

K. Install new plate and frame heat exchanger, solids separator recovery tanks, and pumps as scheduled on the Drawings.

L. Connect new piping between existing piping and equipment as required and shown on the Drawings.

M. Install one (1) new chilled water circulating (primary) CHWP-1 pump with motor starter as required, and as scheduled on the Drawings.

N. Replace 10 HP 1760-RPM CHWP-2 with new CHWP-2 as scheduled on the Drawings.

O. Replace CHWP-2 motor starter with new VFD (Variable Frequency Drive).

1. Provide rental chiller and pump during chilled water piping installation.

P. Install differential pressure sensors in existing chilled water piping in the penthouse or where shown on the Drawings. Pressure sensor furnished by Siemens.

Q. Insulate (N) chilled water piping and un-insulated chilled water piping at the air handling units.

R. Install by-pass at two-way chilled water valve on SF-2 unit in the penthouse. See Details 1/M-7 and 2/M-7.

S. Start-up, test and balance system in conjunction with Siemens Personnel.

T. Check operation and links on all fire damper, report condition to City of Stockton personnel.

U. Replace existing pneumatic temperature controls system with new BAS/EMS. See Section 15950 and Drawings.

1.03.2 Alternate Add Bid #1

A. Remove all reheat coils shown on Drawings M-2, M-3 and M-8 and replace with VAV boxes with reheat coils, as shown on Drawings M-2A, M-3A and M-8A and specified on Drawings.

B. Install new EMS controls as required and shown on Drawings.

C. Balance air and water systems as required in conjunction with Siemens Personnel.

1.03.3 Alternate Add Bid #2

A. Clean all air handling equipment and ductwork. See Section 15500.

1.04 Drawings

A. This project is an upgrade to the existing HVAC system. As-built drawings were used and site surveys reviewed the existing as closely as possible to generate a complete set of drawings. See Section 1.10.

B. Examine all drawings prior to starting of work and report any discrepancies in writing to the ENGINEER.

C. Verify all dimensions at the building site and check existing conditions before beginning work. Make changes which are

necessary to install the work in harmony with other crafts; they shall be first approved by the ENGINEER.

D. Execute work mentioned in the specifications and not shown on the drawings, or vice versa, the same as if specifically mentioned in both.

1.05 Code Rules and Safety Orders

A. Provide all work and materials in full accordance with the latest rules and regulations of the:

1. 2010 California Building Code, reference 2009 IBC
2. 2010 California Plumbing Code, reference 2009 UPC
3. 2010 California Mechanical Code, reference 2009 UMC
4. 2010 California Electrical Code, reference 2008 NEC
5. 2010 California Fire Code, reference 2009 IFC
6. National Fire Protection Association, NFPA latest Ed
7. 2010 California Energy Code
8. 2010 Cal Green Building Code
9. Stockton Municipal Code

Nothing in these plans or specifications is to be construed to permit work not conforming to these codes. Furnish without extra charge, any additional material and labor required to comply with these rules and regulations.

1.06 Fee and Permits

A. Procure and pay for all licenses, fees and permits required.

1.07 Utility Coordination

A. It shall be the contractor's responsibility to arrange and coordinate with the utility companies all requests for service(s) and the installation of meter(s) and services. The contractor shall furnish all documentation and information that the utility companies require prior to start of construction. Within 35 days of the award of contract, the contractor shall submit to the ENGINEER a letter with copies of drawings that are sent to the utility companies for such services.

1.08 Framing, Cutting and Patching

A. Special framing, recesses, chases and backing for work of this section is covered under other sections. Be responsible for proper

placement of all pipe sleeves, hangers and supports and location of openings for work of this section.

1.09 Substitutions and Material List

A. Product names are used as standards only; other materials or methods shall not be used unless approved in writing by the ENGINEER. The burden of proof as to the equality of any proposed material shall be upon the contractor; ENGINEER'S decision is final. Only one request for substitution shall be considered for each item. Equipment capacities specified are minimum acceptable.

B. Submit in indexed folders, five (5) sets of submittals for approval within 35 days after the award of the contract. The submittals shall be accompanied by equipment shop drawings, pump performance curves, and other pertinent data, showing the size, capacity and the proposed materials to be used. Submittals shall be provided whether substitutions or not and shall be listed, in the order in which they appear in the schedules. Submittals shall be submitted and approved prior to start of construction. Email submittals will not be accepted.

C. Any mechanical, electrical, structural or other changes required for the installation of any substituted equipment shall be made to the satisfaction of the ENGINEER and without additional cost to the owner. Approval by the ENGINEER of the substituted equipment and/or dimensional drawings does not waive these requirements. With submittal, submit drawings or mechanical equipment spaces showing substituted equipment.

D. Approval of material shall not be construed as authorizing any deviations from the specifications unless the attention of the ENGINEER has been directed to the specific deviations.

E. Furnish to the Inspector, upon request; complete installation shop drawings of the same.

F. Modification of fire sprinkler systems shall not be started until complete plans and specifications have been approved. Contractor shall provide in his submittal package water supply information and existing fire sprinkler systems and type of hazard, if any. At various stages of completion, the system shall be tested in the presence of the enforcing agent.

1.10 Site Conditions

A. Information on the drawings relative to existing conditions is approximate only. Deviations found necessary during progress of construction to conform to actual conditions, as approved by the ENGINEER, shall be made without additional cost to the owner. The contractor shall be held responsible for any damage caused to the existing property and services. Promptly notify the ENGINEER if services are found which are not shown on the drawings.

1.11 Guarantee

A. Repair or replace any defective work, material or part, which may appear within one year of the date of acceptance. This shall include damage by leaks.

B. On failure to comply with the above guarantee within a reasonable length of time, after notification is given, the ENGINEER shall have the repairs made at the contractor's expense.

1.12 Maintenance and Operating Instruction

A. Furnish four complete sets of operating and maintenance instructions bound in a hardboard binder and indexed. Start compiling the data upon approval of list of materials, Final inspection will not be made until booklets are approved by the ENGINEER.

B. These sets shall incorporate the following:

1. Complete operating instructions for each item of equipment listing in detail the lubricants to be used, frequency of lubrication, inspections required, adjustments, etc.

2. Manufacturer's bulletins with part numbers, instructions, etc., for each item of equipment.

3. Post service telephone numbers and/or addresses in an appropriate place as designated by the ENGINEER.

A. Record Drawings

1. Upon completion of the work, and as precedent to final payment, the contractor shall provide and deliver, to the ENGINEER, updated reproducible drawings showing the work exactly as installed.

PART 2 - PRODUCTS

2.01 General

A. Materials or equipment of the same type shall be of the same brand whenever possible. All materials shall be new and made in **USA**.

2.02 Electric Motors

A. Sterling, Lincoln, Westinghouse, or equivalent product, as accepted by the ENGINEER.

2.03 Variable Frequency Drive

A. The adjustable frequency controller (AFC) shall convert three phase 60 Hertz utility power to adjustable voltage and frequency, three phase, AC power to stepless motor control from 10% to 110% of base speed. The AFC shall be City of Stockton Standard model ACH as manufactured by ABB.

B. The AFC shall be a voltage source type with a PWM output utilizing power transistor semi-conductors.

C. The AFC together with all options and modifications shall mount within standard NEMA-12 enclosure suitable for continuous operation at a maximum ambient temperature of 40³C. All high voltage components within enclosure shall be isolated with steel covers. The complete unit shall be UL approved and labeled.

D. Circuits shall provide DV/DT and DI/DT protection for semi-conductors. AFC shall be capable of starting into a rotating load without trip or delay. Protective circuits shall cause instantaneous trip (IET) should any of the following faults occur:

1. 110% of controller maximum sine wave current rating is exceeded.

2. Output phase to phase and phase to ground (gnd. fault) short circuit condition.

3. High input line voltage.

4. Low input line voltage.

5. Loss of input phase.

6. External fault. This protective circuit shall permit, by means of the terminal strip, wiring of remote NC safety contacts

such as high static, pressure, firestat, etc., to shut down the drive.

E. The following adjustments shall be available in the controller and retained in non-volatile memory:

1. Maximum frequency (15 to 400 Hz) factory set at 60 Hz.

2. Minimum frequency (3 to 60 Hz) factory set at 6 Hz.

3. Acceleration (.1 to 360 seconds) factory set at 20 seconds.

4. Deceleration (.1 to 360 seconds) factory set at 20 seconds.

5. Volts/Hertz ratio factory set for 460V at 60 Hz.

6. Voltage offset or boost factory set at 100% torque.

7. Current limit (50% to 110% sine wave current rating) factory set at 100% current.

F. The AFC shall be capable of following a 0-5, 1-5, 4-20, 10-50 mA: 0-4, 0-8, 0-10 VDC grounded or ungrounded signal.

G. The controller shall have an electronic overload and thermal overload relay designed to protect one A-C motor, operated on AFC output, from extended overload operation.

H. AFC shall be furnished with door mounted operator controls consisting of auto/manual switch, start/stop (reset) switch, and manual speed control. In automatic mode, controller will follow an external signal and respond to remote start-stop contact wired to terminal strip. While in auto mode the controller will attempt up to ten re-starts after a power outage, drive fault or external fault.

I. The controller shall have three adjustable critical frequency avoidance bands.

J. The controller shall have a first fault digital LED panel which shall also indicate current, voltage or frequency. This diagnostic LED panel shall display faults in 3 letter codes for easy trouble shooting. It shall also retain the last three fault conditions.

K. The controller shall be equipped with remote metering interface capabilities:

1. Drive optional remote digital display of volts, amps, frequency and IET indication.

2. Run relay.

3. Isolated 0-10 VDC analog signals of volts, amps, frequency signals to drive analog meters or give feedback to process equipment.

4. Two auxiliary selectable relay contacts.

5. Ten programmable selectable output relay functions.

L. The controller shall have an integrally mounted input line reactor to reduce the harmonics generated back to the power distribution system.

M. Manufacturer shall provide a positive disconnect between the controller and all phases of the incoming A-C line. This disconnect shall be designed to mount inside the controller enclosure and include a mounting bracket and through-the-door interlocking handle with provisions for padlocking. The basic switch shall be magnetic molded case circuit breaker.

N. Manual bypass shall provide all the circuitry necessary to safely transfer the motor from the AFC to the power line or from the line to the controller while the motor is at zero speed.

O. Two motor contactors, electrically interlocked, shall be utilized. One contactor is to be between the controller output and the motor, controlled by the controller regulator; and the other one is to be between the bypass power line and the motor, providing across-the-line starting. Motor protection is to be provided in both the "controller" mode and the "bypass" mode by a motor overload relay and input circuit breaker. The 115VA-C relay control logic, allowing common start-stop commands in the "controller" mode and the "bypass" mode shall also be included within this enclosure.

P. The bypass circuit shall include a second input disconnect installed in the AFC. This disconnect shall provide the ability to safely trouble shoot and test the controller, both energized and de-energized, while operating in the "by-pass" mode. This entire by-pass option shall mount within the controller enclosure. Field wiring of bypass is not acceptable. (Total enclosure shall be no larger than 18" wide by 35" high including bypass).

Q. Manufacturer shall provide protection of input rectification circuit using class J 200,000 AIC fuses. The series rating of the controller

and fuses shall be 25,000 AIC and be as stated on the controller nameplate per UL requirement.

R. The AFC manufacturer shall warrant this product for a period of one-year from start-up or 18 months from shipment, whichever occurs first. The warranty shall include parts and labor.

2.04 Motor Starters (Individually Mounted)

A. Across the line

1. Shall be full voltage magnetic type, unless otherwise shown, with 3-leg overload protection in NEMA 1 or 3R closure. Provide two interlock contacts of the interchangeable open-close type. Provide hand-off automatic selector switch, motor running pilot light and reset button in cover. Circuits 300 volts and over shall be provided with individual 120 control transformers.

2. Starters for fractional horsepower 120-volt motors shall be manual type, unless shown otherwise, equipped with built-in overload protection.

2.05 Flue

A. Flue shall be 316/304 stainless steel double wall construction, with 1” insulated space or as approved by the ENGINEER.

B. The chimney and flue must meet UL-103 (Underwriters Laboratories, Inc.) section 22A for positive pressure exhaust system up to 60” water column and carry the appropriate approval labels. The chimney shall be listed by UL as a “B.H.A.” (Building heating appliance) chimney for continuous operation up to 1000 degrees F. (540 degrees C.) maximum.

C. The chimney and flue components must be of double wall construction and properly designed for positive pressure exhaust. The inner wall must be of 20 gauge 304 stainless steel, with continuous plasma welds. The outer wall must be of 24 gauge 304 stainless steel. High temperature insulation (1 in.) must be installed between walls. The jointing must be made using an assembly band, a finishing band and an appropriate sealing material, as supplied by the manufacturer.

D. All components must be installed according to the manufacturer recommendations and must meet the NFPA and local safety code requirements.

E. The flue stack vendor shall provide a draft calculation at the time of submittal showing that the proposed stack material meets the boiler manufacturers' draft requirements. Failure to provide a draft calculation providing adequate draft range will cause direct rejection of the submitted product.

2.06 Pipe and Fittings For Chilled, Hot and Condenser Water Service (Above Ground):

A. Steel Pipe and Fittings with Screwed or Welded Joints or type 'L' and 'M' copper with wrot copper fittings to be compatible with existing.

B. Mechanically formed joints and tees, as made by T-Drill Industries, Inc., may be used on type 'L' and 'M' copper pipe. All joints shall be brazed with BCuP series filler material and shall have depth stops so that the pipe inserted into the mechanically formed joint of tee shall be inserted a minimum of three (3) times the wall thickness. All joints shall be annealed prior to making the joint.

1. Pipe

Two (2) inches and smaller: Screwed joints ASTM A-120, Schedule 40, grade A or B, black, welded or seamless steel.

Two and one-half (2 1/2) inches and larger: Welded joints ASTM A-53, Schedule 10, grade A or B, black, welded or seamless steel.

One (1) inch to Four (4) inch type 'M' hard drawn copper with wrot copper fittings.

Three eights (3/8) inch to three quarter (3/4) inch type 'L' hard drawn copper with wrot copper fittings. All sizes shown on the drawings are inside diameter.

2. Fittings

Malleable Fittings: ANSI B16.3 for 150 psi; Crane, Grinnell, Stockham.

Cast Iron Fittings: ANSI B16.4 for 125 psi; Crane, Grinnell, Stockham.

Screwed Flanges: ANSI B16.5 for 150 psi (faced to match equipment); Crane, Grinnell, Stockham.

Butt-Welded Fittings: Crane, Tube-Turns, Ladish, Grinnell.

Slip-on Pipe Fittings: ANSI B16.9; Crane, Tube-Turns, Ladish, Grinnell.

Branch Pipe Outlet Fittings: Tee Fittings; Crane, Tube-Turns, Ladish, Grinnell.

Backing Rings: Grinnell Figure 1992.

C. Grooved Pipe (2-1/2" and larger)

1. Mechanically grooved pipe couplings, butterfly and check valves and mechanical - T stub-ins, as manufactured by The Victaulic Co., may be used for piping systems and connecting mechanical equipment in lieu of welded, on chilled, condenser, and hot water systems, in piping 2-1/2" and larger.

2. Piping materials for grooved pipe shall be Schedule 10, lightweight black steel grade pipe conforming to ASTE Specifications A-120, Type E or S, standard square cut grooved to coupling manufacturer's specifications.

3. Couplings shall be Victaulic Style 07, "Zero-flex" rigid type for grooved end pipe. Coupling segments shall be cast of malleable iron conforming to ASTM A-47 or ductile iron conforming to ASTM A-536.

4. Gaskets, elastomer type, shall have properties as designated ASTM C-2000. Water Service-Gasket supplied will be EPDM grade "E" color coded green, conforming to ASTM C-2000 and designated 2CA615A25B44Z for water services to 230 degrees F.

5. Bolts and nuts shall be heat-treated carbon steel. Conforming to ASTM A-183, Minimum tensile 110,000 psi.

6. Branch stub-in connections, where permitted, shall be made with Victaulic Mechanical T- styles 920, 921, and 922 in lieu of welded stubs. For 1/2" or 3/4" branches on 4" or larger standard weight mains style 923 Vic-O-Lets may be used.

7. Fittings shall be of grooved or shouldered end design to accept grooved mechanical couplings without field

preparation, and shall be malleable iron - ASTM A-47, and/or ductile iron - ASTM A-536.

8. Flanges for connecting flanges components into a grooved system shall be Victaulic Vic-Flanges. Flanges shall conform to 125 # cast iron and #150 steel bolt hole alignment.

   Steel Pipe - Vic Flanges for steel pipe shall be Style 741 in sizes 2 1/2" - 24"

   Materials - Malleable Iron ASTM - A-47
   Ductile Iron ASTM - A-536

9. Butterfly valves shall be Victaulic series 300 as scheduled on plans, of grooved end design in sizes 2 1/2" through 12". Valves shall be lined with grade "E" EPDM for operating conditions not to exceed - 30 to 230 degrees F. temperature. All Butterfly valves 8" and larger shall be equipped with manual gear operator.

10. Check valves series 710, 711 or 715 shall be grooved end design. Check valve will be of a non-slamming spring closing operation and suitable in a horizontal or vertical position.

11. Pipe Preparation: The pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing. The dimensions should be according to the standard roll groove specifications as recommended by Victaulic.

12. Pipe and fitting assembly requires that all nuts should be tightened to assure firm metal contact of the coupling pads. All grooved products shall be of one manufacturer.

13. Manufacturer shall provide field service engineer to assure installers adhere to manufacturer's directions and for handling and supporting piping and valving systems.

2.07 Pipe and Fittings Inside Buildings

A. See General Requirements Section for dielectric fittings and pipe protection. Terminate 5'-0" outside the building line or where marked.

B. Water Pipe (Hot and Cold Water)

1. Above Ground: Type 'L' copper tubing, hard-temper, with wrot copper fittings. Joints shall be soldered with "lead free" solder; ASTM B 32 Alloy Grade TC. The melting point shall be 410 degrees F. The tensile strength shall be 7130 PSI. The shear strength shall be 5979 PSI and burst strength of 5800 PSI.

   2" and Larger Type 'L' copper tubing, hard-temper, with wrot copper fittings. Joints shall be brazed with silfos 15 brazing alloy. The brazing alloy shall have a flow temperature of 1300 degrees F. and be used in 1/8" x 20" sticks.

   a. In Ground: Type K copper tubing, hard-temper, with wrot copper fittings. Joints shall be brazed with silfos 15 brazing alloy. The brazing alloy shall have a flow temperature of 1300 degrees F. and be used in 1/8" x 20" sticks.

2. Gas Pipe

   a. Above Grade: Schedule 40 black steel pipe with 150-psi black malleable iron fittings.

   b. Below Grade: Schedule 40 black steel pipe with 150-psi malleable iron fittings enclosed in a ventilated Schedule 40 PVC sleeve.

   c. Piping 2-1/2" and larger shall be black welded pipe and fittings.

3. Condensate Drains: Schedule 40 galvanized pipe and fittings or type M copper, hard temper pipe and fittings.

4. Contractor shall fire stop all penetrations of rated assemblies with a material that meets California State Fire Marshal Standard 43-1.

2.08 Valves and Fittings

A. Valves shall be Crane, Nibco, Kennedy or equivalent product, as accepted by the ENGINEER.

1. Gate valves: 2 inches and under - Crane 438.
   2-1/2 inches and larger - Crane 461 - nut operated.

2. Gas Cocks: Jomar T-100 AGA listed ball valve.

3. Water Service Valves: Meuller AWWA gate valve, 200 P.S.I.W.W.P.

4. Ball Valves: Apollo #64 or Jomar T-100.

5. Balance Valves: B&G Circuit Setter.

B. Valves in the ground shall be installed in Christy Concrete Products #F1 valve box with D210 lid, nut operated, Brooks, or equivalent product, as accepted by the ENGINEER access boxes marked for service. Provide a tee handle wrench for each size. Set access boxes in 4" thick concrete pad, trowel smooth and edge, set flush with grade.

C. Valves in copper lines shall be furnished with adapters, or may be solder joint type of equal quality to screw type valves.

2.09 Union and Flanges

A. Steel 2" and smaller - 300# screwed black or galvanized malleable iron to match pipe. Unions shall be ground joint with brass to iron seat.

B. Copper or brass pipe or tubing 2" and smaller - 150# cast brass ground joint, bronze to bronze seat with copper and connections.

1. Copper or brass pipe or tubing 2-1/2" and larger - 150# brass flange union, flat faxed, full gasket.

C. Gaskets: one-sixteenth inch thick rubber Garlock #122, Johns-Mansville or equivalent product; as accepted by the ENGINEER.

D. Flange Bolts: Cadmium Plated Open-hearth steel bolts with square heads and cold pressed hexagonal nuts. Provide copper bolts and nuts for brass flanges.

PART 3 - EXECUTION

3.01 Installation of Piping System

A. General

1. Should structural difficulties or other work such as ducts, conduits, lights, etc., prevent the running of pipes or the setting of equipment at the points indicated by drawings, changes as authorized by the ENGINEER shall be made

without additional cost to the Owner. All piping shall be concealed unless shown or directed otherwise. Run exposed piping parallel to building surfaces with minimum fittings and support to prevent movement.

2. Close ends of pipe immediately after installation, leave closure in place until removal is necessary for completion of installation.

3. Each piping system shall be thoroughly flushed and proved clean before connection to equipment.

4. Install exposed polished or enameled connections with special care showing no tool marks or threads at fittings.

5. Use reducing fittings; bushings shall not be allowed.

B. Sleeves; Install sleeves of sufficient size to allow for free motion of pipe, 24 gauge galvanized steel. The space between pipe and sleeves through outside walls below grade, through roof, and other locations as directed shall be caulked with oakum and mastic and made watertight.

C. Floor, wall, and Ceiling Plates: Fit all pipes with or without insulation passing through walls, floors, or ceilings, all hanger rods penetrating finished ceilings with chrome plated or stainless steel plates.

D. Flashing: Furnish and install a flashing with counter flashing around each pipe, where it passes through roof. All flashings shall be made of four pound sheet lead with 8" minimum skirt.

E. Hangers and Supports

1. Support all piping so that it is firmly held in place by approved iron hangers and supports and special hangers as required. All hanger material shall be approved by the ENGINEER before installation. Support no piping by any wire, rope, wood, or other makeshift devices.

2. All hanger components shall be Grinnell, Super-Strut, B-Line, or equivalent product, as accepted by the ENGINEER. Individually suspended piping shall be Grinnell 149, Super-Strut C-7ll, complete with threaded rod.

Pipe Size	Rod Size
2" and smaller	3/8"
2-1/2" to 3-1/2"	1/2"
4" to 5"	5/8"

3. Pipe Support and Hanger Spacing Schedule

Type of Pipe	1" Dia. Or Under	1-1/4" to 3"	3-1/2" Dia. Or Over
Steel	8'-0"	l0'-0"	12'-0"
Copper Tub.	6'-0"	8'-0"	l0'-0"
Gas Piping	6'-0"	10'-0"	l0'-0"
Cast iron	Support at every joint and 10'-0" max.		

4. Saddles for insulated pipe shall be B-Line B-316X pipe protection saddle if at roller support or B-338X Calcium Silicate Shield or as approved.

5. Burning, welding or cutting of any structure member may only be done if approved by the ENGINEER.

6. Insulate copper tubing from ferrous materials and hangers with two thickness of 3" wide 10 mil polyvinyl tape wrapped around pipe.

7. No valve or piece of equipment shall be used to support the weight of any pipe.

8. Provide a support or hanger within twelve (12) inches of each change of direction of pipe either horizontal or vertical.

3.02 Pipe Joints and Connections

A. Cutting: Cut pipe and tubing square, remove rough edges and burrs.

B. Threaded pipe: Make joints with Rectorseal #5 or Permatex #1, thread lubricant, use no caulking of any kind, and remake leaky joints with new materials.

3.03 Unions and Flanges

A. Install Epco, or equivalent product as accepted by the ENGINEER, dielectric unions or flanges at points of connection between copper

or brass piping or material and steel or cast iron pipe or material except in drain, waste vent, or rainwater piping. Bushings or couplings shall not be used.

B. Install unions whether shown or not at each connection to all equipment and tanks and at one connection to each valve or cock.

C. Locate the unions for easy removal of the equipment, tank or valve.

D. Dielectric union material must be compatible with the service served.

3.04 Pipe Markers

A. Pipe markers shall conform to ANSI specifications.

B. Each pipe marker shall have ANSI specified color coded background, ANSI specified color of legend in relation to background color, ANSI specified legend letter size, and ANSI specified length of color field and direction of flow arrows.

C. Outdoor markers shall be manufactured with UV inhibitors and plastics.

D. Pipe markers shall be "Setmark" snap-on type.

E. Pipe marker spacing shall be as recommended by the National Safety Council and OSHA.

F. Contractor shall install on all pipes markers indicating direction of flow and material in pipe.

3.05 Concrete Work

A. Thrust blocks, underground anchors, and pads for cleanouts and valve access boxes are included under this section of the specifications. Concrete shall be 2500# psi.

3.06 Insulation Work

A. General

1. All mechanical materials shall have a flame-spread rating not to exceed 25 and a smoke density not to exceed 50 for duct insulation per California mechanical Code (CMC) Section 604. Maximum flame spread 25 and smoke density not to

exceed 450 for pipe insulation per California Building Code (CBC) 719.7.

2. Pipe Insulation Protection

a. See Pipe Hanger Section 15000, 3.01.E.4.

B. Pipe Insulation

1. The term piping used herein shall include pipe, valves, pumps, strainers, solid separators and fittings. Apply insulating cement to fittings and trowel smooth to the thickness of adjacent coverings. Cover with jacket to match insulation. Fitting covers shall be as specified below.

2. Clean thoroughly, test and have approved all piping and equipment before installing insulation.

3.

Pipe Size -	1" and Smaller	1-1/4"-6"	8" and Larger
INSULATION THICKNESS	1"	1"	1-1/2"

C. Insulation of piping (above ground, within uninsulated portion of the building)

1. Insulate all new and exposed existing chilled water and hot water piping with 3-1/2# per cubic foot minimum density. Fiberglass with ASJ-SSL jacket or approved equal.

D. Insulation of piping (above ground, within insulated portion of the building)

1. Insulate all new and abated hot water and chilled water piping with 3 ½ # per cubic foot minimum density. Fiberglass with ASJ-SSL jacket or approved equal.

E. Insulation of piping (above ground, outside building and within boiler and mechanical room)

1. Insulate all new and abated chilled water and hot water piping with 3-1/2# per cubic foot minimum density fiberglass with aluminum or vinyl jacket and aluminum or vinyl fitting covers or approved equal. The jacket shall cover pipe shields specified in Section 15000, 3.01.E.4.

3.07 Test and Adjustment

A. Test the installations in accordance with the following requirements and all applicable codes.

B. Test Schedule: No loss in pressure or visible leaks shall show after two hours at the pressure indicated for gas and hot water.

System Tested	Test Pressure PSI	Test With
Gas	50	Air & Soap
Chilled Water	65	Water
Heating Hot Water	65	Water

C. Perform operational tests for gas, cold/chilled water/hot water systems under a simulated or actual service conditions, including one test of complete plumbing installation with all fixtures and other appliances connected.

D. Should any material or work fail in any of these tests, it shall be immediately removed and replaced by new material, and portion of the work replaced shall again be tested by the contractor at his own expenses.

E. Instruct Owner's operating personnel during operating adjustment period. Lubricant each item of equipment, including motors, before operation.

3.08 System Balance

A. An Independent Balance Contractor shall properly balance and adjust the hot water and chilled water distribution systems as follows. The air distribution system shall be tested under the alternate add (if accepted), otherwise in base bid.

1. Tabulate the results of testing on the approved forms and submit six (6) copies for approval and record. Work shall be performed by a licensed contractor.

2. Perform this work in accordance with the procedures and standards described in the SMACNA Balancing and Adjusting manual. Reports are to be made on SMACNA forms or facsimiles thereof. The Balance Contractor shall be a member of the Associated Air Balance Council (AABC) or certified by the National Environmental Balancing Bureau (NEBB).

3.09 Seismic Restraint for Bracing of Pipes

A. All breeching piping and equipment shall be installed with seismic anchoring/bracing in compliance with the 1998 SMACNA EDITION OF "Guidelines for Seismic Restraints of Mechanical Systems" as published by Sheet Metal Industry Fund of Los Angeles (SMACNA). A copy of this manual shall be at the job site at all times until final acceptance of the project.

B. These guidelines are not intended for the seismic design of the piping. Piping shall be designed with consideration given to the dynamic properties of the piping and structure.

C. Bracing, supports, schedules and notes apply to all types of pipe and all types of joints.

1. Brace all pipes 2-1/2" diameter and larger:

2. Exceptions:

a. Brace all piping 1-1/4" and larger located in boiler rooms, mechanical equipment rooms and refrigeration machinery rooms. Bracing requirements for pipes less than 2-1/2" in diameter shall be the same as for 2-1/2" pipes in all other locations.

b. Brace all fuel gas and oil piping, medical gas piping and compressed air piping 1" and larger.

c. Seismic braces may be omitted: (1) when the top of the pipe is suspended 12" or less from the supporting structure member and the pipe is suspended by an individual hanger. (2) on all piping 3/4" and smaller.

d. Seismic braces may be omitted: (1) when the top of the pipe is suspended 12" of less from the supporting structure member and the pipe is suspended by an individual hanger. (2) on all piping 3/4" and smaller.

D. Details in guidelines provide a lateral bracing system. A typical vertical support system conforming to the following Title 24 requirements must also be used.

1. Vertical Piping

a. Attachment - Vertical piping shall be secured sufficiently close intervals to keep the pipe in alignment and carry the weight of the pipe and contents. Stacks shall be supported at their bases

and if over 2 stories in height at each floor by approved metal floor clamps.

b. Screwed pipe - Screwed pipe (I.S.P.) shall be supported at not less than every other story height.

c. Copper Tubing - Copper Tubing shall be supported at each story for piping 1-1/2" and larger diameter and at not more than 6-foot intervals for piping 1-1/2" and smaller in diameter.

d. Pipes of other approved material shall be supported in accordance with their approved installation standards.

2. Horizontal Piping

a. Supports - Horizontal piping shall be supported at close intervals to keep it in alignment and prevent sagging.

b. Screwed Pipe - Screwed Pipe (I.P.S.) pipe shall be supported at approximately 10 foot intervals.

c. Copper Tubing - Copper tubing shall be supported at approximately 6-foot intervals for tubing 1-1/2" and smaller in diameter and 10 foot intervals for tubing 2" and larger in diameter.

d. Pipes of other approved materials shall be supported in accordance with their approved installation standards.

E. Transverse bracing's at 40' - 0" 0.c. maximum unless otherwise noted. When thermal expansion or contraction is involved, provide longitudinal braces and the connections must be capable of resisting the force induced by expansion and contraction.

F. Longitudinal bracing at 80' - 0" 0.c. maximum unless otherwise noted. When thermal expansion or contraction is involved, provide longitudinal bracings at anchor points. The longitudinal braces and the connections must be capable of resisting the force induced by expansion and contraction.

G. Transverse bracing for one pipe section may also act as longitudinal bracing for the pipe section connected perpendicular to it, if the bracing is installed within 24" of the elbow or tee of similar size.

H. For threaded piping the flexibility may be provided by the installation of swing joints. In welded or solder joint piping the flexibility shall be provided by expansion loops or manufactured flexible connectors. For piping with manufactured ball joints select length of piping offset using "Seismic Drift" in place of "Expansion per Joint Manufacturers" selection table. Seismic Drift = 0.015 ft. per foot of height.

I. Do not use branch lines to brace main lines.

J Trapeze hangers may be used. Provide flexibility in joints where pipes pass through building seismic or expansion joints, or where rigidly supported pipes connect to equipment with vibration isolators.

K. A rigid piping system shall not be braced to dissimilar parts of a building or two dissimilar systems that may respond in a different mode during an earthquake. Examples: Wall and roof; solid concrete wall and a metal deck with lightweight concrete fill.

L. Provide large enough pipe sleeves through walls or floors to allow for anticipated differential movements.

M. At vertical pipe risers, wherever possible, support the weight of the riser at a point or points above the center of gravity of the riser. Provide lateral guides at the top and bottom of the riser, and at intermediate points not to exceed 30'-0" on center.

N. Cast iron pipe of all types, glass pipe and any other pipe joined with a shield and clamp assembly where the top of the pipe is a 12" or more from supporting structure shall be braced on each side of a change in direction of 90 degrees or more. Riser joints shall be braced or stabilized between floors.

O. For gas piping, the guideline bracing details, schedules and notes may be used except that transverse bracing shall be at 20'-0" o.c. maximum. Also 1", 1-1/4", 1-1/2" and 2" diameter pipes shall be braced the same as 2-1/2" diameter pipe in the schedule. (No bracing is required for pipes 3/4" diameter and smaller).

P. Proprietary bracing systems approved by DSA may be used in lieu of the braces shown in the details.

Q. The seismic bracing and support of fire sprinkler piping shall comply with the 1999 edition of NFPA 13. U-type hangers used as sway bracing must have legs bent out 10 degrees and must have a

slenderness ration not exceeding 200. Provide calculations and details for support and bracing members and connections not covered by NFPA 13, or, where applicable, refer to the latest SMACNA "Guidelines for Seismic Restraints of Mechanical Systems and Plumbing Piping Systems" or No. R-0003, the "Superstrut Seismic Restraint System" or No. R-0071 the "Kin Line Seismic Restraint System."

R. It is the responsibility of the user of the guidelines to ascertain that an appropriate size device be selected for each individual piece of equipment.

S. The design force level used in this guideline exceeds most Seismic Class III force levels in nuclear installation. (Reference only).

T. Essential facilities or life safety equipment. “Essential facilities” mentioned in the guidelines are those structures or buildings which must be safe and usable for emergency purposes after an earthquake in order to preserve the health and safety of the general public.

3.10 Seismic Restraint Guidelines for Equipment

A. Equipment Restraints

1. Mechanical Equipment Anchorages such as bolts, expansion anchors, screws, etc., shall comply with the force level requirements of Title 24, Part 2 Code of Regulations, Table No. 16A-0.

B. Restraining Devices shall be designed to conform to the force level requirements of Note 1. The following companies, in the past, have met these requirements on a job to job submittal. The names are listed for convenience only with no intention of excluding other companies.

California Dynamics Corporation
Mason Industries, Inc.
M.W. Sausse and Company, Inc.

Manufacturers shall provide submittals for all vibration isolators and their anchorages, showing the manufacturer, model type, model number, base plate size, quantity used and location at each piece of equipment, and how it is connected to the structure. Provide calculations, details, and/or test data to substantiate their structural adequacy to resist vertical and lateral loads.

C. Restraining devices must be placed on all sides of the equipment base, as shown on the Drawings.

D. It is the entire responsibility of the Equipment Manufacturer to design his equipment so that the strength and anchorage of the internal components of the equipment exceeds the force level used to restrain and anchor the unit itself to the supporting structure.

E. It is the responsibility of the Mechanical Engineer to ascertain that an appropriate size device be selected for each individual piece of equipment.

END OF SECTION 15000

SECTION 15200 - HEATING, VENTILATION AND AIR CONDITIONING

PART 1 – GENERAL

1.01 The General Conditions apply to this section, also applicable provisions of Section 15000.

1.02 Scope

A. Furnish and install all heating, ventilating and air conditioning work indicated on the drawings and described herein. Also, any incidental work not shown or specified that is necessary to provide the complete system.

PART 2 – PRODUCTS

2.01 Hot Water Pumps

A. Pump shall be of the close-coupled, inline type, and high performance.

B. Pump casing shall be closed grain, cast iron fitted with a replaceable bronze case wear ring. Motor and rotating parts shall be designed to be removed without removing the pump from piping.

C. Pump shaft shall be fitted with a leakless mechanical seal.

D. Pump impeller shall be of the enclosed type of cast bronze and shall be statically and dynamically balanced.

E. The entire pump and motor unit, on base mounted pump, shall be mounted on a cast iron base.

F. The pump motor shall be Premium Duty Open Drip Proof, the horsepower, voltage, phase, RPM as scheduled on the Drawings.

2.02 Hot Water Boiler

A. The boiler shall be Bryan type DR850-W flexible water tube type, as scheduled on the Drawings, ASME 60 psi, and 250 degrees F construction with 60 psi relief valve.

B. The tubes in the section shall be easily removable from one side and replaced without welding.

C. The boiler shall be furnished with large volume downcomers to provide full and rapid circulation and temperature equalization. The boiler shall have a minimum of 5.0 square feet of heating surface per boiler horsepower.

D. The boiler shall meet the requirements and construction of the State of California and the ASME Boiler Code and stamped with the ASME symbol. Boiler vessel is to be completely insulated & jacketed.

E. The burner shall be of the forced draft type. Firing shall be as shown on the equipment schedule and provided with gas valves and regulators for Natural Gas quiet operation.

F. Electronic combustion safety control, automatic operating gas valve, safety gas valve, pilot solenoid valve, pilot ignition assembly, main manual gas shut-off valve, pilot cock, pilot and main gas pressure regulators, air safety switch, control panel, all controls installed and wired.

G. Control voltage shall be 120-volt single phase and shall comply with California Boiler Safety Orders.

2.03 Chilled Water Pumps

A. Pump shall be of the close-coupled, base mounted or inline type and high performance as specified on the Drawings.

B. Pump casing shall be closed grain, cast iron fitted with a replaceable bronze case wear ring. Motor and rotating parts shall be designed to be removed without removing the pump from piping.

C. Pump shaft shall be fitted with a leakless mechanical seal.

D. Pump impeller shall be of the enclosed type of cast bronze and shall be statically and dynamically balanced.

E. The base mounted pump and motor unit shall be mounted on a cast iron base.

F. The pump motor shall be Premium Duty Open Drip Proof, the horsepower, voltage, phase, RPM as scheduled on the Drawings.

2.04 Liquid/Solids Separator (SS-1)

A. A centrifugal vortex separator shall be as shown on the Drawings to remove all separable solids from the system. The separator shall be a "sidestream" or "in-line" type and shall remove 98%, by weight, of separable solids 200 mesh (5 to 75 microns) and larger.

B. The separator shall be designed with tangential entry into the acceptance chamber. Upon tangential entry, the liquid/solids are drawn through internal tangential slots and accelerated into the reduce diameter separation cylinder. The solids heavier than the carrying liquid are centrifugally spiraled down the perimeter of the separation cylinder past the deflector stool and allowed to accumulate in the separator's collection chamber. The liquid (free of separable solids) will follow the vortex created and centered on the deflector stool up through the interior of the separation cylinder and into the vortex finder which becomes the separator outlet.

C. The separator shall also incorporate a pressure relief line from the collection chamber to the venturi located in the tangential inlet to enhance separation by facilitating quiescent solids sedimentation in the collection chamber. Quiescent solids accumulation shall also be facilitated by the baffle spin arrestor below the deflector stool in the collection chamber. Separation and collection of solids shall not promote excessive wear or require a continuous "involuntary" underflow.

D. The separator shall have a flanged tangential inlet and a flanged outlet. The separator shall have a purge outlet and an auxiliary bleed outlet. The separator shall operate with flow range and pressure drop as scheduled on the Drawings. The separator shall be designed for a maximum operating pressure of 125 psi.

E. Separator construction shall be fabricated of carbon steel and be provided with 150 pounds A.N.S.I. raised face flanges. The "in-line" separator shall also be provided with a removable upper lap, conveniently located to allow for the potential servicing or inspection of the collection chamber.

F. The separator shall be as scheduled on the Drawings or approved equal.

G. Solids collected shall pass from the separator collection chamber via a purge connection to a closed liquid recovery tank where the purged solids will be collected and the purged liquid will be able to return back into the system.

H. Components included with separator are: centrifugal pump with cast iron strainer housing, with a stainless steel 7mm mesh basket; electrical control panel with pump starter with overload protection and controls.

I. All components piped and assembled on a skid plate made of 3/16" stainless steel.

J. Five (5) year warranty on separator. All other components are warranted for twelve (12) months from date of start up or eighteen (18) months from date of shipment.

2.05 Closed Recovery Tank

A. The closed recovery tank shall be equipped internally with a solids collection bag in a stainless steel basket which will collect all purged solids. The closed recovery tank shall be equipped with an "indicator package" which will signal the need to clean the collection bags.

B. Construction of the closed recovery tank and lid shall be carbon steel with a minimum thickness of 3/16" with an internal epoxy coating. The internal basket is stainless steel and will be provided with polyester-felt collector bags. The indicator package shall include (2) 3/4" bronze body, stainless steel ball valves, (2) 3/4" bronze body sightglasses, (1) 3/4" bronze body flow control orifice, (1) "pop-up" style annunciator with necessary hardware.

C. The closed recovery system shall be as scheduled on the Drawings or approved equal.

2.06 Heat Exchanger: (Plate & Frame)

A. Furnish and install as scheduled on the drawings, heat exchangers with enhanced baffle plate design.

B. Heat exchangers shall be cleanable with a cleaning solution or by disassembly. Fluid flow paths shall be counterflow. No parallel or crossflow fluid paths shall be allowed. The heat exchanger shall be supplied with integral housing to protect the plates.

C. Plates

1. The plate shall be of type 304 SS. The plate heat transfer surface design shall be rectangular washboard or herring bone as scheduled on the drawings.

2. The plate shall have internal weep holes that will allow the transfer of the heat transfer fluids when a leak develops to the outside of the plate with no cross-contamination.

D. Frame Assembly

1. The frame assembly shall be carbon steel with a baked epoxy enamel finish. The bolts and nuts for compressing and holding the plates in place shall be type 316 SS.

2. The plate and frame assembly shall be pressure tested under water with air at 150 PSI.

3. The frame shall be supplied with 150# ASA rated steel flanges.

E. Compression Seal

1. A compression seal shall be provided between the plate and frame, and each plate. The compression seal shall be nitrile rubber and be able to withstand the operating pressure and temperature ranges as specified on the drawings. Over-tightening of the tightening bolts shall not damage the structural integrity of the heat exchanger.

2.07 Access Doors (Painted Wall or Ceiling)

If additional access doors are required then present an RFI for change order request prior to installation.

A. Milcor Style M, Karp, or as approved with concealed hinges, allen head locks, and prime coated with rust inhibitive paint. Door to suit ceiling or wall construction including fire-rating, when required. Doors shall be 14 gauge C.R. Steel and shall be 12 inches by 12 inches unless otherwise noted on the Drawings.

2.08 Access Doors (Tile Surface or Where Specified)

A. Milcor Style MS, Karp, or as approved with concealed hinges, allen head locks, stainless steel door and frame. Door to suit ceiling or wall construction including fire-rating, when required. Doors shall

be 16 gauge stainless steel and shall be 12 inches by 12 inches unless otherwise noted on the Drawings.

B. Furnish and install where shown on the Drawings a flush mounted, State Fire Marshal listed, access door.

C. Frame shall be 16 GA steel with a l" flange.

D. Door shall be 20 GA steel with a continuous hinge and a flush key latch.

E. Finish shall be a prime coat and a finished coat of baked enamel to match adjacent surface.

PART 3 - EXECUTION

3.01 FILTERS

A. Air filters shall be of an approved type tested in accordance with test method SFM Std. 12-71-1 as shown in Part 12, Title 24, California Code of Regulations. Preformed filters having combustible framing shall be tested as a complete assembly. Air filters in all occupancies shall be Class 2 or better (as shown in the State Fire Marshall listing).

B. Provide temporary filters for all fans that are used during construction; after all construction dirt has been removed from the building, install new filters at no additional cost to the Owner.

C. Air filters shall be accessible for cleaning or replacement.
D. Filters shall be 2" thick Farr 30/30, Eco-Air E-35 or approved equal.

3.02 SHEET METAL WORK

A. Construct and install all sheet metal in accordance with the latest SMACNA recommendations. Provide variations in duct size, and additional duct fittings as required to clear obstructions and maintain clearances, as approved by the Engineer, at no extra cost to the Owner. Pressure class shall be 3" wc.

B. Exterior ductwork shall be sealed watertight with hardcast RTA 50 adhesive and DT-tape or Glenkote.

C. Interior ductwork shall be sealed watertight with hardcast RTA 20 adhesive and DT-tape or Glenkote.

D. Duct sealer system must be installed in strict conformance with the manufacturer's application instructions.

E. Provide drive slip or equivalent flat seams for ducts where necessary due to space limitations. On ducts with flat seams, provide standard reinforcing inside of duct.

F. Provide Duro-Dyne Ventlon flexible connections on inlet and outlet of each fan.

G. Duct size shown on lined duct is the inside dimension.

H. All round ductwork shall be metal, except fiberglass flexible duct shall be used on to the requirements of C.M.C. Standard No. 6-1. Each portion of a factory-made air duct system shall be identified by the manufacturer with a label or other suitable identification indicating compliance with C.M.C. Standard No. 6-1 and its class designation. These ducts shall be listed and shall be installed in the final 6'-0" connection to the diffuser in concealed areas. Transformation and bends to ductwork, to avoid obstructions, must be approved by the Engineer. Protect ductwork from damage during and after erection until final inspection.

I. Flexible ducts shall conform the following requirements:

1. Factory-made air ducts shall be approved for the use intended or shall conform accordance with the terms of their listing.

2. Flexible ducts shall consist of an exterior reinforced laminated vapor barrier, 1-1/2" thick fiber glass insulation (K=.25 @ 75 degrees F), encapsulated spring steel wire Helix and impervious, smooth, non-perforated interior vinyl liner. Individual lengths of flexible ducts shall contain factory fabricated steel connection collars.

3. Flexible ducts shall be supported at or near mid-length with 2” wide 28 GA. Steel hanger collar attached to the structure with an approved duct hanger. Installation shall minimize sharp radius turns or offsets. The maximum length connecting to terminal outlets shall be seven feet.

4. Flexible ducts may be used to cross-seismic joints without offsets.

5. Flexible air ducts shall be anchored and supported per the latest SMACNA air duct annual.

3.03 GRILLES

A. Provide all outlets with gaskets and install so that there will be no streaking of the walls or ceiling due to leakage.

B. Furnish all diffusers, registers, and grilles with off-white baked enamel finish and white gaskets on ceiling-mounted outlets. Paint to match adjacent ceiling color.

C. All visible surfaces behind air outlet faces to be painted flat black.

3.04 VARIABLE VOLUME BOXES (Alternate Add)

A. The Variable Volume Boxes shall be Titus Series ESV 3000 single duct pressure independent type with hot water coils.

B. The boxes shall be set at the factory for a minimum of 50 percent CFM.

C. The box controller shall have an amplifying probe and flow logic analyzer.

D. See schedule for size and accessories.

E. Duct Heating Coil

1. Coils shall be 5/8" O.D. copper tubing, 025" wall thickness, with continuous flat aluminum plate fins, 8 fpi maximum, and hydraulically tested at 300 psi.

3.05 START-UP PROCEDURE

A. Hot and chilled water system.

B. Fill the system with clean water through the quick-fill by-pass and with all air bleeds open.

C. Open all control valves.

D. When the system is full, check the pump rotation and shut-it off.

E. Shut all manual air bleeds.

F. Close the butterfly valve on the pump discharge to 25% open.

G. Start the pump and check amperage of the pump motor.

H. Open the butterfly valve on the pump discharge until the motor amperage reaches the system water design flow.

I. Allow the system to operate until all air is purged from the system.

J. Clean all the strainers in the system.

K. Check all systems for leaks.

L. Shut-off the quick-fill by-pass valve and reduce the system pressure to normal operating pressure.

M. Balance the systems as required in SECTION 15000, PART 3 – EXECUTION, Item “l”.

N. Sample the water and provide the proper amount of inhibitors to protect the system.

O. Provide start-up and balance reports to the Owner.

3.06 TEMPERATURE CONTROLS (See SECTION 15950)

END OF SECTION 15200

SECTION 15500 - DUCT CLEANING

PART 1 – SPECIAL PROVISIONS

1.01 Qualification of the HVAC System Cleaning Contractor

A. Membership: The HVAC system cleaning contractor shall be a certified member of the National Air Duct Cleaners Association (NADCA), or shall maintain membership in a nationally recognized non-profit industry organization dedicated to the cleaning of HVAC systems.

B. Certification: The HVAC system cleaning contractor shall have a minimum of one (1) Air System Cleaning Specialist (ASCS) certified by NADCA on a full time basis, or shall have staff certified by a nationally recognized certification program and organization dedicated to the cleaning of HVAC systems.

C. Supervisor Qualifications: A person certified as an ASCS by NADCA, or maintaining an equivalent certification by a nationally recognized program and organization, shall be responsible for the total work herein specified.

D. Experience: The HVAC system cleaning contractor shall submit records of experience in the field of HVAC system cleaning as requested by the City of Stockton. Bids shall only be considered from firms which are regularly engaged in HVAC system maintenance with an emphasis on HVAC system cleaning and decontamination.

E. Equipment, Materials and Labor: The HVAC system cleaning contractor shall possess and furnish all necessary equipment, materials and labor to adequately perform the specified services.

1. The contractor shall assure that its employees have received safety equipment training, medical surveillance programs, individual health protection measures, and manufacturer's product and material safety data sheets (MSDS) as required for the work by the U.S. Occupational Safety and Health Administration, and as described by this specification. For work performed in countries outside of the U.S.A., contractors should comply with applicable national safety codes and standards.

2. The contractor shall maintain a copy of all current MSDS documentation and safety certifications at the site at all times, as well as comply with all other site documentation

requirements of applicable OSHA programs and this specification

3. Contractor shall submit to the City of Stockton all Material Safety Data Sheets (MSDS) for all chemical products proposed to be used in the cleaning process.

F. Licensing: The HVAC system cleaning contractor shall provide proof of maintaining the proper license(s), if any, as required to do work in this state. Contractor shall comply with all Federal, state and local rules, regulations, and licensing requirements.

1.02 Standards

A. NADCA Standards: The HVAC system cleaning contractor shall perform the services specified here in accordance with the current published standards of the National Air Duct Cleaners Association (NADCA).

1. All terms in this specification shall have their meaning defined as stated in the NADCA Standards.

2. NADCA Standards must be followed with no modifications or deviations being allowed.

1.03 Documents

A. Mechanical Drawings: The City of Stockton shall provide the HVAC system cleaning contractor with one copy of the following documents:

1. Project drawings and specifications.

2. Approved construction revisions pertaining to the HVAC system.

3. Any existing indoor air quality (IAQ) assessments or environmental reports prepared for the facility.

PART 2 – HVAC SYSTEM CLEANING SPECIFICATIONS/REQUIREMENTS

2.01 Scope of Work

A. Scope: This section defines the **minimum** requirements necessary to render HVAC components clean, and to verify the cleanliness

through inspection and/or testing in accordance with items specified herein and applicable NADCA Standards.

B. The Contractor shall be responsible for the removal of visible surface contaminants and deposits from within the HVAC system in strict accordance with these specifications.

C. The HVAC system includes any interior surface of the facility's air distribution system for conditioned spaces and/or occupied zones. This includes the entire heating, air-conditioning and ventilation system from the points where the air enters the system to the points where the air is discharged from the system. The return air grilles, return air ducts to the air handling unit (AHU), the interior surfaces of the AHU, mixing box, coil compartment, condensate drain pans, supply air ducts, fans, fan housing, fan blades, turning vanes, filters, filter housings, reheat coils, and supply diffusers are all considered part of the HVAC system. The HVAC system may also include other components such as dedicated exhaust and ventilation components and make-up air systems.

Note: Reheat coils will **not** need cleaning, if "alternate add #1" is accepted.

2.02 HVAC System Component Inspections and Site Preparations

A. HVAC System Component Inspections: Prior to the commencement of any cleaning work, the HVAC system cleaning contractor shall perform a visual inspection of the HVAC system to determine appropriate methods, tools, and equipment required to satisfactorily complete this project. The cleanliness inspection should include air handling units and representative areas of the HVAC system components and ductwork. In HVAC systems that include multiple air handling units, a representative sample of the units should be inspected.

The cleanliness inspection shall be conducted without negatively impacting the indoor environment through excessive disruption of settled dust, microbial amplification or other debris. In cases where contamination is suspected, and/or in sensitive environments where even small amounts of contaminant may be of concern, environmental engineering control measures should be implemented

1. Damaged system components found during the inspection shall be documented and brought to the attention of the City of Stockton.

B. Site Evaluation and Preparations: Contractor shall conduct a site evaluation, and establish a specific, coordinated plan which details how each area of the building will be protected during the various phases of the project.

C. Inspector Qualifications: Qualified personnel should perform the HVAC cleanliness inspection to determine the need for cleaning. At minimum, such personnel should have an understanding of HVAC system design, and experience in utilizing accepted indoor environmental sampling practices, current industry HVAC cleaning procedures, and applicable industry standards.

2.03 General HVAC System Cleaning Requirements

A. Containment: Debris removed during cleaning shall be collected and precautions must be taken to ensure that Debris is not otherwise dispersed outside the HVAC system during the cleaning process.

B. Particulate Collection: Where the Particulate Collection Equipment is exhausting inside the building, HEPA filtration with 99.97% collection efficiency for 0.3-micron size (or greater) particles shall be used. When the Particulate Collection Equipment is exhausting outside the building, Mechanical Cleaning operations shall be undertaken only with Particulate Collection Equipment in place, including adequate filtration to contain Debris removed from the HVAC system. When the Particulate Collection Equipment is exhausting outside the building, precautions shall be taken to locate the equipment down wind and away from all air intakes and other points of entry into the building.

C. Controlling Odors: Measures shall be employed to control odors and/or mist vapors during the cleaning process.

D. Component Cleaning: Cleaning methods shall be employed such that all HVAC system components must be Visibly Clean as defined in applicable standards (see NADCA Standards). Upon completion, all components must be returned to those settings recorded just prior to cleaning operations.

E. Air-Volume Control Devices: Dampers and any air-directional mechanical devices inside the HVAC system must have their position marked prior to cleaning and, upon completion, must be restored to their marked position.

F. Service Openings: The contractor shall utilize service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry, and inspection.

1. Contractor shall utilize the existing service openings already installed in the HVAC system where possible.

2. Other openings shall be created where needed and they must be created so they can be sealed in accordance with industry codes and standards.

3. Closures must not significantly hinder, restrict, or alter the airflow within the system.

4. Closures must be properly insulated to prevent heat loss/gain or condensation on surfaces within the system.

5. Openings must not compromise the structural integrity of the system.

6. Construction techniques used in the creation of openings should conform to requirements of applicable building and fire codes, and applicable NFPA, SMACNA and NADCA Standards.

7. Cutting service openings into flexible duct is not permitted. Flexible duct shall be disconnected at the ends as needed for proper cleaning and inspection.

8. Rigid fiber glass duct systems shall be resealed in accordance with NAIMA recommended practices. Only closure techniques that comply with UL Standard 181 or UL Standard 181a are suitable for fiber glass duct system closures.

9. All service openings capable of being re-opened for future inspection or remediation shall be clearly marked and shall have their location reported to the City of Stockton in project report documents.

G. Ceiling sections (tile): The contractor may remove and reinstall ceiling sections to gain access to HVAC systems during the cleaning process.

H. Air distribution devices (registers, grilles & diffusers): The contractor shall clean all air distribution devices.

I. Air handling units, terminal units (VAV, Dual duct boxes, etc.), blowers and exhaust fans: The contractor shall insure that supply, return, and exhaust fans and blowers are thoroughly cleaned. Areas to be cleaned include blowers, fan housings, plenums (except ceiling supply and return plenums), scrolls, blades, or vanes, shafts, baffles, dampers and drive assemblies. All visible surface contamination deposits shall be removed in accordance with NADCA Standards. Contractor shall:

1. Clean all air handling units (AHU) internal surfaces, components and condensate collectors and drains.

2. Assure that a suitable operative drainage system is in place prior to beginning wash down procedures.

3. Clean all coils and related components, including evaporator fins.

J. Duct Systems. Contractor shall:

1. Create service openings in the system as necessary in order to accommodate cleaning of otherwise inaccessible areas.

2. Mechanically clean all duct systems to remove all visible contaminants, such that the systems are capable of passing Cleaning Verification Tests (see NADCA Standards).

2.04 Health and Safety

A. Safety Standards: Cleaning contractors shall comply with applicable federal, state, and local requirements for protecting the safety of the contractor's employees, building occupants, and the environment. In particular, all applicable standards of the Occupational Safety and Health Administration (OSHA) shall be followed when working in accordance with this specification.

B. Occupant Safety: No processes or materials shall be employed in such a manner that they will introduce additional hazards into occupied spaces.

C. Disposal of Debris: All Debris removed from the HVAC System shall be disposed of in accordance with applicable federal, state and local requirements.

2.05 Mechanical Cleaning Methodology

A. Source Removal Cleaning Methods: The HVAC system shall be cleaned using Source Removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and safely remove contaminants from the facility. It is the contractor's responsibility to select Source Removal methods that will render the HVAC system Visibly Clean and capable of passing cleaning verification methods (See applicable NADCA Standards) and other specified tests, in accordance with all general requirements. No cleaning method, or combination of methods, shall be used which could potentially damage components of the HVAC system or negatively alter the integrity of the system.

1. All methods used shall incorporate the use of vacuum collection devices that are operated continuously during cleaning. A vacuum device shall be connected to the downstream end of the section being cleaned through a predetermined opening. The vacuum collection device must be of sufficient power to render all areas being cleaned under negative pressure, such that containment of debris and the protection of the indoor environment are assured.

2. All vacuum devices exhausting air inside the building shall be equipped with HEPA filters (minimum efficiency), including hand-held vacuums and wet-vacuums.

3. All vacuum devices exhausting air outside the facility shall be equipped with Particulate Collection including adequate filtration to contain Debris removed from the HVAC system. Such devices shall exhaust in a manner that will not allow contaminants to re-enter the facility. Release of debris outdoors must not violate any outdoor environmental standards, codes or regulations.

4. All methods require mechanical agitation devices to dislodge debris adhered to interior HVAC system surfaces, such that debris may be safely conveyed to vacuum collection devices. Acceptable methods will include those, which will not potentially damage the integrity of the ductwork, nor damage porous surface materials such as liners inside the ductwork or system components.

B. Methods of Cleaning Fibrous Glass Insulated Components

1. Fibrous glass thermal or acoustical insulation elements present in any equipment or ductwork shall be thoroughly

cleaned with HEPA vacuuming equipment, while the HVAC system is under constant negative pressure, and not permitted to get wet in accordance with applicable NADCA and NAIMA standards and recommendations.

2. Cleaning methods used shall not cause damage to fibrous glass components and will render the system capable of passing Cleaning Verification Tests (see NADCA Standards).

C. Damaged Fibrous Glass Material

1. Evidence of damage: If there is any evidence of damage, deterioration, delaminating, friable material, mold or fungus growth, or moisture such that fibrous glass materials cannot be restored by cleaning or resurfacing with an acceptable insulation repair coating, they shall be identified for replacement.

2. Replacement: When requested or specified, Contractor must be capable of remediating exposed damaged insulation in air handlers and/or ductwork requiring replacement.

3. Replacement material: In the event fiber glass materials must be replaced, all materials shall conform to applicable industry codes and standards, including those of UL and SMACNA.

Replacement of damaged insulation is **not** covered by this specification.

D. Cleaning of coils

1. Any cleaning method may be used which will render the Coil Visibly Clean and capable of passing Coil Cleaning Verification (see applicable NADCA Standards). Coil drain pans shall be subject to Non-Porous Surfaces Cleaning Verification. The drain for the condensate drain pan shall be operational. Cleaning methods shall not cause any appreciable damage to, displacement of, inhibit heat transfer, or erosion of the coil surface or fins, and shall conform to coil manufacturer recommendations when available. Coils shall be thoroughly rinsed with clean water to remove any latent residues.

E. Antimicrobial Agents and Coatings

1. Antimicrobial agents shall only be applied if active fungal growth is reasonably suspected, or where unacceptable levels of fungal contamination have been verified through testing.

2. Application of any antimicrobial agents used to control the growth of fungal or bacteriological contaminants shall be performed after the removal of surface deposits and debris.

3. When used, antimicrobial treatments and coatings shall be applied in strict accordance with the manufacturer's written recommendations and EPA registration listing.

4. Antimicrobial coatings shall be applied according to the manufacturer's written instructions. Coatings shall be sprayed directly onto interior ductwork surfaces, rather than "fogged" downstream onto surfaces.

2.06 Cleanliness Verification

A. General: Verification of HVAC System cleanliness will be determined after mechanical cleaning and before the application of any treatment or introduction of any treatment-related substance to the HVAC system, including biocidal agents and coatings.

B. Visual Inspection: The HVAC system shall be inspected visually to ensure that no visible contaminants are present.

1. If no contaminants are evident through visual inspection, the HVAC system shall be considered clean; however, the City of Stockton reserves the right to further verify system cleanliness through Surface Comparison Testing or the NADCA vacuum test specified in the NADCA standards.

2. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re-cleaned and subjected to re-inspection for cleanliness.

3. NADCA vacuum test analysis should be performed by a qualified third party experienced in testing of this nature.

C. Verification of Coil Cleaning

1. Cleaning must restore the coil pressure drop to within 10 percent of the pressure drop measured when the coil was first installed. If the original pressure drop is not known, the coil

will be considered clean only if the coil is free of foreign matter and chemical residue, based on a thorough visual inspection (see NADCA Standards).

2.07 Pre-existing System Damage

A. Contractor is not responsible for problems resulting from prior inappropriate or careless cleaning techniques of others.

2.08 Post-project Report

A. At the conclusion of the project, the Contractor shall provide a report to the City of Stockton indicating the following:

1. Success of the cleaning project, as verified through visual inspection and/or gravimetric analysis.

2. Areas of the system found to be damaged and/or in need of repair.

2.09 Applicable Standards and Publications:

A. The following current standards and publications of the issues currently in effect form a part of this specification to the extent indicated by any reference thereto:

1. National Air Duct Cleaners Association (NADCA): “Assessment, Cleaning & Restoration of HVAC Systems (ACR 2005),” 2004.

2. National Air Duct Cleaners Association (NADCA): “Understanding Microbial Contamination in HVAC Systems,” 1996.

3. National Air Duct Cleaners Association (NADCA): “Introduction to HVAC System Cleaning Services,” 2004.

4. National Air Duct Cleaners Association (NADCA): Standard 05 “Requirements for the Installation of Service Openings in HVAC Systems,” 2004.

5. Underwriters’ Laboratories (UL): UL Standard 181.

6. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE): Standard 62-89, "Ventilation for Acceptable Indoor Air Quality".

7. Environmental Protection Agency (EPA): "Building Air Quality," December 1991.

8. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): “HVAC Duct Construction Standards - Metal and Flexible,” 1985.

9. North American Insulation Manufacturers Association (NAIMA): "Cleaning Fibrous Glass Insulated Air Duct Systems," 1993.

END OF SECTION 15500

SECTION 15950 - TEMPERATURE CONTROLS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Building Automation System (BAS) manufacturer shall furnish and install a fully integrated building automation system, incorporating direct digital control (DDC) for energy management, equipment monitoring and control, and subsystems with open communications capabilities as herein specified. **The BAS shall be Siemens Apogee product to match City standards. No others will be accepted.**

B. The installation of the control system shall be performed under the direct supervision of the controls manufacturer with the shop drawings, flow diagrams, bill of materials, component designation or identification number and sequence of operation all bearing the name of the manufacturer. The installing manufacturer shall certify in writing, that the shop drawings have been prepared by the equipment manufacturer and that the equipment manufacturer has supervised their installation. In addition, the equipment manufacturer shall certify, in writing, that the shop drawings were prepared by their company and that all temperature control equipment was installed under their direct supervision.

C. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed specially for this project. All systems and components shall have been thoroughly tested and proven in actual use for at least two years.

D. BAS manufacturer shall be responsible for all BAS and Temperature Control wiring for a complete and operable system. All wiring shall be done in accordance with all local and national codes.

E. Temperature Controls (Boiler System)

1. All controls shall be Siemens Apogee product to match existing. Contact Andrew Jensen at 916-553-6926 for coordination.

2. Provide system color graphic.

3. Replace existing supply and return water temperature sensor and tie into New BAS field panels located in the basement.

4. Replace existing SCU-1, 2 & 3 with new Siemens Apogee PXC control panels. Reused all existing field wiring and conduit when applicable. Connect reused existing wiring to new field panels.

5. Furnish and install a flow switch where shown on the drawings and tie into new field panel.

6. Replace the boiler system, enable relay and tie into new field panel.

7. Replace existing current sensing relay and tie into new field panel.

8. Re-use existing outside air temperature sensor and tie into new field panel.

9. Replace existing current sensing relay for primary HWP-1 and tie into new field panel.

10. Replace existing current sensing relay for primary HWP-2 and tie into new field panel.

11. Replace secondary pump motor starter with VFD and tie into new field panel.

12. Provide water differential pressure sensor and tie into new field panel.

13. Provide and install all temperature controls, relays, switches and low voltage wiring for a complete temperature control system.

14. The Electrical Contractor shall install all line voltage wiring conduit and devices shown dotted on the mechanical drawings.

15. Temperature control device wells and differential pressure sensors shall be installed by Mechanical Contractor.

F. Temperature Controls (Cooling System)

1. All controls shall be Siemens Apogee product to match existing. Contact Andrew Jensen at 916-553-6926 for pricing.

2. Provide chiller/heat exchanger color graphic.

3. Replace existing supply water temperature sensor and tie into new field panel.

4. Furnish and install a flow switch where shown on the drawings and tie into new field panels.

5. Replace the on-off, enable relay and tie into tie into new field panels located in the basement.

6. Replace existing current sensing relay and tie into new field panels located in the basement.

7. Re-use existing outside air temperature sensor and tie into tie into new field panels.

8. Replace existing current sensing relay for primary CHWP-1 and tie into tie into new field panels.

9. Replace existing current sensing relay for primary CHWP-2 and tie into tie into new field panels.

10. Replace secondary pump motor starter with VFD and tie into new field panels.

11. Provide water differential pressure sensor and tie into field panel.

12. Provide and install all temperature controls, relays, switches and low voltage wiring for a complete temperature control system as shown on drawings and specifications..

13. The BAS contractor shall install all line voltage wiring conduit and devices shown dotted on the mechanical drawings.

14. Temperature control device wells and differential pressure sensors shall be installed by Mechanical Contractor.

1.02 WORK BY OTHERS

A. Mechanical contractor installs all wells, valves, taps, dampers, flow stations, etc. furnished by BAS manufacturer.

B. Electrical Contractor provides:

1. 120V power to all BAS an/or Temperature control panels

2. Wiring of all power feeds through all disconnect starters to electrical motor.

3. Wiring of any remote start/stop switches and manual or automatic motor speed control devices not furnished by BAS manufacturer

C. Products furnished but not installed under this section

1. Hydronic Piping:

    a. Control Valves
    b. Flow Switches
    c. Temperature Sensor Wells and Sockets
    d. Flow Meters

2. Refrigerant Piping:

    a. Pressure and Temperature Sensor Wells and Sockets

3. Duct-work Accessories:

    a. Automatic Dampers
    b. Air-flow Stations

1.03 RELATED WORK

A. DIVISION ONE GENERAL REQUIREMENT
B. SECTION15000 MECHANICAL
C. SECTION15200 HVAC
D. SECTION16000 ELECTRICAL

1.04 QUALITY ASSURANCE

A. The BAS system shall be designed and installed, commissioned and serviced by manufacturer employed, factory trained personnel. Manufacturer shall have an in-place support facility within 20 miles of the site with technical staff, spare parts inventory and necessary test and diagnostic equipment. **Distributors or licensed installing contractors are not acceptable.**

    The manufacturer shall provide an on site, experienced project manager for this work, responsible for direct supervision of the design, installation, start up and commissioning of the B.M.S.

    The Bidder shall be regularly engaged in the manufacturing, installation and maintenance of BMS systems and shall have a minimum of ten (10) years of demonstrated technical expertise and experience in the manufacture, installation and maintenance of B.M.S. systems similar in size and complexity to this project.

B. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of

automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.

C. All BAS peer-to-peer network controllers, central system controllers and local user displays shall be UL Listed under Standard UL 916, category PAZX; Standard ULC C100, category UUKL7; and under Standard UL 864, categories UUKL, UDTZ, and QVAX. and be so listed at the time of bid. All floor level controllers shall comply, at a minimum, with UL Standard UL 91 6category PAZX; Standard UL 864, categories UDTZ, and QVAX, and be so listed at the time of Bid.

D. The BAS peer-to-peer network controllers and local user display shall also comply with the Australian Electromagnetic Compatibility (EMC) Framework, and bear the C-Tic Mark to show compliance. The purpose of the regulation is to minimize electromagnetic interference between electronic products, which may diminish the performance of electrical products or disrupt essential communications.

E. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

F. The manufacturer of the building automation system shall provide documentation supporting compliance with ISO-9002 (Model for Quality Assurance in Production, Installation, and Servicing) and ISO-140001 (The application of well-accepted business management principles to the environment). The intent of this specification requirement is to ensure that the products from the manufacturer are delivered through a Quality System and Framework that will assure consistency in the products delivered for this project.

G. This system shall have a documented history of compatibility by design for a minimum of 15 years. Future compatibility shall be supported for no less than 10 years. Compatibility shall be defined as the ability to upgrade existing field panels to current level of technology, and extend new field panels on a previously installed network.

Compatibility shall be defined as the ability for any existing field panel microprocessor to be connected and directly communicate with new field panels without bridges, routers or protocol converters.

1.05 SUBMITTALS

A. Submit seven (7) complete sets of following before start of work:

1. Valve and damper schedules

2. Equipment data cut sheets

3. System schematics, including:

   Sequence of operations

   Point names

   Point addresses

   Interface wiring diagrams

   Panel layouts.

   System riser diagrams

4. Auto-CAD compatible submittal drawings

B. Upon project completion, submit operation and maintenance manuals, consisting of the following:

   Index sheet, listing contents in alphabetical order

   Manufacturer's equipment parts list of all functional components of the system, Auto-CAD disk of system schematics, including wiring diagrams

   Description of sequence of operations

   CSV files with trend descriptions

   As-Built interconnection wiring diagrams

   Operator's Manual

   Trunk cable schematic showing remote electronic panel locations, and all trunk data

   List of connected data points, including panels to which they are connected and input device (ionization detector, sensors, etc.) Conduit routing diagrams

1.06 WARRANTY

A. Provide all services, materials and equipment necessary for the successful operation of the entire BAS system for a period of one year after system completion.

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

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Siemens Apogee Product, as provided and distributed by Siemens Industry, Inc.

B. No substitutions or equals will be allowed.

2.02 NETWORKING COMMUNICATIONS

A. The design of the BAS will tie into the existing Siemens City network. It is the responsibility of the City's I.T. Department to insure a proper working network connection and dedicated telephone line (if warranted for emergency access) to the field panel.

B. The design of the BAS shall network operator workstations and stand-alone DDC Controllers. The network architecture can consist of three levels, a campus-wide (Management Level Network)

C. The design of BAS shall allow the co-existence of new DDC Controllers with existing DDC Controllers in the same network without the use of gateways or protocol converters.

D. Peer-to-Peer Building Level Network:

1. All operator devices either network resident or connected via dial-up modems shall have the ability to access all point status and application report data or execute control functions for any and all other devices via the peer-to-peer network. No hardware or software limits shall be imposed on the number of devices with global access to the network data at any time.

2. The peer-to-peer network shall support a minimum of 100 DDC controllers and PC workstations

3. Each PC workstation shall support a minimum of 4 peer to peer networks hardwired or dial up.

4. The system shall support integration of third party systems (fire alarm, security, lighting, PCL, chiller, boiler) via panel mounted open protocol processor. This processor shall exchange data between the two systems for interprocess control. All exchange points shall have full system functionality as specified herein for hardwired points.

2.03 DDC CONTROLLER FLOOR LEVEL NETWORK

A. This level communication shall support a family of application specific controllers and shall communicate with the peer-to-peer network through DDC Controllers for transmission of global data.

2.04 DDC & HVAC MECHANICAL EQUIPMENT CONTROLLERS

A. The DDC & HVAC Mechanical Equipment Controllers shall reside on the Building Level Network.

B. DDC & HVAC Mechanical Equipment Controllers shall use the same programming language and tools. DDC & HVAC Mechanical Equipment Controllers which require different programming language or tools on a network are not acceptable.

2.04.1 DDC CONTROLLER

A. DDC Controllers shall be a 16-bit stand-alone, multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules. Controller size shall be sufficient to fully meet the requirements of this specification and the attached point I/O schedule. Each controller shall support a minimum of three (3) Floor Level Application Specific Controller Device Networks.

B. Each DDC Controller shall have sufficient memory to support its own operating system and databases, including:

1. Control processes

2. Energy management applications

3. Alarm management applications including custom alarm messages for each level alarm for each point in the system.

4. Historical/trend data for points specified

5. Maintenance support applications

6. Custom processes

7. Operator I/O

8. Dial-up communications

9. Manual override monitoring

C. Each DDC Controller shall support firmware upgrades without the need to replace hardware.

D. Provide all processors, power supplies and communication controllers so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring.

E. DDC Controllers shall provide a minimum two RS-232C serial data communication ports for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals. DDC Controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers or terminals.

F. The operator shall have the ability to manually override automatic or centrally executed commands at the DDC Controller via local, point discrete, on-board hand/off/auto operator override switches for digital control type points and gradual switches for analog control type points.

1. Switches shall be mounted either within the DDC Controllers key-accessed enclosure, or externally mounted with each switch keyed to prevent unauthorized overrides.

2. DDC Controllers shall monitor the status of all overrides and inform the operator that automatic control has been inhibited. DDC Controllers shall also collect override activity information for reports.

G. DDC Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Graduated intensity LEDs or analog indication of value shall also be provided for each analog output. Status indication shall be visible without opening the panel door.

H. Each DDC Controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components. The

DDC Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.

I. Isolation shall be provided at all peer-to-peer network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:

- RF-Conducted Immunity (RFCI) per ENV 50141 (IEC 1000-4-6) at 3 V
- Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact
- Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500 V signal, 1 kV power
- Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max) Isolation shall be provided at all peer-to-peer panels' AC input terminals to suppress induced voltage transients consistent with:
- IEEE Standard 587-1980
- UL 864 Supply Line Transients
- Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)

J. In the event of the loss of normal power, there shall be an orderly shutdown of all DDC Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 60 days.

1. Upon restoration of normal power, the DDC Controller shall automatically resume full operation without manual intervention.

2. Should DDC Controller memory be lost for any reason, the user shall have the capability of reloading the DDC Controller via the local RS-232C port, via telephone line dial-in or from a network workstation PC.

K. Provide a separate DDC Controller for each AHU or other HVAC system as indicated in Section 3.02. It is intended that each unique system be provided with its own point resident DDC Controller.

2.04.2 HVAC MECHANICAL EQUIPMENT CONTROLLERS

A. HVAC Mechanical Equipment Controllers shall be a 12-bit stand-alone, multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors.

B. Each HVAC Mechanical Controller shall have sufficient memory to support its own operating system and databases, including:

1. Control processes

2. Energy management applications

3. Alarm management applications including custom alarm messages for each level alarm for each point in the system.

4. Historical/trend data for points specified

5. Maintenance support applications

6. Custom processes

7. Operator I/O

8. Dial-up communications

C. Each HVAC Mechanical Equipment Controller shall support firmware upgrades without the need to replace hardware.

D. HVAC Mechanical Equipment Controllers shall provide a RS-232C serial data communication port for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals.

E. HVAC Mechanical Equipment Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device.

F. Each HVAC Mechanical Equipment Controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all components. The HVAC Mechanical Equipment Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.

G. Isolation shall be provided at all peer-to-peer network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:

- RF-Conducted Immunity (RFCI) per ENV 50141 (IEC 1000-4-6) at 3 V

- Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact
- Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500 V signal, 1 kV power
- Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max) Isolation shall be provided at all peer-to-peer panels' AC input terminals to suppress induced voltage transients consistent with:
- IEEE Standard 587-1980
- UL 864 Supply Line Transients
- Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)

H. In the event of the loss of normal power, there shall be an orderly shutdown of all HVAC Mechanical Equipment Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.

1. Upon restoration of normal power, the HVAC Mechanical Equipment Controller shall automatically resume full operation without manual intervention.

2. Should HVAC Mechanical Equipment Controller memory be lost for any reason, the user shall have the capability of reloading the HVAC Mechanical Equipment Controller via the local RS-232C port, via telephone line dial-in or from a network workstation PC.

2.05 DDC & HVAC MECHANICAL EQUIPMENT CONTROLLER RESIDENT SOFTWARE FEATURES

A. General:

1. The software programs specified in this Section shall be provided as an integral part of DDC and HVAC Mechanical Equipment Controllers and shall not be dependent upon any higher level computer for execution.

2. All points shall be identified by up to 30 character point name and 16 character point descriptor. The same names shall be used at the PC workstation.

3. All digital points shall have user defined two-state status indication (descriptors with minimum of 8 characters allowed per state (i.e.summer/winter).

B. Control Software Description:

1. The DDC and HVAC Mechanical Equipment Controllers shall have the ability to perform the following pre-tested control algorithms:

a. Two-position control

b. Proportional control

c. Proportional plus integral control

d. Proportional, integral, plus derivative control

e. Automatic tuning of control loops

C. DDC and HVAC Mechanical Equipment Controllers shall provide the following energy management routines for the purpose of optimizing energy consumption while maintaining occupant comfort.

1. Start-Stop Time Optimization (SSTO) shall automatically be coordinated with event scheduling. The SSTO program shall start HVAC equipment at the latest possible time that will allow the equipment to achieve the desired zone condition by time of occupancy. The SSTO program shall also shut down HVAC equipment at the earliest possible time before the end of the occupancy period, and still maintain desired comfort conditions.

a. The SSTO program shall operate in both the heating and cooling seasons.

1. It shall be possible to apply the SSTO program to individual fan systems.

2. The SSTO program shall operate on both outside weather conditions as well as inside zone conditions and empirical factors.

b. The SSTO program shall meet the local code requirements for minimum outside air while the building is occupied.

2. Event Scheduling: Provide a comprehensive menu driven program to automatically start and stop designated points or groups of points according to a stored time.

a. It shall be possible to individually command a point or group of points.

b. For points assigned to one common load group, it shall be possible to assign variable time delays between each successive start or stop within that group.

c. The operator shall be able to define the following information:

1. Time, day

2. Commands such as on, off, auto, and so forth.

3. Time delays between successive commands.

4. There shall be provisions for manual overriding of each schedule by an appropriate operator.

d. It shall be possible to schedule events up to one year in advance.

1. Scheduling shall be calendar based.

2. Holidays shall allow for different schedules.

D. DDC and HVAC Mechanical Equipment Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.

1. A single process shall be able to incorporate measured or calculated data from any and all other DDC and HVAC Mechanical Equipment Controllers on the network. In addition, a single process shall be able to issue commands to points in any and all other DDC and HVAC Mechanical Equipment Controllers on the network. Database shall support 30 character, English language point names, structured for searching and logs.

2. Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of a dial-up connection to a remote device such as a printer or pager.

3. DDC and HVAC Mechanical Equipment Controller shall provide a HELP function key, providing enhanced context sensitive on-line help with task orientated information from the user manual.

4. DDC and HVAC Mechanical Equipment Controller shall be capable of comment lines for sequence of operation explanation.

E. Alarm management shall be provided to monitor and direct alarm information to operator devices. Each DDC and HVAC Mechanical Equipment Controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent alarms from being lost. At no time shall the DDC and HVAC Mechanical Equipment Controllers ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device or communications with other panels on the network.

1. All alarm or point change reports shall include the point's English language description and the time and date of occurrence.

2. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of six priority levels shall be provided for each point. Point priority levels shall be combined with user definable destination categories (PC, printer, DDC Controller, etc.) to provide full flexibility in defining the handling of system alarms. Each DDC and HVAC Mechanical Equipment Controller shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.

3. Alarm reports and messages will be directed to a user-defined list of operator devices or PCs based on time (after hours destinations) or based on priority.

4. In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 200 character alarm message to more fully describe the alarm condition or direct operator response.

5. In dial-up applications, operator-selected alarms shall initiate a call to a remote operator device.

F. A variety of historical data collection utilities shall be provided to manually or automatically sample, store and display system data for points as specified in the I/O summary.

1. Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be

collected and stored in each DDC and HVAC Mechanical Equipment Controllers point group. Two methods of collection shall be allowed: either by a pre-defined time interval or upon a pre-defined change of value. Sample intervals of l minute to 7 days shall be provided. Each DDC and HVAC Mechanical Equipment Controller shall have a dedicated RAM-based buffer for trend data and shall be capable of storing a minimum of __ data samples. All trend data shall be available for transfer to a Workstation without manual intervention.

2. DDC and HVAC Mechanical Equipment Controllers shall also provide high resolution sampling capability for verification of control loop performance. Operator-initiated automatic and manual loop tuning algorithms shall be provided for operator-selected PID control loops as identified in the point I/O summary.

    a. Loop tuning shall be capable of being initiated either locally at the DDC and HVAC Mechanical Equipment Controller, from a network workstation or remotely using dial-in modems. For all loop tuning functions, access shall be limited to authorized personnel through password protection.

G. DDC and HVAC Mechanical Equipment Controllers shall be capable of automatically accumulating and storing run-time hours for digital input and output points and automatically sample, calculate and store consumption totals for analog and digital pulse input type points, as specified in the point I/O schedule.

H. The peer to peer network shall allow the DDC and HVAC Mechanical Equipment Controllers to access any data from or send control commands and alarm reports directly to any other DDC and HVAC Mechanical Equipment Controller or combination of controllers on the network without dependence upon a central or intermediate processing device. DDC and HVAC Mechanical Equipment Controllers shall send alarm reports to multiple workstations without dependence upon a central or intermediate processing device. The peer to peer network shall also allow any DDC and HVAC Mechanical Equipment Controller to access, edit, modify, add, delete, back up, and restore all system point database and all programs.

I. The peer to peer network shall allow the DDC and HVAC Mechanical Equipment Controllers to assign a minimum of 50 passwords access and control priorities to each point individually. The logon password (at any PC workstation or portable operator terminal) shall enable the operator to monitor, adjust and control the points that the operator is authorized for. All other points shall not be displayed on the PC workstation or portable terminal (e.g. all base building and all tenant points shall be accessible to

any base building operators, but only tenant points shall be accessible to tenant building operators). Passwords and priorities for every point shall be fully programmable and adjustable.

2.06 FLOOR LEVEL NETWORK APPLICATION SPECIFIC CONTROLLERS (ASC)

A. Each DDC Controller shall be able to extend its performance and capacity through the use of remote application specific controllers (ASCs) through Floor Level LAN Device Networks.

B. Each ASC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor. Provide the following types of ASCs as a minimum:

1. Central System Controllers

2. Terminal Equipment Controllers

Each ASC shall be capable of control of the terminal device independent of the manufacturer of the terminal device.

C. Terminal Equipment Controllers:

1. Provide for control of each piece of equipment, including, but not limited to, the following:

a. Variable Air Volume (VAV) boxes
b. Constant Air Volume (CAV) boxes
c. Dual Duct Terminal Boxes
d. Unit Conditioners
e. Heat Pumps
f. Unit Ventilators
g. Room Pressurization

2. Controllers shall include all point inputs and outputs necessary to perform the specified control sequences. Analog outputs shall be industry standard signals such as 24V floating control, 3-15 psi pneumatic, 0-10V allowing for interface to a variety of modulating actuators.

3. All controller sequences and operation shall provide closed loop control of the intended application. Closing control loops over the FLN, BLN or MLN is not acceptable.

2.07 PERSONAL COMPUTER OPERATOR WORKSTATION HARDWARE (tie into existing City of Stockton Computer Workstation in Central Building Maintenance)

Provide new computer workstation to meet minimum Apogee Workstation guidelines.

2.08 WORKSTATION OPERATOR INTERFACE

A. Basic Interface Description— Existing Siemens Insight Software

2.09 FIELD DEVICES

A. Provide instrumentation as required for monitoring, control or optimization functions. All devices and equipment shall be approved for installation in the City of Stockton.

1. Room Temperature Sensors

a. Digital room sensors shall have LCD display, day / night override button, and set point push button adjustment override options. The set point push button adjustment can be software limited by the automation system to limit the amount of room adjustment.

Temperature monitoring range	+20/120°F -13° to 49°C)
Output signal	Changing resistance
Accuracy at Calibration point	±0.5°F (+/- 0.3°C)
Set Point and Display Range	55° to 95° F (13° to 35°C)

b. Liquid immersion temperature:

Temperature monitoring range	+30/250°F (-1°/121°C)
Output signal	Changing resistance
Accuracy at Calibration point	±0.5°F (+/-0.3°C)

c. Duct (single point) temperature:

Temperature monitoring range	+20/120°F (-7°/49°C)
Output signal	Changing resistance
Accuracy at Calibration point	±0.5°F (+/-0.3°C)

d. Duct Average temperature:

Temperature monitoring range	+20° ±120°F(-7°/+49°C)
Output signal	4 – 20 mA DC
Accuracy at Calibration point	±0.5°F (±03°C)
Sensor Probe Length	25’ L (7.3m)

e. Outside air temperature:

Temperature monitoring range	-58°±122° F(-50ºC to +50ºC)
Output signal	4 – 20 mA DC
Accuracy at Calibration point	±0.5°F (+/-0.3°C)

2. Liquid Differential Pressure Transmitter

Ranges	0-5/30 inches H20 0-25/150 inches H20 0-125/750 inches H20
Output	4 – 20 mA DC
Calibration Adjustments	Zero and span
Accuracy	±-0.2% of span
Linearity	±-0.1% of span
Hysteresis	±-0.05% of span

3. Differential pressure:

   a. Unit for fluid flow proof shall be Penn P74.

Range	8 to 70 psi
Differential	3 psi
Maximum differential pressure	200 psi
Maximum pressure	325 psi

   b. Unit for air flow shall be Siemens Building Technologies SW141.

      Set point ranges: 0.5” WG to 1.0” WG (124.4 to 248.8 Pa)
      1.0” WG to 12.0” WG (248.8 to 497.6 Pa)

   c. Static pressure sensor:

Range	0 to .5” WG (0 to 124.4 Pa) 0 to 1” WG (0 to 248.8 Pa) 0 to 2” WG (0 to 497.7 Pa) 0 to 5” WG (0 to 1.2 kPa) 0 to 10” WG (0 to 2.5 kPa)
Output Signal	4 – 20 mA VDC
Combined static error	0.5% full range
Operating Temperature	-40º to 175º F (-40C to 79.5ºC)

4. Air Pressure Sensor:

Range:	0 to 0.1 in. water (0 to 24.9 Pa) 0 to 0.25 in. water (0 to 63.2 Pa)

	0 to 0.5 in. water (0 to 124.5 Pa) 0 to 1.0 in. water (o to 249 Pa) 0 to 2.0 in water 90 to 498 Pa) 0 to 5.0 in. water (0 to 1.25 kPa) 0 to 10.0 in.water (0 to 2.49 kPa)
Output signal	4 to 20 mA
Accuracy	±1.0% of full scale

5. Humidity Sensors:

Range	0 to 100% RH
Sensing Element	Bulk Polymer
Output Signal	4 – 20 mA DC
Accuracy	At 77°F(25ºC) ± 2% RH

6. Insertion Flow Meters (Equal to Onicon Series F-1200)

Sensing Method	Impedance Sensing
Accuracy	± 2% of Actual Reading
Maximum Operating Pressure	400 PSI
Output Signal	4 – 20 mA

Bi-directional where required.

7. Pressure to Current Transducer

Range	3 to 15 psig (21 to 103 kPa) or 3 to 30 psig (21 to 207 kPa)
Output signal	4 – 20 mA
Accuracy	± 1% of full scale (± 0.3 psig)

8. Control Valves (all control valves shall have electric actuators).

a. Electric Control

Rangeability	40:1
Flow Characteristics	Modified. Equal percentage
Control Action	Normal open or closed as selected
Medium	Steam, water, glycol
Body Type	Screwed ends 2” and smaller, flanged Valves 2½” and larger
Body Material	Bronze
Body Trim	Bronze
Stem	Stainless Steel
Actuator	0-10 VDC, 4-20 MA or 2 position 24 VAC/120VAC

b. All automatic temperature control valves in water lines shall be provided with Characterized throttling plugs and shall be sized for minimum 25% of the system pressure drop or 5 psi, whichever is less.

1. Positive positioning relays shall be provided on pneumatic control when required to provide sufficient power for sequencing.

2. Two position valves shall be line size.

B. Damper Actuators

1. Electric control shall be Siemens Building Technologies OpenAir™ direct coupled actuators or equal.

2. Damper actuators shall be Brushless DC Motor Technology with stall protection, bi-directional, fail safe spring return, all metal housing, manual override, independently adjustable dual auxiliary switch.

a. The actuator assembly shall include the necessary hardware and proper mounting and connection to a standard ½" diameter shaft or damper blade.

3. Actuators shall be designed for mounting directly to the damper shaft without the need for connecting linkages.

4. All actuators having more than 100 lb-in torque output shall have a self-centering damper shaft clamp that guarantees concentric alignment of the actuator's output coupling with the damper shaft. The self-centering clamp shall have a pair of opposed "v" shaped toothed cradles; each having two rows of teeth to maximize holding strength. A single clamping bolt shall simultaneously drive both cradles into contact with the damper shaft.

5. All actuators having more than a 100 lb-in torque output shall accept a 1" diameter shaft directly, without the need for auxiliary adapters.

6. All actuators shall be designed and manufactured using ISO900registered procedures, and shall be Listed under Standards UL873 and CSA22.2 No. 24-93 l.

2.10 MISCELLANEOUS DEVICES

A. Thermostats

1. Room thermostats shall be of the gradual acting type with adjustable sensitivity.

2. They shall have a sensing element capable of responding to a temperature change of one-tenth of one degree. (Provide all thermostats with limit stops to limit adjustments as required to prevent heating/cooling overlap).

3. Thermostats shall be arranged for either horizontal or vertical mounting.

4. In the vertical position thermostat shall fit on a mullion of movable partitions without overlap.

B. Freezestats:

1. Install freezestats as indicated on the plans and provide protection for every square foot of coil surface area with one linear foot of element per square foot of coil.

a. Upon detection of low temperature, the freezestats shall stop the associated supply fans and return the automatic dampers to their normal position. Provide manual reset.

PART 3 - EXECUTION

3.01 PROJECT MANAGEMENT

Provide a designated project manager who will be responsible for the following:

Construct and maintain project schedule

On-site coordination with all applicable trades, subcontractors, and other integration vendors

Authorized to accept and execute orders or instructions from owner/architect

Make necessary field decisions relating to this scope of work
Coordination/Single point of contact

3.02 SEQUENCE OF OPERATIONS

AH-1, AH-2, AH-3, AH-4 and SF-2E

A. Supply fan shall be started as determined by the Owner. The duct smoke detectors shall shut down the fans on detection of products of combustion, and shall send an alarm to the DDC host computer stating "Unit off due to duct smoke detector alarm".

B. A manual stop button, when pushed, will manually stop the supply fans.

C. Night Set Back (where required)

1. During unoccupied periods, the space temperature set point shall be lowered to 55° degrees adjustable. If the space temperature falls below 55° degrees then the hot water system shall be energized, the supply fans shall start and the minimum outside air dampers shall remain closed. Warm air shall be provided until the space temperature rises above 55 °degrees.

D. Morning Warm-Up (where required)

1. Two hours (adjustable) before the occupied period is to begin the primary heating pump and the boiler shall start. The supply fan shall start after boiler water reaches minimum set points, secondary HW pump shall start and the AH unit HW valves shall open to their controlled heating setting and shall modulate until the zone temperature sensors in the space sense the space set point temperature. When return temperature is within 2°degrees of room set point, the minimum outside dampers shall open to minimum positioned; EF-3 shall start and RF-2E shall track SF-2E operation.

E. Heating System

1. When there is a call for heating from any space temperature sensor the hot water pumps shall be energized. Once flow is proven the boiler shall be energized. The hot water temperature shall be reset as required by the space heating load demand. The boiler shall accept an external 0-10 VDC signal provided by the DDC system to reset the hot water temperature from building demand.

F. When there is no call for heating from the space the boiler shall be de-energized and the hot water pump shall remain operating for 10 minutes after the boiler is de-energized and then commanded off.

PLATE & FRAME HEAT EXCHANGER (WATER SOURCE ECONOMIZER)

A. When there is a call for cooling from any of the space temperature sensors and outside air dew point temperature is below 60° degrees

(adjustable), the isolation valves on the heat exchanger shall be opened and the isolation valves that isolate the chiller shall remain closed. The condenser water pump CWP-1 and solids separator SS-1 shall be energized and the cooling tower fan speed shall be modulated to maintain HX-1 leaving chilled water set point.

B. The primary chilled water pump CHWP-1 condenser pump, CWP-1 and SS-1 run at a constant speed.

C. The secondary pump CHWP-2 speed is varied by the VFD through the system pressure differential sensor, set at 5 psi or as required at water balance, mounted near the end of the chilled water loop.

D. The chilled water supply temperature is to be maintained through the temperature sensor, (adjustable) mounted in the heat exchanger HX-1 chilled water leaving temperature, by the cooling tower fan VFD.

MECHANICAL COOLING

A. When the water source economizer cannot maintain the chilled water set point temperature and there is a cooling demand in the space. The chilled water primary pump CHWP-1 and condenser water pump CWP-1 shall stop and the secondary chilled water pump CHWP-2 shall continue to operate. The control valves that isolate the heat exchanger shall be closed and the isolation valves for the chiller open. Primary pump CHWP-1 and CWP-1 shall start when flow is proven through the evaporator and condenser side of the chiller CH-1, then the chiller shall be energized.

B. The chilled water shall be controlled from the chiller. Set point shall be reset from the DDC system to satisfy the warmest space in the system.

C. The secondary chilled water pump VFD shall control the speed of the CHWP-2 to maintain the differential pressure set point of the differential pressure transducer across the cooling chilled water loop which is farthest hydraulically from the pump. The differential pressure set point shall be determined at the time of system water balance.

D. The cooling tower fan shall be controlled through the VFD from the tower leaving water temperature.

E. If the tower fan and CHWP-2 are running at slow speed and the outdoor dew point is below set point, the system may return to water source economizer HX-1 cooling by shutting down the chiller with chiller isolation valves open and ramping up the tower fans to cool down the cooling tower, then stopping primary pumps CHWP-1 and CWP-1 then restart the

economizer HX-1 cycle, after a minimum chiller/pump shut down of 5 minutes (adjustable).

CONTROL POINT LOGS

A. The following points shall be set up in trends and logged. The CSV read only data file with point descriptions shall be provided to the Engineer for review.

1. Supply air temperatures of each fan system and fan zones.
2. Space temperatures.
3. Return air temperatures.
4. Mixed air temperatures.
5. Duct static pressures.
6. Building static pressures.
7. Return plenum pressures.
8. Outside air temperature, dew point and relative humidity. (1 required)
9. All water temperatures.
10. Secondary CHWP and HWP speed.
11. Chilled water differential pressure.
12. Pump run times.
13. Cooling tower supply and return water temperature.
14. Cooling tower fan speed.
15. Economizer cooling or mechanical cooling time of operation.

3.03 POINT SCHEDULE MATRIX - I/0 SCHEDULE

Refer to project plans

The contractor shall collaborate with the owner directly to determine the owner's preference for naming conventions, etc. before entering the data in to the system.

3.04 ELECTRICAL WIRING AND MATERIALS

A. Install, connect and wire the items included under this Section. This work includes providing required conduit, wire, fittings, and related wiring accessories. All exposed wiring to be in EMT Conduit, concealed wiring to be in plenum rated cable.

B. Provide wiring between thermostats, aquastats and unit heater motors, all control and alarm wiring for all control and alarm devices for all Sections of Specifications.

C. Provide status function conduit and wiring for equipment covered under this Section.

D. All wiring to be compliant to local building code and the NEC.

E. Provide electrical wall box and conduit sleeve for all wall mounted devices.

3.05 TRAINING

A. The manufacturer shall provide full instruction to designated personnel in the operation of the system installed. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. The manufacturer shall provide all students with a student binder containing product specific training modules for the system installed. All training shall be held during normal working hours of 8:00 am to 4:30 PM weekdays.

B. Provide 16 hours of training for Owner's designated operating personnel. Training shall include:

Explanation of drawings, operations and maintenance manuals
Walk-through of the job to locate control components
Operator workstation and peripherals
DDC controller and ASC operation/function
Operator control functions including graphic generation and field panel programming
Operation of portable operator's terminal
Explanation of adjustment, calibration and replacement procedures
Student binder with training modules

C. Since the Owner may require personnel to have more comprehensive understanding of the hardware and software, additional training must be available from the Manufacturer. If such training is required by the Owner, it will be contracted at a later date.

END OF SECTION 15950

SECTION 16000 - ELECTRICAL

PART 1 - GENERAL PROVISIONS

1.01 INCLUSION OF GENERAL CONDITIONS AND DIVISION ONE: The General Conditions, Supplemental Conditions, and Division 1, General Requirements, are a part of this Section and the Contract for this work and apply to this Section as fully as if repeated herein.

1.02 SCOPE: Work under this Section includes all labor, materials, tools, plant equipment and transportation, and perform all operations necessary for proper execution and completion of all electrical work whether specifically mentioned or not; all as indicated, specified herein, and/or implied thereby to carry out the apparent intent thereof. Items of work include, but are not limited to, the following:

A. Study work and related drawings and specifications of all other crafts whose work abut, adjoins, or in any manner is affected by work of this section. Consult with other trades and with them expedite and coordinate materials and labor to avoid omissions and delays.

B. Complete system of wiring distributions including transformer, panel boards and all branch circuits as shown on the drawings.

C. Excavation, backfill, framing and other associated work required for the installation of the electrical system.

D. Submission of shop drawings.

E. As-Built drawings.

F. Tests.

G. Prepare day-by-day record of "as built" changes as specified hereinafter.

H. Furnish, install and connect all line voltage conduit and wiring to mechanical equipment.

I. Furnish and install disconnect switches, as required for the mechanical equipment and controls as shown on electrical and mechanical drawings. Install all motor starters furnished loose by Mechanical Contractor.

1.03 WORK NOT INCLUDED: The following work as outlined is not included in the Electrical Contract; however, this Contractor shall cooperate with other contractors involved and shall be responsible to give complete directions on sizes of openings, locations, etc., and to insure that the completed electrical

installations shall be of good workmanship and in accordance with drawings and specifications.

A. Equipment or work indicated "NIC" or "By others."

B. Mechanical Contractor shall furnish motors included in mechanical equipment.

1.04 PERMITS AND ORDINANCES: Comply with all codes, ordinances, and authorities having jurisdiction, including all local public utility requirements, the California Building Code and the California Electrical Code. Electrical Contractor shall procure and pay for all permits, licenses, etc. required to carry on and complete the work.

1.05 SPECIFICATION AND CONTRACT DRAWINGS: Accuracy of data given herein and on the drawings is as exact as could be secured, but their extreme accuracy is not guaranteed. The drawings and specifications are for the assistance and guidance of the Contractor and exact locations, distances, levels, etc., will be governed by the building and the Contractor shall accept same with the understanding.

A. Drawings and specifications may be superseded by later detail specifications and detail drawings prepared by the Engineer, and the Contractor shall conform to them and to such reasonable changes in the Contract drawings as may be called for by those revised drawings without extra cost to the Owner. Where work called for exceeds code requirements, drawings and specifications shall take precedence.

B. Layouts of equipment, accessories and wiring systems are diagrammatic (not pictorial), but shall be followed as closely as possible. Architectural, structural and other mechanical drawings shall be examined, noting all conditions that may affect this work. Report conflicting conditions to the Engineer for adjustment before proceeding with work.

C. Should Contractor proceed with work without so reporting the matter, he does so on his own responsibility, and shall alter work if directed by the Engineer at his own expense. Right is reserved to make minor changes in locations of equipment and wiring systems shown, providing change is ordered before conduit runs and/or work directly connected to same is installed and no extra materials are required.

1.06 STRUCTURAL REQUIREMENTS: Installation under this Section shall comply with the California Building Code and Title 21.

1.07 EXAMINATION OF SITE: The Contractor shall be held to have visited the site

and satisfied himself as to the conditions under which the work is to be performed. He shall check existing conditions which may affect his work. No allowance shall subsequently be made in his behalf for any extra expense to which he may be put due to failure or neglect to discover conditions affecting his work.

1.08 MANUFACTURER'S DIRECTIONS: Follow manufacturer's directions where these directions cover points not included in the drawings or in the specifications.

1.09 CLEANING: After all work has been accomplished such as sanding, painting, etc., lighting fixtures, panelboards, and switchboards shall be cleaned to remove all dust, dirt, grease, paint, or other marks. All electrical equipment shall be left in a clean condition inside and outside, satisfactory to the Engineer.

1.10 WORKMANSHIP: Workmanship shall be of the best quality and shall be performed by skilled craftsmen to insure long and trouble-free service. The requirements of the Codes and Safety Orders are minimum standards.

1.11 REVIEW SUBMITTALS:

A. MATERIALS LIST: Submit to the Engineer for review, seven (7) copies of a complete materials list covering the following items to be furnished under this Section. This submittal shall specifically include:

1. Starter

For ease of maintenance and parts replacement, to the maximum extent possible use equipment of a single manufacturer. The Engineer reserves the right to reject any Materials List which contains equipment from various manufacturers if suitable Materials can be secured from fewer manufacturers and to require that the source of materials be unified to the maximum extent possible.

B. When specific names are used in connection with materials, they are used as standards only, but this implies no right upon the part of the Contractor to use other materials or methods unless approved as equal in quality and utility by the Engineer in writing and in accordance with provisions for substitutions previously stipulated in these specifications.

C. Shop drawings and all supporting data shall be submitted as instruments of the Contractor. Contractor shall place his stamp on the cover sheet of submittal documents, thereby stating that the equipment meets all requirements of the conditions. At least one set of submittals

shall have check marks at each item indicating that the Contractor has verified compliance with the above requirements.

D. Should the original submittal of a proposed substitution be rejected, the specified item shall be furnished.

E. Within fourteen (14) days after award of contract, submit (7) bound copies of brochures containing complete information and catalog cuts on all equipment including that which is to be furnished as specified. Include wiring diagrams where so required. The brochures shall be bound separately according to classifications of equipment such as power, light fixtures, fire alarm system, signals systems and miscellaneous systems. Submittals which consist of all brochures for all classifications of equipment to be furnished bound in one single book shall be returned unreviewed. Proposed substitutions shall be accompanied by catalog cuts, ratings, sizes, performance curves, shop drawings and other data complete to prove full equality to the specified item. At least one copy of the submittals for each system shall be made up of original printed manufacturer's cut sheets. Additional copies by may be made up of Xerox copies. FAX submittals are not acceptable and will be returned unreviewed.

F. Approval of a substitution does not authorize any deviation from the utility, size or function of the specified item unless specifically pointed out and approval requested in the letter of submittals. Responsibility for conflicts due to space limitations are not relieved by approval of a substitution. If revision of wiring, piping or arrangement of other equipment is necessary, after approval, furnish the Engineer with (7) copies for file and future reference.

G. Panel board submittals shall be arranged to show bussing circuit numbers with respective branch circuit devices similar to schedules on drawings. Switchboard and motor control center submittals shall show elevations indicating layout of devices, metering, etc. Device ratings, circuit numbers and nameplates shall be in table form. Terminal cabinet submittals shall include elevations with terminal strip mounting arrangement.

H. Unless otherwise shown or specified, material shall be new, full weight, standard, the best quality of its' kind and satisfactory to the Engineer. Materials shall be stored and protected as necessary and/or required by the Engineer, and the Contractor shall be entirely responsible for damage or loss from any cause. Unless otherwise shown or specified, major equipment shall be the product of a manufacturer who has for a period of not less than five (5) years, been in successful manufacture of the equipment and who has nationally distributed catalog covering ratings and

specifications of said equipment.

I. Electrical materials shall bear the label of, or be listed by, the Underwriters' Laboratories unless of a type for which label or listing service is not provided.

J. Materials and components shall conform to industrial standards including:

N.E.M.A. - National Electrical Manufacturers' Association
A.S.A. - American Standards Association
A.S.T.M. - American Society of Testing Materials
I.P.C.E.A. - Insulated Power Cable Engineers' Association
C.B.M. - Certified Ballast Manufacturers

1.12 CUTTING AND PATCHING: Obtain the Engineer's approval before performing any cutting or patching of concrete, masonry, or wood structure by this installation and including provisions for holes in concrete before concrete is poured.

1.13 PROTECTION: The Contractor shall protect from damage during construction, the work and materials of other trades as well as the electrical work and materials. Electrical equipment stored and installed on the job site shall be protected from dust, water, or any other damage.

1.14 IDENTIFICATION OF EQUIPMENT:

A. Nameplates shall be installed on electrical equipment. Equipment to be labeled shall include the following:

1. Individual enclosures such as disconnect switches, time switches, pushbuttons, contactors, relays, motor starters, etc.

2. Group mounted equipment such as panel boards, switchboards, and motor control devices.

3. Individual circuit breakers on switchboards.

4. Wall switches for lighting or other use where the control function is not self-evident.

B. Each panel shall be labeled externally to provide the following information as a minimum:

1. Panel name.
2. Size of feeder feeding the panel.

3. Rated voltage, amps and phases.

C. Each main service switchboard and distribution panel shall be labeled to provide the following information as a minimum:

1. Rated voltage, amps and phases.
2. Main switch rating.
3. Feeder circuit breaker rating with name of panel or equipment fed and size of feeder to this equipment.

D, Nameplates shall adequately describe the item and its' function or use of the particular equipment involved.

E. Manufacturers label shall include date of manufacture.

F. Nameplate material shall be laminated phenolic plastic, black front and back with white core. Engraving shall be through the outer layer. Embossed plastic pressure sensitive labels are not acceptable.

G. In lieu of plastic plates, device plates shall be engraved directly with lettering filled with black enamel.

H. Nameplates shall be securely fastened to the equipment with #4 Phillips round head cadmium plated steel self-tapping screws, brass bolt, or with a plastic resin adhesive glue, Goodyear "Pliebond" or equal.

1.15 EXCAVATION AND BACKFILL: Perform excavation and backfill required for electrical installation. Restore surfaces, roadways, walks, curbs, walls, existing underground installations or original condition in an acceptable manner.

A. Excavation: Dig trenches straight and true to line and grade, with bottom smoothed of any rock points. Support conduit for entire length on undisturbed, original earth. Minimum conduit depth of pipe crown shall be twenty-four (24") below finished or natural grade.

B. Backfill: All backfill material, placement and compaction shall conform to applicable requirements of Site Work, Section 1.

1.16 TESTS: The entire electrical installation shall be free from short circuits and improper grounds. Test all wiring and connections for continuity and grounds before any fixtures or equipment are connected and where such tests indicate faulty insulation or other defects, they shall be located, repaired and retested at the Contractor's expense. Electrical load shall be balanced at the panel boards. Rotation of all motors shall be checked and corrected, if necessary, after final connections are made. Demonstrate to the Owner and the Engineer that the

entire installation is complete, in proper operating condition and that the Contract has been properly and fully executed. Provide all instruments to make such tests.

1.17 WORKING SPACE: Adequate working space shall be provided around electrical equipment in strict compliance with the Electrical Safety Orders. In general, provide six and one-half feet (6'-6") of headroom and thirty-six inches (36") minimum clear workspace in front of panelboards and controls for 120 volts.

1.18 AS-BUILT DRAWINGS:

A. Upon completion of work covered by this Contract, furnish Engineer with Mylar transparencies, as required by the General Conditions, upon which shall be shown all changes of feeders, panels, circuits, light fixtures, etc., within building and installed under this Contract, which are not in accord with these drawings for the work. Diazo sepia transparencies will not be acceptable.

B. In addition, furnish one tracing showing all underground lines, pull boxes, etc. installed under this Contract. Locate and dimension all work with reference to permanent landmarks.

C. All symbols and designations used in preparing "Record" Drawings shall match those used in Contract drawings. Record drawings shall be the same size and scale as the contract drawings.

D. Properly identify all stubs for future connections, as to locations and use, by setting of concrete marker at finished grade in the manner suitable to the Engineer.

1.19 GUARANTEE: Acceptance of the Contract for this work includes this guarantee: The Contractor guarantees that he has performed the work in accordance with the Contract Documents. Contractor agrees to replace or repair, as new, any defective work, materials, or part which may appear within one year (1) year of final acceptance, if, in the opinion of the Engineer or the Owner, the defect is due to workmanship or material.

1.20 WARRANTIES, GUARANTEES, CERTIFICATES, ETC.: Warranties, Guarantees, Certificates, etc. that are furnished and available for equipment and materials furnished and installed under this Section shall be properly filled out as of the date of acceptance of the work by the Owner and shall be delivered to the Engineer.

1.21 COOPERATION AND COORDINATION: Cooperate and coordinate with other crafts in putting the installation in place at a time when the space required by this

installation is accessible. Work done without regard to other crafts shall be moved at the Contractor's expense.

1.22 FLASHING AND SEALING: Flash and counterflash roof and wall penetrations in manner described under other applicable sections of this specification and as approved by the Engineer. Conduits, ducts, etc. passing through finished walls shall be fitted with steel escutcheon plates, chrome or paint finish as directed. Conduits which penetrate floor slabs and concrete or masonry walls shall be grouted and sealed watertight at penetration.

1.23 ELECTRICAL WORK FOR MOTORS AND APPLIANCES FURNISHED BY OTHERS:

A. Work is shown on drawings according to best information available at time drawings was prepared; but this Contractor shall obtain accurate information on equipment power requirements and connection points from Contractors furnishing the actual equipment and shall install electrical work to suit at no extra cost to Owner. Should Contractor proceed with work without first verifying accuracy of the plans, he does so at his own risk and shall alter work if required at his own expense.

B. Mechanical and Plumbing Contractors shall furnish written or printed specifications, dimension sheets and diagrams for the electrical work applying to the actual equipment being installed. Electrical Contractor shall assist other Contractors in testing of their systems, but his responsibility is restricted to having correctly installed and connected electrical work in accordance with diagrams and specifications furnished him by the other Contractors.

1.24 ACCEPTANCE BY GOVERNING AUTHORITIES: Upon the completion of the electrical work, and as a condition of its acceptance, this Contractor shall obtain final inspections and acceptance from local building inspection agencies, utility companies, and/or other governing authorities. Deliver to the Owner and the Engineer verification of such acceptance.

1.25 CLEANING UP: Keep the premises in a neat, safe and orderly condition at all times during the execution of the electrical work. Areas adjacent to the electrical work, both interior and exterior shall be free from accumulations of debris and/or shipping containers and packing. All refuse shall be removed to the area of the job site set aside for its storage. All items removed from the existing installation shall be removed from the site.

****END OF SECTION 16000****

SECTION 16110

PART 1 - RACEWAYS AND FITTINGS

1.01 RACEWAYS: All wiring shall be in raceways. Raceways shall be run in slabs, walls, above ceilings or exposed as indicated on drawings. Acceptable raceway and their limitations of use are as follows:

A. Rigid Steel Conduit may be used in all areas.

1. Standard weight, zinc coated on outside by hot dipping or sherardized process, with either zinc coating or other approved corrosion resistant coating on the inside.

2. Fittings shall be threaded and finished similar to conduit. Threadless fittings shall not be used.

3. Conduits connected to boxes and cabinets shall be fitted with two locknuts and insulated bushing, OA "A" Series.

4. Conduits not connected with locknuts and bushings shall be fitted with grounding bushing, OZ "BL" Series, U. L. approved and bonded.

5. Conduit stubs underground shall be capped with coupling, nipple, coupling and plug.

6 Conduits connected to boxes, cabinets, etc., exposed to weather or in areas subject to excessive moisture shall be fitted with watertight sealing hubs of steel or malleable iron with sealing ring and insulated throat, T & B 370 Series, Efcor 40-50B Series or equal.

7. Conduit shall be wrapped with black 10 mil PVC tape for underground installation. Not required to be concrete encased when run underground except at road or alley crossings.

8. Only conduit approved for use on roof and within 8 feet of grades on exterior walls.

B. Electrical Metallic Tubing (EMT):

1. Rolled steel, zinc coated outside with either zinc coating or other approved corrosion-resistant coating on the inside.

2. Couplings shall be rain compression type Appleton 93T Series,

Efcor 760 Series or equal.

3. Connectors shall be rain tight compression type with insulated throat Appleton 84T Series, Efcor 750B Series or equal.

4. May be used:

   a. Concealed in drywall partitions.
   b. Exposed in telephone and electrical equipment rooms above six-foot elevation.
   c. Concealed above furred ceilings.
   d. Exposed in fan rooms and/or plenum chambers provided location is dry.

5. May not be used:

   a. Any location subject to physical damage.
   b. Normal exposed locations on exterior walls, within 8 ft. of grade or roofs.
   c. In boiler and mechanical rooms.
   d. Any other areas not listed under (5) above unless specifically otherwise noted on the plans.

C. Flexible Metal Conduit may be used only for indoor final connections to mechanical equipment (not to exceed 36") and final connections to recessed fluorescent lighting fixtures (not to exceed 72") unless otherwise noted on drawings.

1. Minimum trade size - one-half inch (½").

2. Connectors - T & B "Tite Bite" insulated.

3. Suitable for connection of recessed fixtures, control and mechanical equipment. Not permitted where exposed to weather or other wet or corrosive conditions.

4. Length shall be a practical minimum, but to allow for movement of equipment connected without restricting flexibility of conduit.

D. Liquid Tight Flexible Metal Conduit - Sealtight: May be used only for outdoor final connections to mechanical equipment and to surface panels and boxes on portable classrooms which are not anchored and tied down to bases.

1. Minimum trade size - one-half inch (½").

2. Connectors - Appleton STB Series through two-inch trade size and ST Series with insulated bushings over

   Two-inch trade size. Appleton, Crouse-Hinds or equal may be used.

3. Length shall be practical minimum, but to allow for movement of equipment connected without restricting flexibility of Sealtight.

E. Poly-Vinyl-Chloride Schedule 40 may not be used.

F. Surface Wire mold: May be used only for indoor installations at locations specifically permitted on the plans.

1. Shall be Wiremold #200 and 500 with matching connectors and accessories.

2. Paint raceway to match wall or ceiling finish.

3. Non-metallic surface raceways are not approved.

G. Aluminum conduit of any shape or size is not approved for use on this project anywhere.

H. Conduit Support:

1. Conduit shall be supported with straps, with galvanized malleable split ring and rod for individual runs or with Kindorf, Unistrut, or equal channel for multiple runs. Distance between supports shall not exceed 10 feet. Conduits shall be supported independently of one another.

2. Conduits run on roof shall be fastened to a 4" x 6" x length as required redwood block set in mastic on roof structure using galvanized double hole straps and screws. Multiple conduit runs shall be gathered neatly in straight lines and fastened individually to the redwood block.

I. Conduit straps for individual runs shall be secured by toggle bolts on hollow masonry, expansion shields and machine screws on solid concrete or masonry, machine screws or bolts on metal surfaces and wood screws on wood construction. Use of nails to anchor straps on wood construction is prohibited. Straps shall be two hole malleable iron or snap type steel with ribbed back, galvanized or cadmium plated. Use of

perforated strap iron or nail type straps is prohibited.

J. Conduit Fittings: Except where otherwise noted, conduit fittings shall be Appleton. Unilets shall be malleable iron and fitted with covers and gaskets. Aluminum fittings are not acceptable.

K. Underground conduit bends shall have a minimum radius of twelve times the conduit trade size.

L. Conduits shall be capped during construction.

M. Provide pull wires in empty conduits. Pull wires shall be #12 TW in conduits 1" and smaller and 3/16" polypropylene rope in conduits 1-1/4" and larger.

N. Minimum size underground conduit shall be 3/4".

O. Electrical non-metallic tubing may not be used.

P. Liquid tight non-metallic flexible conduit may not be used.

1.02 BOXES: Boxes shall be of the shape and size best suited for the particular application and shall be supported directly to structural members, framing or blocking by means of screws, anchors, and bolts or embedded in masonry.

A. Switch and receptacle box shall be one piece drawn steel boxes. Minimum size shall be four inches (4") square. Boxes shall be fitted with flush device covers, plaster rings, or tile switch rings in masonry. In areas where exposed wiring is permissible, boxes shall be fitted with surface type covers.

B. Weatherproof boxes shall be Appleton FD Series and fitted with gasketed cast covers.

C. Boxes for special equipment shall be suitable for the particular equipment.

D. Boxes shall be located and placed according to Architectural and structural requirements.

1.03 PULL OR JUNCTION BOXES: Install where indicated, or as required by Code; pull boxes and junction boxes of sufficient size and capacity to facilitate all wiring. Boxes shall be sized to properly accommodate all conductors entering same.

1.04 SUPPORTS: Furnish all necessary foundations, supports, backing, etc., for all

electrical enclosures, conduits and equipment. Attach all boxes, cabinets, etc. to wood with wood or lag screws, to metal with machine screws or bolts and to concrete with expansion anchors and machine screws or bolts.

1.05 CONDUCTORS: Deliver to the site in unbroken packages, plainly marked with the manufacturer's name, date of manufacture (not more than six months old), voltage size and classification no.

A. Branch circuit conductors shall be stranded copper conductors, Type THHN/THWN, for conductors #8 or smaller, unless otherwise noted.

B. Conductors #6 or larger shall be stranded copper conductors, Type THWN, unless otherwise noted.

C. Conductors for feeders and branch circuits installed on the roof shall be stranded copper conductors, Type THWN/THHN, unless otherwise noted.

D. Minimum size of all conductors shall be #12 AWG unless otherwise indicated on the drawings.

E. Conductors shall be as manufactured by Anaconda, General Electric, Rome Cable Co., or equal.

1.06 SPLICES: Splices of #10 and smaller, including fixture tape, shall be made with Scotchlok connectors, T & B "Piggys" or equal.

A. Splices of #8 through #4 shall be split bolt service connectors "Kerneys", T & B "Lock Tites" or equal, insulated with Scotch #88 or Okeweld four-purpose tape.

B. Splices #2 and larger shall be OZ "ST" Series insulated with Scotchfil and Scotch #88 or Okeweld.

C. Splices in underground pull boxes shall be Scotchcast cast resin splices.

D. Wire splicing devices shall be sized according to manufacturer's recommendations.

1.07 CONDUCTORS IN PANELS: Conductors in panels, motor control centers, etc. shall be laced with T & B Ty-raps.

1.08 LUBRICANT: Lubricant for conductor installation shall be powdered soapstone, Y-er EAS, Minerallac "Pull-In" compound or other U.L. approved lubricant. Flax soap is not approved and not permitted on the job.

1.09 CABLE IDENTIFICATION: Non-ferrous identifying tags or pressure sensitive labels shall be securely fastened to all cables, feeders and power circuits in pull boxes and manholes. Tags or labels shall be stamped or printed to correspond with markings on drawings or marked so that feeder or cable may be readily identified.

****END OF SECTION 16110****

SECTION 16200 – MAIN SERVICE

PART 1 - SWITCHBOARD/PANELBOARDS/MOTOR CONTROL ENTERS

1.01 The electrical distribution equipment is existing. See plans for modifications.

1.02 GROUNDING AND BONDING: Grounding and bonding shall be installed as required by the applicable codes, rules, regulations and safety orders. Attention is directed to Article 250 of the California Electrical Code.

A. All raceway systems, supports, cabinets, switchboard, control equipment, motor frames, lighting fixtures, and utilization apparatus shall be permanently and effectively grounded.

B. Where the raceway is used as equipment bond, good contact shall be made between conduit or tubing and panels, cabinets, outlet boxes and equipment, lighting, etc. to maintain continuity of equipment bond. Where it is not possible to obtain good contact, additional bonding shall be provided. Supplemental bonding shall be provided between raceway and enclosures at concentric knockouts and at reducing washers.

C. All grounding type receptacles shall be bonded to outlet box, using code size copper conductor, green insulated, attached to receptacle grounding terminal and to lug or screw terminal in box. This requirement is also provided in CEC Article 250-74.

D. Provide bonding conductor around flexible metallic conduit (Greenfield). Bonding conductor shall be inside flex.

E. Raceway size shall be increased if necessary to accommodate bonding conductors and shall be based on raceway fill tables.

F. Where cabinets are furnished with grounding bus, all required bonding conductors shall connect thereto, each with separate lug.

G. Provide a green ground conductor, sized per Code, in all flexible conduits, irrespective of whether conduit constitutes an approved ground or not.

****END OF SECTION 16200****

SECTION 16300

PART – 1 DISTRIBUTION

1.01 DISCONNECT SWITCHES: Units shall be fused disconnect switches, two or three pole type, where indicated on the Drawings, or as required by Code. Switches and fuses shall be as required by the loads serving. Fuse rating shall be the maximum indicated on the nameplate of the equipment.

1.02 HVAC SYSTEMS:

A. All low voltage control components for low voltage wiring, low voltage conduits and low voltage wiring for Heating, Ventilating and Air Conditioning are not in this section.

B. This Contractor shall provide line voltage conduit and line voltage wiring and disconnects for HVAC system units.

C. This Contractor shall make all line voltage connections to all motors and controls furnished under another Section. Use Sealtite Type VA or approved equal flexible conduit at each motor and as specifically called for.

1.03 WIRING DEVICES:

A.

Wiring Devices	Leviton #	Hubbell #	P&S
Duplex conv outlet	5252	5252	5252
Duplex GFI outlet		GF5262	

B. Furnish in standard colors (brown, white, grey, beige or ivory) as selected by the Engineer.

1.04 DEVICE PLATES:

A. All device plates shall be Sierra brushed stainless steel.

B. Outdoor receptacle plates shall be Sierra line stainless steel, Type 302.

****END OF SECTION 16300****