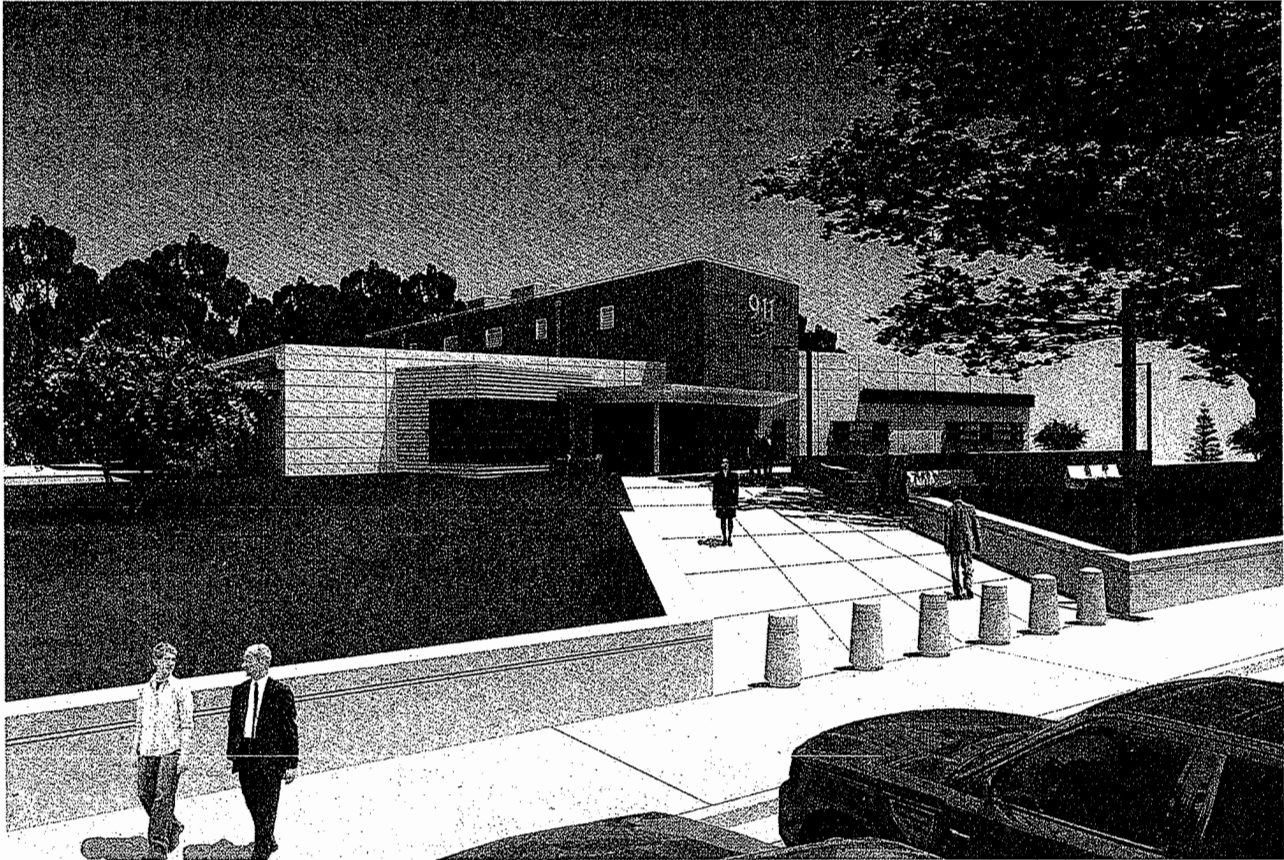


PROJECT MANUAL *for*

A NEW FACILITY FOR THE ORLEANS PARISH COMMUNICATION DISTRICT



ARCHITECT'S PROJECT No.: STBA 51000.09

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MECHANICAL

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SECTION 15050

BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The General Provisions of the Contract, including General and Supplementary Conditions and General Requirements apply to the work specified in this Section.
- B. Separation of specifications into sections is for convenience only and is not intended to establish limits of work or liability. The following are the Sections that will apply to this project.

- 15050 - Basic Materials and Methods
- 15250 - Piping and Equipment Insulation
- 15400 - Plumbing
- 15425 - Water Well
- 15450 - Sewerage Treatment Center
- 15500 - Fire Suppression Systems
- 15650 - Diesel Systems and Products
- 15800 - Heating, Ventilation and Air Conditioning
- 15850 - Testing, Adjusting, and Balancing of Air and Hydronic Systems
- 15900 - Valves, Strainers, Unions and Fittings
- 15950 - Building Temperature Control and Energy Management System

1.2 DESCRIPTION OF WORK

- A. The work to be done under this heading includes the furnishing of labor, materials, equipment, and service necessary for and reasonably incidental to the proper completion of all mechanical work as shown on the drawings and herein specified.
- B. Visit and examine the job site, and with all authorities concerned in order to become familiar with all existing conditions pertinent to the work to be performed thereon. No additional compensation will be allowed for failure to be so informed. Pay all costs and fees for utility connections.
- C. Materials and equipment shall be new, except where otherwise indicated, of the best quality, with same brand of manufacturer for all similar material. All equipment shall be installed in accordance with manufacturer's requirements. Equipment with electrical components shall be laboratory tested.
- D. All work shall be performed in a neat and workmanlike manner, and in accordance with all codes, standards, and requirements of the industry. All workers shall be trained in the tasks they perform. Training shall be by an industry accepted trade school.

- E. In general, provide the installation of plumbing, fire standpipe system, HVAC systems and central plant renovations complete with all pumping, piping, fittings, fixtures, equipment, etc.
- F. Regardless of titles and subdivisions herein employed, consider these specifications as one complete document with General Section applying to all other sections. All bidders are cautioned to read entire specifications and to thoroughly familiarize themselves with all requirements thereof.
- G. Check all specifications and all drawings and bring to attention any conflicts or variations as shown as noted.
- H. Specifications and accompanying drawings apply to all contracts or sub-contracts entered into for supplying material or labor for construction of work specified herein and shown on drawings.
- I. Protect Owner and his agents including Construction Manager, Architect and/or Engineer from any and all damages and expense arising from fulfillment of contract and at completion of work repair all damages done.
- J. For any points which are not clear, or for items and/or details which the Contractor feels are in need of clarification, consult the Architect before submission of a proposal.
- K. The drawings and the specifications are complementary and what is shown and/or called for on one shall be furnished and installed the same as if shown and/or called for in the other.
- L. In case of discrepancies and/or ambiguities in the drawings and/or in the specifications, the Architect shall be consulted prior to submission of a proposal. Failure to do so on the part of the successful bidder shall be construed as explicit agreement on his part to abide by the Architect's decision in such matters.
- M. The word "provide" as used in these Specifications and on the Drawings shall be termed to mean "furnish and install".
- N. Contractor shall include in base bid the connection of all sewer, storm Drain and water piping to mains as shown on the drawings. Contractor shall include all material and all costs for complete installation.
- O. If the Contractor notices during the bidding any items of the contract documents which will violate any applicable code, these items shall be brought to the attention of the Architect before the bid date. Failure to bring these items to the attention of the Architect shall be construed as explicit agreement that the Contractor has included in his bid price any and all modifications necessary to complete the project in accordance with all applicable codes.

1.3 RELATED WORK SPECIFIED IN OTHER SECTIONS

- A. All exposed piping, ductwork and other equipment requiring painting will be painted under PAINTING SECTION. Leave all these surfaces clean of oil, dirt, plaster, etc., ready for painting section's work.
- B. Power wiring for all equipment shall be done under ELECTRICAL SECTION.
- C. Provide approved wiring diagrams to the Electrical Contractor showing interlocking of all equipment and controls, assisting in all wiring problems affecting his equipment, checking and verifying that same is wired correctly under the Electrical Section for proper operating of all mechanical items.
- D. Furnish under this section all heating, air conditioning, ventilating and other mechanical systems controls, starters, combination starter/disconnects, firestats, relays, and related equipment.
- E. Openings for all access doors, relief and return air grilles, etc., shall be provided under the respective trade sections.
- F. Curbs, flashings, etc., for exhaust fans, vents, etc., shall be provided under the respective sections.
- G. All HVAC control wiring shall be furnished and installed by Building, Automation and Temperature Control Contractor.
- H. Piping and ductwork penetrations through fire rated partitions/floors shall be fire sealed in accordance with the UL fire resistance directory. See Sealant Specification for materials. The integrity of the fire rating, as indicated on the architectural drawings, shall be maintained.

1.4 QUALITY ASSURANCE

- A. The Contractor bidding on this portion of the work must be fully experienced in installations of equal size, complexity, and quality, and must be licensed to perform such work as required by the Louisiana State Legislature.
- B. In bidding he acknowledges that he fully understands the scope of work and design, and has the ability for the contract price to assemble and install the equipment, piping and ductwork shown or specified, so as to mold same into a satisfactory workable system and arrangement.
- C. Contractor shall recognize that a fault or error in his work remains his responsibility regardless of whether such difficulty was discovered after the work had progressed, and shall make corrections at no cost to the Owner.
- D. Adequate and competent constant supervision shall be provided by Contractor to assure that work is done in accordance with good standard practice and workmanship and with intent of drawings and specifications. Contractor shall recognize that amount of information and detail could be provided to contract documents is limitless and could extend into every minute detail and sequence of operations, to a point where only

workmen would be required, without drawing on ability, experience and ingenuity of the Contractor.

- E. All work shall be installed in strict accordance, with all existing local and state codes and ordinances, with National Board of Fire Underwriters
- F. This Contractor shall secure all permits and inspections and shall pay all fees and taxes and shall provide Owner with certificates of approval from agencies having jurisdiction over various phases of work.
- G. Contractor shall maintain and service all equipment until time of acceptance by Owner. Contractor shall include all required service access in the installation as required by the manufacturer and governing codes.
- H. Prior to starting any work, the Contractor shall submit a quality assurance plan for approval by the Architect. In the quality assurance plan, the Contractor shall provide the following information:
 - 1. List of all sub-contractors and equipment suppliers.
 - 2. List of all foreman and job superintendents including job experience for all trades.
 - 3. Construction time schedule demonstrating coordination with other trades and showing detailed time lines for test and balance and commissioning being completed prior to final punch list inspection.

1.5 SUBMITTALS

A. Shop Drawings and Submittal Data required:

- 1. Submit to the Architect for review, complete descriptive information and dimensional data on all items of equipment, materials and accessories, including duct, equipment and sprinkler layouts. Piecemeal submissions shall not be approved. Written approval thereof must be obtained before ordering or installation. The following shall be submitted:

Exhaust Fans
Air Handling Units
Insulation
Chillers
Pumps
Valves, Strainers, Unions & Fittings
Fire Protection Layout and Calculations
Plumbing Piping Layout
VAV Boxes
Sample Commissioning Reports
Quality Assurance Plan
Expansion Tank & Air Separator
Building Automation and Temperature Controls

Ductwork Layout
Equipment Layout
Diffusers, Grilles & Registers
Unit Heaters
Plumbing Fixtures
All Mechanical Room Layouts
Variable Frequency Drives
Hydronic Piping Layout
Air Filters
UV Lights
Motor Starters
Water Heaters

2. Shop drawings and submittal data shall be considered to be instruments of service only and submitted for the sole purpose of convenience to the Contractor to assist him in the performance of the contract. The Architect's review of the shop drawings and submittal data shall not supersede these specifications, the accompanying drawings, or the contract terms, unless specifically covered by a properly executed change order, and then only to the extent specifically and explicitly stipulated therein.
 3. Submit in accordance with requirements of Architectural Sections, Division 1.
 4. Ductwork shop drawings shall be at a minimum 1/4" scale. Duct shop drawings shall show the following:
 - a. All structural members larger than 4".
 - b. All hydronic piping 2" or larger.
 - c. All conduit 2" or larger
 - d. All duct fittings, take-offs, volume dampers, control devices and fire dampers.
 - e. All grilles, louvers, registers and diffusers.
 - f. Duct dimensions and insulation methods.
 - g. Duct dimensioned from structural beams and columns.
 - h. Architectural ceiling heights, furrings, chases, etc.
 - i. Cross-sections in areas of congestion or conflict.
 - j. Installation details for all duct and related equipment.
 - k. Lights, speakers, smoke detectors and other ceiling mounted devices.
- B. After completion of project Contractor shall turn over to the Architect complete operating and maintenance instructions including listing of supply and repair items and locations of places to purchase same. Comply with requirements of Division 1 Sections.
- C. Substitutions:
1. All material, equipment, methods, and accessories entering into the work under this section of contract are subject to approval or disapproval of the Owner. Approval of any manufacturer, material, or product shall not constitute a waiver of Owner's right to demand full compliance with contract requirements, including shape, size, quality and performance.
 2. Equality of materials is that established by opinion of Owner. Decision of Owner is final.
 3. Whenever a material or article of equipment is specified by use of a proprietary name, or by naming the manufacturer or vendor, any material or article which will perform adequately the duties imposed by the design will be considered for substitution, providing it is of equal substance, and function, meets specifications, and is aesthetically acceptable to the Owner. Refer to Division 1 Sections for approval procedures.
 4. Literature, technical data, etc., includes complete data and samples if necessary, with submissions for substitutions. Burden of proof that material offered for substitution is equal, or superior, in construction and efficiency to that named, rests

on Contractor, and unless proof is satisfactory to Architect, substitution will not be approved. Contractor shall note any deviations from specified equipment with the substituted submittal. Failure to note deviations will result in rejection of substituted equipment and materials.

D. See Architectural Specifications for "As-Built" requirements.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

Take necessary precautions to protect all material, equipment, apparatus and work from damage. Failure to do so to the satisfaction of the Architect will be sufficient cause for the rejection of the material, equipment or work in question. Contractor is responsible for the safety and good condition of the materials installed until final acceptance by the Owner. Comply with equipment manufacturer's requirements. No insulation or electrical components, shall be subject to water damage.

1.7 JOB CONDITIONS

- A. Accompanying drawings, including plans, details, diagrams, notes, etc., are shown to limit and explain structural conditions, construction requirements, sizes, capacities and method of installation and erection. Structural and other conditions may require certain modifications and adjustments from conditions shown. Such deviations are permissible; however, specific sizes capacities and requirements affecting the satisfactory performance and operation of the installation shall remain unchanged. Make allowance for normal job conditions and interferences.
- B. Whenever it becomes necessary to shift ducts or pipes or to change shape of ducts, such changes shall be referred to Architect for approval.
- C. Ask for details whenever uncertain about method of installation. Lack of details not requested shall not excuse improper installation and correction shall be responsibility of Contractor. Contractor shall consult manufacturer for details specific to their items of equipment.
- D. Furnish detailed duct layout and equipment room shop drawings based on field measurements and actual job conditions.
- E. Schedule and perform all mechanical work to avoid delays to the Contractor and other trades.
- F. In addition to the basic work covered under this contract, the Contractor shall plan and schedule the work to permit continuous operation of essential services of existing facilities. Planning shall also include scheduling necessary interruptions of service on water lines, drain lines, etc., to existing building at times when such interruptions will cause minimum interference with existing routine and services. All such interruptions shall be made only after consultation with the Owner. This is extremely important since included in the work is a relocation and rerouting of and connecting to existing facilities, piping, etc. No additional compensation will be allowed for failure to be so informed.

- G. It is essential that all adjacent areas of the Site be kept in operation at all times, except when specific permission is given to contrary. Before any lines or equipment are shut down for disconnecting, tie-ins, or rearranging of services, make arrangements with Architect to do this work at night, or Sunday, or at special time of day or year with length of shutdown agreed upon before work is begun. Contractor to bear any overtime or work costs in the connection.
- H. All piping, cleanouts and covers, and other mechanical items in way of construction or remodeling, shall be rerouted, relocated or otherwise adjusted to work out with such construction or changes shown or specified in any or all of various sections of specifications. Unknown piping that is encountered will be referred immediately to Architect for method of disposition before continuation of work.
- I. The Contractor shall review the architectural drawings to become familiar with the phasing of construction required for this project.

1.8 GUARANTEE AND SERVICE

- A. Guarantee all equipment, materials, and workmanship for a period of one (1) year following date of acceptance.
- B. During the period of guarantee any defects in equipment, materials, or workmanship shall be promptly corrected without cost to the Owner.
- C. Guarantee includes equipment capacity and performance ratings specified without excessive noise levels. Any deficiencies in equipment capacity specified shall be promptly corrected.
- D. Guarantee does not include maintenance items.

PART 2 - PRODUCTS

2.1 ACCESS PANELS

- A. Provide all access panels necessary for proper access to valves, traps, fixture connections, control devices or other items installed under this contract.
- B. Panels to be Milcor, Type M, or KARP Model D3C-214M hinged with screwdriver lock or as indicated on drawings for special locations, minimum size 12" x 12" or larger as required for proper access.
- C. Exact locations for panels to be directed by Architect.

2.2 TOOLS AND SCAFFOLDING

Furnish all tools, equipment, scaffolding and other facilities required to properly and expeditiously perform the work.

2.3 SIPHON PREVENTORS

Furnish and install on all equipment and fixtures requiring same, backflow preventors or vacuum breakers of a type approved by the Louisiana Health and Human Resources. Water connections to fixtures and equipment shall be made in such a way as to prevent back siphonage when the water supply is out or the pressure drops. Provide reduced pressure type back flow preventors where indicated on drawings. They shall be Watts series 900 or Febco Series 825, size as indicated on drawings.

2.4 SLEEVES AND THIMBLES

- A. Pipe sleeves - wrought iron or cast iron of sufficient size for piping and installation to be installed in floors, walls below grade, and grade beams where piping passes through.
- B. Thimbles above grade - heavy galvanized steel of proper size to allow freedom of piping and insulation, set in floor or roof slab as work progresses, also to be installed in wall and partitions where piping passes through.
- C. Thimbles below grade - same as pipe sleeves above.
- D. Sleeves through floors extend 1" above finished floor. Caulk around and seal all piping in chases and piping passing through floor slab.
- E. Provide sleeve seals and shields for all pipe penetrations of ground floor slab.
- F. Provide UL listed fire-stopping in all pipe penetrations of rated floors and walls, see Architectural Specifications for Requirements.

2.5 BUCKS, GROUNDS AND CHASES

- A. Be responsible for proper location and sizes or for any errors or omission in placing same.
- B. Failure to inform the General Contractor promptly of such requirements shall not relieve the Mechanical installer of the responsibility for providing a complete mechanical system.

2.6 HANGERS

- A. Horizontal piping above grade without hubs shall be rigidly supported. Distance between pipe supports:
 - 1. 1/2" pipe 6'-0" maximum
 - 2. 3/4" pipe 7'-0" maximum

3.	1" pipe	8'-0" maximum
4.	1 1/4" pipe	9'-0" maximum
5.	1 1/2" pipe and over	10'-0" maximum

- B. Hangers shall be similar to "Split Ring" type.
- C. Metal strap or wire will not be acceptable.
- D. For two or more systems of piping run parallel and with same grade trapeze hangers may be used.
- E. Use #22 gauge galvanized sheet steel saddles, minimum 18" long between the pipe covering and each pipe hanger on all insulated lines. Saddles shall extend along pipe runs and at least half way up piping on each side.
- F. All above grade horizontal sewer drain, vent, waste and similar piping shall be hung at every hub using the same type hangers as specified for other piping.
- G. All underground piping under building shall be supported from slab as detailed on the drawings.
- H. Rods supporting pipe hangers shall have the following dimensions:

1/2" to 2" pipe	3/8" rod
2-1/2" to 3" pipe	1/2" rod
4" to 5" pipe	5/8" rod
6" pipe	3/4" rod
8" through 12"	7/8" rod
- I. Rods for trapeze hangers shall be a minimum of 3/8" and shall have the equivalent cross section, listed above, for pipe supported.

2.7 PAINTING AND IDENTIFICATION

- A. Equipment, including pumps, motors, and similar factory fabricated and assembled units shall be furnished with factory applied protective prime coat paint of finished baked enamel. Equipment surfaces damaged during course of construction or shipment shall be refinished by the Mechanical Contractor.
- B. Uncoated black ferrous piping and fittings shall be cleaned under this section and painted with one coat of enamel paint under PAINTING SECTION. Color of piping shall be selected by Architect. Hangers and supports shall be coated by dipping or brush painting with one coat of asphalt varnish. Steel frame equipment supports shall be cleaned and painted with one coat of aluminum paint.
- C. Detached motor controllers, disconnects, etc., shall be identified with metal or plastic plates with etched letters to completely identify service of electrical equipment.

- D. Major control and sectionalizing valves shall be identified by means of etched brass plates bracketed to valve handle. Contractor shall prepare schedule of such identifying plates for Architect's approval.
- E. Exposed ductwork shall be cleaned under this Section and painted under Painting Section.

PART 3 - EXECUTION

3.1 EXCAVATION, TRENCHING AND BACKFILL

- A. The Contractor shall perform all excavation of every description and of whatever substances encountered to the depths indicated on the drawings. During excavation material suitable for backfill shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All material not suitable for backfilling shall be removed completely from job site. Such shoring shall be done as hereinafter specified.
- B. Trenches shall be of necessary width for the proper laying of the pipe and the banks shall be as nearly vertical as practicable. The bottom of the trenches shall be accurately graded to provide uniform bearing and support. Bottom of trenches shall have 6" layer of compacted limestone aggregate. Care shall be taken to provide uniform bearing and support.
- C. Bell holes and depressions for joints shall be dug after compaction and grading in order that the pipe will be supported along its entire length. Whenever wet or otherwise unstable soil that is incapable of receiving the bottom preparation and support piping, as determined by the Engineer, is encountered, such soil shall be removed to the depth required and the trench backfilled to the proper grade with river sand.
- D. All shoring required to perform and protect the excavation, and as required for the safety of employees, shall be installed. The sides of the trenches, four (4') feet or less shall be protected as required. For trenches more than four (4') feet in depth, the sides shall be secured by the use of continuous sheet piling and shall be not less than two (2") inches in thickness. Meet the minimum requirements of OSHA for trench shoring not described above.
- E. The trenches shall not be backfilled until all required pressure tests are performed and until the certificates of inspection from the proper authorities are obtained by the Contractor. The trenches shall be carefully backfilled with the excavated materials approved for backfilling consisting of earth, loam, sandy clay, sand and gravel, or other approved materials free from large clods of earth or stone, deposited in six (6") inch layers and thoroughly and carefully rammed until the pipe has a cover of not less than two (2') feet. The remainder of the backfill material shall then be thrown into the trench in one (1') foot layers and tamped. Any trench improperly backfilled, or where settlement occurs, shall be reopened to the depth required for proper compaction, then refilled and compacted, with the surface restored to the required grade and compaction, mounded over, and smoothed off. Sidewalks, drives and streets broken up by this work shall be repaired and returned to original condition.

3.2 FLASHING AND COUNTERFLASHING

All pipes and ducts that pass through roof and walls shall run so as not to interfere with the structural system and to permit proper application of base and counterflashing. All plumbing vents are to be finished with 2-1/2 pound sheet lead turned down into pipe. Other pipes to be provided with suitable curbs and flashed to roof or walls as indicated. Flues shall be properly flashed and counterflashed with approved type jacks. Roof drains shall have 2-1/2 pound lead sheet base secured to drain clamp and extending minimum of 2'-0" in all directions.

3.3 CLEANING, STERILIZING AND PIPING

- A. When all work has been finally tested, Contractor shall clean all fixtures, pipes and exposed work.
- B. All pipes shall be free from all obstructions.
- C. All plated and other finished products shall be thoroughly cleaned and polished.
- D. New water piping shall be sterilized as required by State Sanitary Code. Provide detailed reports describing sterilization method and duration for each piping section.
- E. All piping shall be installed so that it may expand and contract freely without damages to equipment, other work, or injury to piping system. All necessary swing joints, expansion joints, or offsets to protect piping, etc., shall be installed whether indicated or not. Piping shall be graded to allow for system drainage.
- F. Stainless steel or chromium plated floor, wall and ceiling plates shall be furnished on all exposed piping passing through floor, walls, or ceilings. Plates shall be secured in place with round head screws or toggle bolts of proper size and type for adjacent construction.
- G. All piping shall be installed and sized as indicated on plans and be of equivalent materials to piping as hereinafter specified.
- H. All piping shall be installed with runs arranged parallels or perpendicular to walls and ceilings with symmetrical and equal spacing between parallel pipes. Offsets shall be made using factory fittings, bending of piping shall not be accepted.
- I. Notify Engineer a minimum 72 hours prior to enclosing piping in concealed spaces so that piping may be inspected.

3.4 TESTING AND INSTRUCTION

- A. Piping shall be tested to pressure hereinafter specified. Where pressures are not mentioned, it shall be understood that testing to 1-1/2 times service conditions, before

insulation is applied, will be acceptable. All tests shall be held for a minimum of 24 hours before inspection.

- B. Furnish all necessary gauges, pumps, test plugs, and temporary connections and shall test sections of the building as work progresses.
- C. All new underground sewerage, waste and storm drainage piping shall be plugged at outlets and tested hydrostatically to 10 psi before being covered. Notify Engineer a minimum 72 hours prior to any backfill of underground piping so that piping may be inspected. Failure to notify Engineer prior to backfill will constitute a rejection of the underground piping installation. All other drainage piping, vent and waste risers shall be plugged and tested by filling with water from top to bottom of each floor prior to being connected to fixtures. Tests shall be held a minimum of 24 hours.
- D. All new cold and hot water supply piping shall be tested hydrostatically to 125 pounds per square inch before application of insulation. Test shall be held a minimum of 24 hours.
- E. All new gas piping shall be air tested to a pressure of 75 PSI. During the test, all joints shall be painted with a soap solution to test for leak. The test shall be held a minimum of 24 hours.
- F. All tests shall be made in the presence of the Architect or his representative. Where pipes or connections in new piping are found to leak, they shall be made tight and the tests repeated.
- G. Make all necessary adjustments to controls, dampers, valves, etc., to obtain best operation first with empty building and later under actual conditions. A minimum of two job site visits required.
- H. Thoroughly check the operation of each item of equipment and controls while testing, without waiting first for the Owner or Architect to complain about their operation. Verify that same are wired correctly and completely, notifying the proper parties for necessary corrections. Thoroughly instruct the Owner's representative in the operation and care of controls, individual equipment, and entire system.
- I. Provide Architect with six (6) copies of balance reports as hereinafter specified. See Section 15850.
- J. After adjustment period and before acceptance replace construction filters specified in 3.9 with specified type.

3.5 CUTTING AND PATCHING

Cooperate to the fullest extent with all other trades to reduce to a minimum the amount of cutting and patching of other work necessary for this installation. Do not cut or patch the work of other trades but arrange to provide cutting templates in time, or otherwise pay the respective other contractors for changing theirs, to accommodate this work. No cutting into any structural units likely to impair the strength shall be done without the approval of the Architect.

3.6 CLEAN UP

Remove debris, surplus and waste materials, oil, grease or stains resulting from the work performed and leave the premises in a broom clean condition AT THE END OF EACH WORKING DAY. All debris, surplus and waste material shall be removed completely from the job site.

3.7 COMMISSIONING

- A. Contractor shall install all items of equipment as identified in this specification in strict accordance with manufacturer's requirements (whether identified in this specification or not), shop drawings and contract documents. Contractor shall coordinate with Electrical and Building Automation and Temperature Control System Contractors to insure a complete installation. Start-up of all equipment shall be by manufacturer authorized representative. Start-up services shall be provided for as long a period of time as is necessary to insure proper operation of the equipment items. The start-up technician shall conduct all operating tests as required to insure the equipment is operating in accordance with design parameters. Complete testing of all safety and emergency control devices shall be made. The start-up technician shall submit a written report to the engineer (prior to final punch list inspection) containing all test data recorded as required above and a letter certifying that the equipment is operating properly.
- B. Other specific items of commissioning shall be as follows:
1. Visually inspect insulation system to verify that insulation is continuous and vapor barrier is complete. Verify there is no condensation or hot spots.
 2. Thoroughly test all piping systems to insure no leaks are present. Adjust valves, pressure reducing valves, etc., as required by operating characteristics of the system. Set pressures of domestic water systems.
 3. Check operation of all plumbing fixtures to insure proper water flow (hot & cold) and drainage. Verify that roof drains, floor drains and hub drains are not clogged and drain water. Adjust hot water recirculation balance cocks, pumps and piping to insure hot water flow is present at all fixtures within 10 seconds.
 4. Ductwork and hydronic piping shall be tested by the balancing Contractor. See Section 15850.
 5. Vibration isolation shall be tested by running equipment and checking deflection of spring isolators. Make adjustments as required. No isolator shall be fully compressed.
 6. Piping shall be checked and labeled to insure direction of flow.
 7. Fire Suppression System (15500) shall be installed and tested in accordance with NFPA-13, 14, 20 and 24 requirements. See 15500-2.19.

8. Coordinate with section 15950 Contractor to insure mechanical systems operate in accordance with plans and specifications. Heating and cooling modes of HVAC equipment shall be tested. Actual values of temperature in space shall be checked against setpoint values and deviations shall be corrected.
9. Provide written reports for all startup and commissioning tests listed above for Engineer review prior to final punch list inspection.

3.8 WELDING

A. Codes and Standards

1. American Society of Mechanical Engineers (ASME) B31.1
2. ASME Boiler and Pressure Vessel Code - Section V and IX
3. American Welding Society (AWS) D10

- B. Qualifications for Welding Work: The fabricator and/or installer shall qualify each welder or welding operator for the welding processes to be used during production and field welding. The performance qualification shall be in accordance with a qualified Welding Procedure Specification (WPS). The WPS shall be governed by the essential variables listed in ASME Section IX and AWS D10.9 as may be applicable for the welding processes for which the welder is being qualified. Provide certification that the welders performing work on this project are qualified in accordance with the WPS, as well as the parameters used in the qualification.

- C. Welds shall be in accordance with ASME and AWS standards as qualified under ASME Section IX. Owner shall employ a testing agency to perform a visual inspection of 5% of the welds in accordance with ASME Section V. The following visual examination indications shall be deemed unacceptable and shall be corrected at Contractor's expense:

1. Cracks on external surfaces
2. Surface undercut greater than 1/32 inch deep.
3. Weld reinforcement greater than specified in ASME Table 127.4.2
4. Lack of fusion on surface
5. Incomplete penetration

Future inspections for failed welds shall be tested at Contractor's expense.

3.9 OPERATION OF AIR-HANDLING UNITS DURING CONSTRUCTION

Contractor shall provide 4"-85% efficient filters for units with 1.0" ESP and greater or (sets of 2) MERV 12, 1" filters for units under 1.0" ESP for air-units operated during construction. In addition roll type filter media shall be provided on all return air grilles and unit openings. Contractor shall be responsible for changing media as required. The Contractor is to protect the air unit coils and keep air-unit and duct interior surfaces clean. If the Contractor fails to comply with the filtration requirements, the Contractor shall clean and/or replace the coils and duct system at his expense.

END OF SECTION

SECTION 15250

PIPING AND EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide a complete system of insulation, as herein specified, for both inside and outside of building.
- B. The General Provisions of the Contract including General and Supplementary Conditions and General Requirements apply to the work specified in this Section.
- C. Refer to Section BASIC MATERIALS AND METHODS, which is applicable to this Section.
- D. Insulation shall include insulating materials, their applications, finish, bands, tie wire and weather protection for all piping, fittings, valves, and equipment as indicated and specified herein.

1.2 GENERAL

- A. All insulation shall be applied in a workmanlike manner by skilled workmen regularly engaged in this type of work.
- B. All pipe insulation shall have COMPOSITE flame and smoke hazard ratings as tested in accordance with standard testing methods (NFPA) 255 and UL 723).
- C. Composite ratings shall not exceed: flame spread 25, smoke developed 50.
- D. Accessories such as adhesive, mastic, cement, tapes and asbestos cloth shall have the same component ratings as listed above.
- E. THE INSULATION CONTRACTOR SHALL CERTIFY IN WRITING, PRIOR TO INSTALLATION, THAT ALL PRODUCTS TO BE USED WILL MEET THE ABOVE CRITERIA.

PART 2 - PRODUCTS

2.1 CHILLED WATER PIPING ABOVE GROUND

- A. All chilled water piping and fittings shall be insulated with 100% rigid cellular glass molded pipe insulation. Insulation shall have an average density of 8 lb./cu.ft. and shall have a thermal conductivity of 0.31 BTU-in/hr.sf.degrees F. at 50 degrees F. The insulation shall comply with ASTM C 552, Type II furnished in half sections of 24" long.

- B. Insulation shall be installed with all seams and joints sealed with water proof sealant as recommended by the manufacturer. After sealant is applied insulation shall be secured with ½" wide by 0.010" thick stainless steel bands with matching seals. Sealants shall be applied full depth of all joints and shall not be used to fill voids or cracks.
- C. Cover all new insulation with an all purpose jacketing of kraft paper/aluminum foil/vinyl coating construction.
- D. Insulate fittings, flanges and valves with same material and thickness as adjacent piping. Cover insulation with same jacket as adjacent piping.
- E. Chilled water pipe insulation shall have the following thickness:

Pipe Size	Insulation Thickness
Up to 1"	2"
1-1/4" to 4"	2-1/2"
5" to 12"	3"

- F. Provide one or two layer expansion/contraction joints in accordance with manufacturer's recommendations.

2.3 ROOF DRAINS

Insulate the body of all roof drains and the roof drain piping and fittings from the drain through all horizontal runs to the connection with the vertical leader as specified for domestic cold water pipe, fittings, flanges and valves; thickness to be ½ inch for all pipe sizes. At Contractor's option 1-1/2" thick flexible fiberglass insulation with vapor barrier may be used in lieu of rigid fiberglass. Insulation shall be same type as specified for exterior duct wrap. All joints shall be sealed with pressure sensitive tape.

2.4 PUMPS

Insulate chilled water and heating water pumps with rigid glass fiberboard insulation having minimum density of 3 PCF with factory applied foil-scrim-kraft (FSK) facing, KNAUF insulation board, or approved equal, 1-1/2 inch thick. Form a box to enclose pump and fill void between pump and box with flexible glass fiber insulation. Seal joints with 3-inch wide strips of same facing material adhered with vapor barrier adhesive. Vapor seal and finish with vapor barrier mastic, Foster 30-35, Manville Duramesh No 206 or approved equal, reinforced with white glass fabric.

2.5 AIR CONDITIONING DRAINS

- A. Insulate all air conditioning condensate drains, pipe, fittings, flanges and valves with flexible foamed plastic tubing insulation, J-M Aerotube 11, Nomaco K-flex, or approved equal. Thickness to be 3/4 inch.

- B. Insulate all horizontal waste piping (new or existing) above ground that receives A/C condensate from drain to vertical stack. Also insulate the "P" trap of those drains. Insulation shall be same as specified for above ground domestic cold water piping, fitting flanges and valves except thickness shall be 1/2 inch for all pipe sizes.

2.6 DUCT INSULATION

- A. DUCT SIZES SHOWN ON DRAWINGS ARE FREE AREA SIZES. See Section 15800 for insulation and duct material and type required for each application. Insulation shall be as per the following:
- B. Lined Duct system - All lined ducts shall be lined with Knauf Duct Liner E-M, Owens Corning ductliner, or approved equal. Duct Lining shall be applied in strict accordance with the latest edition of SMACNA's "HVAC Duct Construction Standard Metal & Flexible." Mechanical fasteners shall meet "Standards for Mechanical Fasteners MF-1-1975." Length of mechanical fasteners shall not compress the insulation more than 1/8" and shall be installed perpendicular to the duct surface. Adhesive shall conform to ASTM C 916 and be applied to the sheet metal with a 90% minimum coverage. All exposed edges of the duct liner material shall be coated with the same adhesive. All rips and tears shall also be repaired using adhesive. All internal duct areas shall be covered with duct liner. Transverse joints shall be firmly butted with no gaps, and coated with adhesive. Longitudinal corner joints shall be overlapped and compressed. For velocities from 4001 to 6000 FPM, metal nosing shall be applied to all upstream transverse edges to additionally secure the insulation." Liner shall be 1" thick, 1.5 PCF.
- C. Exterior Duct Wrap - Exterior insulation duct wrap shall be 2" thick .75 PCF fiberglass wrap with F.S.K. jacket, Owens Corning, KNAUF, duct wrap, or approved equal.
- D. All ductwork on the exterior of the building shall be insulated with 2" thick, 6 pcf density, fiberglass rigid board insulation applied to the exterior of the ductwork, and completely covered with a complete covering of Flex Clad 400 stucco embossed flexible aluminum with self adhering adhesive of rubberized asphalt. As manufactured by MFM Building Products or approved equal. At contractors option a 2" thick closed cell flexible elastomeric insulation with 13-ply laminate exterior membrane (6 layers of aluminum foil, 4 layers of polyester film around a scrim reinforced core) Armatuff Plus as manufactured by Armaflex or approved equal attached with applied adhesive or pre applied pressure sensitive adhesive, may be used. Seams and joints shall be covered with pressure sensitive Seal Tape. All insulation shall be sloped to prevent water ponding and shall be installed in strict accordance with Manufacturers recommendations.

2.7 DOMESTIC HOT AND COLD WATER PIPING ABOVE GROUND

- A. Insulate all new above ground hot & cold water pipe with glass fiber pipe insulation with factory applied white all service jacket, with self-sealing lap (ASJ-SSL) as manufactured by KNAUF, Owens Corning, or approved equal.
- B. Insulate fittings, flanges and valves with performed insulation with PVC premolded one-piece fitting covers, with fiberglass inserts, Proto covers, or approved equal. Premolded

or shop fabricated Glass Fiber covers may be used in lieu of above at the Contractor's option. Optional covers to be given a smoothing coat of finishing cement, Ryder "V" one coat, or approved equal, in exposed areas and vapor sealed in all areas with vapor barrier mastic coating. Foster 30-35, or approved equal, reinforced with white glass fabric.

- C. Insulation thickness for all cold water piping to be ½ inch.
- D. All new domestic hot water and hot water circulating piping shall be insulated in accordance with the Schedule below.

	PIPE DIAMETER	INSULATION THICKNESS
Runouts to individual fixtures, not exceeding 12 feet in length	upto 2"	½"
All mains, branches and other piping	2" and less 2-1/2" to 4"	1" 1-1/2"

- E. Provide an isolating vapor seal between pipe insulation jacket and pipe at butt joints of insulation at fittings, flanges, valves, hangers and at 21 foot intervals on continuous runs. Using Foster 30-35 vapor barrier mastic coating, or approved equal.
- F. Adhere longitudinal laps and butt strips of jacket with factory applied pressure sensitive tape system, as manufactured by KNAUF, Owens Corning, or approved equal.

2.8 CHILLED WATER PIPING EXTERIOR INSTALLATION

- A. All chilled water piping and fittings installed underground or exposed to the weather shall be insulated with 100% rigid cellular glass molded pipe insulation. Insulation shall have an average density of 7.5 lb/cu.ft. and shall have a thermal conductivity of 0.28 BTU-IN/HR.SF. degrees F at 50 degrees F.
- B. Insulation shall be installed with all seams and joints sealed with water proof sealant as recommended by the manufacturer. After sealant is applied insulation shall be secured with ½" wide by 0.010" thick stainless steel bands. Sealants shall be applied full depth of all seams and joints and shall not be used to fill voids or cracks.
- C. Cover all insulation with a special bituminous containing laminate water waterproofing membrane. Covering shall be 125 mil, thick Pittwrap or approved equal. Jacket shall be installed per manufacturer's recommendations. Provide S.S. Bands as required by manufacturer installation details.
- D. Insulation thickness shall be 2" thick up to 1" pipe size and 2-1/2" thick up to 4" pipe size, and 3" thick above 4" pipe size.

- E. Insulation shall be Foamglass Super K as manufactured by Pittsburg Corning or approved equal and shall be installed in strict accordance with their recommendations and requirements.

PART 3 - EXECUTION

3.1 WORKMANSHIP AND INSTALLATION

- A. All insulation shall be applied per manufacturer's specifications and installation requirements.
- B. Insulation shall be applied over clean dry surfaces after all test have been performed and approved.
- C. Methods of application and other details not specified herein shall be in accordance with manufacturer's recommendations, which shall constitute minimum standards.
- D. Sheet Metal Saddles - 10" long shall be provided on all hangers supporting insulated lines. They shall be fabricated to conform with the outside diameter of the pipe covering and shall be fabricated from 22 gauge sheet iron for pipe through 2-1/2" 20 gauge sheet iron for pipes through 8" and 16 gauge for all pipes over 8".
- E. A rigid insulation material shall be used at each pipe hanger as an insert and the pipe covering shall pass full thickness through the hangers.
- F. On all outdoor piping insulation above ground (including covered parking area), provide aluminum jacket 0.016 inch thick with longitudinal z-joint secured with preformed 2" wide butt strips, as manufactured by KNAUF, RPR, or approved equal. Provide preformed aluminum fitting cover on all fittings.

END OF SECTION

SECTION 15400

PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION OF WORK

- A. Furnish and install new fixtures, waste, vent, cold water and hot water piping shown on plans.
- B. Connections of all equipment and fixtures with accessory fittings, shut-off valves, trimmings, traps, structural supports, insulation, etc., as herein specified and/or as shown on drawings.
- C. Refer to SECTION 15050 which is applicable to this Section.
- D. Include (but not necessarily limited to) the following items of mechanical equipment, fixtures and materials installed and in a first class operating condition:
 - 1. All labor, materials, equipment, accessories, and miscellaneous items required to provide a complete plumbing system. Provide adequate supervision at all times during the progress of the work.
 - 2. All plumbing piping and hangers for same as specified herein and where shown on the Architectural and/or mechanical drawings.
 - 3. New water service and meter, and connection to water distribution thru booster water pump, as shown on the drawings.
 - 4. New sewer services, with connections to service mains and piping distribution, as shown on the drawings.
 - 5. Hose bibbs.
 - 6. Floor and miscellaneous drains.
 - 7. All sewer, waste and vent piping and all cleanouts necessary for a complete operation installation as shown on mechanical drawings, or as required by the State and Local Sanitary Codes.
 - 8. Temporary water, sanitary, etc., facilities during construction period.

1.3 QUALITY ASSURANCE

- A. Manufacturer: Provide plumbing fixtures and accessories for work in this Section produced, meeting the requirements specified.

- B. Soldering processes shall conform to ASME B31.3 Process Piping and Copper Development Association recommended practices.

PART 2 - PRODUCTS

2.1 SANITARY SEWER

- A. All soil, waste and vent piping 2" in size and larger shall be service weight cast-iron, bell and spigot. All cast-iron lines shall have neoprene gaskets. All waste and vent lines 1-1/2" in size and smaller shall be galvanized steel cast-iron drainage fittings. Contractor's option piping above ground may be "No-Hub".
- B. Cleanouts in sanitary lines, both inside and outside at building, cast-iron body caulking ferrules with brass thread flanged plugs as manufactured by Alabama Pipe Co., or approved equal.
- C. Cleanout covers located in floors for sewer lines inside of building, with satin brass scoriated tops and covers.
- D. Cleanouts shall be installed in each change of direction of sewer lines where more than a 45 degree angle turn is made. Cleanouts shall be provided within 18" of each sanitary tee.
- E. Cleanouts on underground lines shall be brought to a cast-iron cleanout box, with service marking, 1/2" thick flanged type and loose cover. Provide 12" X 4" thick concrete slab around cover and frame.
- F. Size and distance between cleanouts shall be required by local authorities and/or as indicated on drawings.
- G. All floor drains shall be provided with trap primers and 1/2" trap primer line.

2.2 DOMESTIC WATER

- A. Ball valves shall be provided where indicated on drawings and shall be designed for a minimum water working pressure of not less than one hundred fifty (150) pounds per square inch. Each underground valve shall be protected by a cast-iron valve box with minimum thickness of 3/16 inch. The cover shall have the word "WATER" cast in the metal.
- B. Hot and cold water piping inside the building shall be hard drawn seamless copper tubing, type "L", with wrought copper sweat fittings and lead free solder above grade. No joints shall be allowed under building slab, on piping 1" and smaller, larger pipe sizes shall have joints with lead free solder. Water piping underground shall be Type "K". Piping on exterior of building shall be Type "K".

- C. All piping, fittings, solder and flux used in conjunction with the potable water systems shall be lead free. The term "lead free" shall be as defined in the Safe Drinking Water Act Amendment of 1986 (P.L. 99-339).

2.3 FIXTURES

- A. Furnish, install and/or connect all plumbing fixtures indicated on drawings or as herein specified. Refer to Mechanical as well as Architectural Drawings for location and number of fixtures required. If any fixtures shown on Architectural Plans but not on Mechanical Plans, or vice versa, these fixtures shall be furnished, installed and connected the same as if indicated on all drawings. See Architectural Drawings for specific fixtures required. Where a specific manufacturer's name and catalog number is used to indicate the type and quality required, it shall be assumed that other manufacturer's products may be used, where they are equal and approved by the Architect as stipulated elsewhere herein.
- B. Each plumbing fixture shall be fitted with all necessary and proper fittings, trim and operating devices and shall be left in perfect operating condition. The finish of all traps, wall escutcheons, and exposed metal work in connection with fixtures, trimmings and operating devices shall be chromium plated.
- C. Before setting any fixtures or rough-in for fixtures, obtain the exact mounting height, as desired, from the Architect.
- D. Equipment shown on drawings to be furnished under other sections shall be roughed-in, installed and connected by this Contractor under this Section. This Contractor shall furnish and install all necessary valves, piping, fittings and waste traps, etc., not provided with said equipment but as required for proper operation and installation. Obtain rough-in dimensions before installing any piping.
- E. Plumbing fixtures shall be as follows:

WATER CLOSET (MARK P-1)

Wall hung; china; elongated rim; top spud; low consumption; open front white seat less cover; electronic battery operated flush valve with metal cover, over-ride button, screwdriver stop and back flow vacuum breaker.

Fixture - Kohler Model K-4330

Flush Valve - Sloan Optima Plus Model 8111-LH-MC

WATER CLOSET (MARK P-1A)

Wall hung; china; elongated rim; top spud; low consumption; mount for handicap use, ADA compliant; open front white seat less cover; battery operated flush valve with metal cover, over-ride button, screwdriver stop and back flow vacuum breaker.

Fixture - Kohler Model K-4330

Flush Valve - Sloan Optima Plus Model 8111-LH-MC

WATER CLOSET (MARK P-1B)

Floor mounted; china; elongated rim; top spud; low consumption; mount for handicap use, ADA compliant; open front white easy lift seat less cover; battery operated flush valve with metal cover, over-ride button, screwdriver stop and back flow vacuum breaker.

Fixture - Kohler Model K-4405
Flush Valve - Sloan Optima Plus Model 8111-LH-MC
Seat - Kohler Model K - 4731-SC

LAVATORY (MARK P-2)

Under counter; china; grid strainer with 1-1/2" tailpiece; 1-1/2" c.p. "P" trap with offset waste to wall; self contained above deck battery operated electronic gooseneck faucet and control module; 3/8" flexible metal c.p. risers with wheel handle stops; provide all piping from supplies to fixture.

Fixture - Kohler Model K-2210
Faucet - Kohler Model K- 10952 - 4

LAVATORY (MARK P-2A)

Under counter ; china; mount for handicap use, ADA compliant; grid strainer with 1-1/2" tailpiece; 1-1/2" c.p. "P" trap with offset waste to wall; self contained above deck battery operated electronic gooseneck faucet and control module; 3/8" flexible metal c.p. risers with wheel handle stops; provide all piping from supplies to fixture; insulate waste and water piping under fixture with closed cell insulation as manufactured by Truebro or approved equal.

Fixture - Kohler Model K-2210
Faucet - Kohler Model K- 10952 - 4

LAVATORY (MARK P-2B)

Wall hung; china; mount for handicap use, ADA compliant; grid strainer with 1-1/2" tailpiece; 1-1/2" c.p. "P" trap with offset waste to wall; wide spread faucet; 3/8" flexible metal c.p. risers with wheel handle stops; provide all piping from supplies to fixture; insulate waste and water piping under fixture with closed cell insulation as manufactured by Truebro or approved equal.

Fixture - Kohler Model K-2030
Faucet - Kohler Model K-15265 - 4

URINAL (MARK P-3)

Wall hung; china; top spud; low consumption; wall hanger; mount for handicap use, ADA compliant; battery operated flush valve with metal cover, over-ride button, screwdriver stop and back flow vacuum breaker.

Fixture - Kohler Model K-5024 - T
Flush Valve - Sloan Optima Plus Model 8186-1-LH-MC

URINAL (MARK P-3A)

Same as P-3 except mount for handicap use ADA compliant.

SINK (MARK P-4)

Stainless steel; two compartment; countertop; U-channel mounting; self rimming; 18 ga. type 304 s.s.; Swing spout faucet with lever handle and hose spray; 3/8" flexible supplies with wheel handle stops; two stopper strainers; continuous waste; 1-1/2" c.p. "P" trap with waste to wall.

Fixture - Elkay Model LR 3319

Faucet - Elkay Model LKE4101 swing spout, single lever and spray.

Continuous Waste - (2) 1-1/2" drain with 1-1/2" tailpiece, 1-1/2" continuous waste

Stoppers - (2) Elkay Model LK-35

SINK (MARK P-4A)

Stainless steel; single compartment; countertop; U-channel mounting; self rimming; 18 ga. type 304 s.s.; Swing spout faucet with lever handle and hose spray; 3/8" flexible supplies with wheel handle stops; two stopper strainers; continuous waste; 1-1/2" c.p. "P" trap with waste to wall.

Fixture - Elkay Model LR 1919

Faucet - Elkay Model LKE4101 swing spout, single lever and spray.

Waste - 1-1/2" drain with 1-1/2" tailpiece

Stopper - Elkay Model LK-35

DRINKING FOUNTAIN (MARK P-5)

Wall mounted; Dual level; electric fountain; ADA compliant; Lead Free; stainless steel; 120V; 1-1/2" "P" trap; 3/8" c.p. metal supply with wheel handle stop; 8 GPH to 50 degree F at 90 degree F ambient.

Fixture - Haws Model 007B.8

SHOWER (MARK P-6)

Field Constructed shower stall, see Architectural details. Provide pressure activated mixing valve; adjustable temperature limit stop; 2.5 GPM shower head arm and flange; hand held shower with guide rail and diverter valve; and 2" floor drain.

Mixing Valve & Shower Head - Leonard Model 4500.

SERVICE SINK (MARK P-7)

Molded Stone floor mop sink; 12" high sides; 24" X 24" X 10"; faucet with integral stops; wall brace and vacuum breaker; hose and hose bracket; stainless steel strainer and 3" deep seal "P" trap.

Fixture - Fiat Model MSB-2424

Faucet - Fiat Model #830-AA

Hose - Fiat Model #832-AA

HOSE BIBB (MARK HB)

3/4" rough brass, loose key sill cock with vacuum breaker, Smith 5609.QT or Minfab MHY-16. Use for all interior hose bibs.

HOSE BIBB (MARK HB-1)

Wall hydrant J. R. Smith 5509.QT or Minfab MHY-26 cast box with cover, bronze finish, loose key with vacuum breaker.

HOSE BIBB (MARK HB-2)

Free standing, post hydrant, bronze, non freeze, cast iron casing guard handle key, ¾" hose connection with vacuum breaker, J.R.Smith model 5910.

FLOOR DRAIN (MARK FD)

J. R. Smith 2005-B, or Minfab F1100C-S, cast-iron - See plans for sizes. Nickel brass square strainers in toilet rooms and finished areas. All floor drains shall have 4" deep seal traps and trap primer connections.

FLOOR DRAIN (MARK FD-1)

J.R. Smith No 2010-F37 or Minfab F1100C-ER cast iron body and flashing collar with extended rim nikaloy strainer, install with rim flush with floor. All floor drains shall have 4" deep seal traps and trap primer connections.

FLOOR DRAIN (MARK FD-2)

Side wall angle drain, J.R. Smith 6270T, cast iron body with chrome plated bronze face. See plans for sizes, provide 4" deep seal traps and trap primer connection.

TRAP PRIMER (MARK TP)

Automatic water metering type, Precision Plumbing Products Model PR-500, with SS-8 supply tube and DU distribution unit to serve drains as shown on drawings. Install per manufacturers recommendations and provide wall access panel for periodic inspection. Alternate Manufacturer Minfab Model MI-DU.

2.4 VALVES, STRAINERS, UNIONS AND FITTINGS

General - All material shall be new, of the best quality with same brand or manufacturer for all similar installations. SEE SECTION 15900 for type and manufacturer.

2.5 WATER HAMMER ARRESTORS

- A. Provide arrestors as marked A.C. (air chambers) where shown on the drawings and/or as necessary to prevent water hammer in the piping based on actual piping arrangement on the job.
- B. Install fluid water hammer arrestors in compliance with ASSE Standard 1010.
- C. Each unit shall be constructed with a single moving part. The barrel shall be fabricated of Type "K" hard drawn copper, with the cap fabricated from standard wrought copper fittings attached to the barrel with lead free solder. The piston shall be machined from brass and equipped with rubber "O" rings.

2.6 WATER HEATERS

For sizes and requirements of all water heaters see schedules and details on the drawings.

PART 3 - EXECUTION

3.1 WORKMANSHIP

- A. All piping, waste and stacks shall be run concealed underground, in ceiling spaces, walls or in chases provided. The entire installation must present an appearance truly in keeping with the best practice and indicative of skill and neatness. In areas of exposed ceilings piping shall be grouped together and run on common pipe hangers with piping run parallel to building lines.
- B. All material shall be installed in a neat and workmanlike manner by competent specialists for each sub-trade. The installation of any materials and equipment not meeting these standards may be condemned by the Architect and shall be removed and re-installed at no additional cost to the Owner. Contractor is responsible for the safety and good condition of the materials installed until final acceptance by the Owner.

3.2 INSTALLATION

- A. Pipe shall be laid to the grades and alignment indicated on the drawings. Each pipe shall be laid line to line and grade and in such manner as to form a close concentric joint with the adjoining pipe and to prevent sudden offsets of the flow line. The interior of the pipe shall be cleaned of all dirt and superfluous materials of every description. Trenches shall be kept free from water until the pipe joining material has set and pipe shall not be laid when the conditions of the trench or the weather is unsuitable for such work. At times when the work is not in progress, open ends of pipe and fittings shall be securely closed, so that no trench water, earth or other substance will enter the pipe or fittings. Minimum compacted pipe coverage shall be 2'-0", or as indicated on drawings.
- B. Where the location of the sewer is not clearly defined by dimensions on the drawings, the sewer shall not be run closer horizontally than 6'-0" to water supply main except that the bottom of the water pipe will be at least twelve (12") inches above the top of the sewer pipe, both pipes may be laid in the same trench. Where sewer mains cross above water services the sewer piping for a distance of ten (10') feet each side of the crossing shall be cast-iron without any joint closer horizontally than three (3') feet to the crossing.

3.3 SANITARY SEWER PIPING

- A. New piping shall be a complete system to waste and vent lines from all fixtures.
- B. All waste lines shall be installed on a continuous waste and vent system as required by codes and/or regulations.
- C. All piping shall be installed straight and true and sized as indicated on drawings.

- D. All changes in direction shall be made by the use of 45 degree wyes, double wyes, long sweep quarter bend or 1/8 bends, except that single sanitary tees may be used on vertical stacks. Tees and crosses may be used in vent pipes.
- E. Cleanouts easily accessible shall provide at the foot of each vertical waste or soil stack. Cleanouts shall be of nominal size as the pipes up to four (4") inches and not less than four (4") inches for larger pipes. The distance between cleanouts in horizontal lines shall not exceed those distances required by local authorities, whether indicated or not.
- F. All cleanouts installed so as to be easily accessible, and all outside cleanouts installed flush with finished grade.
- G. Horizontal soil or waste lines shall be run at uniform grade of not less than 1/4" per foot. Horizontal lines shall be supported or anchored at intervals specified in GENERAL MECHANICAL. All stacks shall be supported at their base and every floor to the roof line and pipes shall be rigidly secured.
- H. Every fixture trap shall be protected against siphonage and back pressure and air circulation assured by means of a soil or waste stack vent, a continuous waste or soil vent, a loop or circuit vent.
- I. No vents shall be less than 2" in diameter and no case shall branch or main vent have a diameter less than half that of the soil or waste pipe served, or as required by local code.
- J. Make all arrangements with Local Authority for the inspection of the installation of the new sanitary sewer system, and pay all costs and assessed fees.

3.4 HOT WATER AND COLD WATER SYSTEMS

- A. This installation comprises a complete and operating system of hot and cold water distribution and connection to each and every fixture and appliance requiring this service and/or as indicated on drawings.
- B. All ends of tubing shall be square cut and burrs removed before assembling. Joints shall be thoroughly cleaned with sandpaper or emery cloth before applying the flux.
- C. All water supply piping, fittings, and fixtures shall be protected against water hammer shock, or surge pressure, by adequate air chambers.
- D. Each riser battery shall be valved in an accessible location.
- E. No hot water piping shall be run closer than six (6") inches from cold water pipes.
- F. Distribution and sizes shall be as indicated on drawings.
- G. Pitch all piping to low points to allow for system drainage.
- H. Make all arrangements with Local Authority for inspection of the new water system and for the building, pay all assessed costs and fees.

3.5 MISCELLANEOUS ITEMS OF WORK

- A. Contractor shall be responsible for securing all information and data for connection to all utilities and pay all costs and fees.
- B. Contractor shall provide temporary water and sewerage on site for use during construction period as required.
- C. All valves shall be installed so as to be easily accessible for cleaning, inspection maintenance, and operation.
- D. Provide access panels at all concealed valves.
- E. All welded piping to be welded by Certified welders skilled in the work to be done.
- F. No piping of dissimilar metals placed in contact or in close proximity with each other. Provide bronze valves wherever piping of dissimilar metals is jointed.
- G. Provide all necessary steel frames supports, anchor bolts, sleeves, etc., required for safe support of equipment and piping installed under this contract. The Mechanical Contractor shall be completely responsible for the accurate position and dimensions of all foundations and support times.

END OF SECTION

SECTION 15425

WELL WATER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION OF WORK

- A. Furnish and install new sewer treatment plant with all piping shown on plans.
- B. Complete installation shall meet the requirements of the Stets Board of Health and all Agencies having jurisdiction.
- C. Refer to SECTION 15050 and 15400 which are applicable to this Section.

PART 2 - PRODUCTS

2.1 WATER WELLS

- A. The new water well shall be as described and detailed on the drawings.
- B. Capacities shall be as detailed on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Entire installation shall be in conformance with the Manufacturer's recommendations.
- B. Contractor shall be required to obtain all installation and operational approvals from the Agencies having jurisdiction, and shall provide the Owner with copies of approval certificates.

3.2 WORKMANSHIP AND INCIDENTAL ITEMS

- A. All valves shall be installed so as to be easily accessible for cleaning, inspection, maintenance, and operation.

- B. Major control and sectionalizing valves throughout building shall be identified by means of a brass valve tag bracketed to valve handle. Contractor shall prepare schedule of such identifying plates and frame under glass for installation in main equipment room.
- C. All welded piping to be welded by certified welders skilled in the work to be done.
- D. No piping of dissimilar metals placed in contact or in close proximity with each other. Provide bronze valves wherever piping of dissimilar metals is joined.
- E. Run all piping concealed unless specifically noted otherwise, making all necessary offsets, turns, etc., necessary to conceal piping from view.
- F. Provide all necessary steel frame supports, anchor bolts, sleeves, etc., required for safe support of equipment and piping installed under this contract. The Mechanical Contractor shall be completely responsible for the accurate position and dimensions of all foundations and support items.

END OF SECTION

SECTION 15450

SEWER TREATMENT CENTER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION OF WORK

- A. Furnish and install new sewer treatment plant with all piping shown on plans.
- B. Complete installation shall meet the requirements of the Stets Board of Health and all Agencies having jurisdiction.
- C. Refer to SECTION 15050 and 15400 which are applicable to this Section.

PART 2 - PRODUCTS

2.1 MODULAR PACKAGE TREATMENT PLANTS

- A. The system shall be based on High-Speed BioTech biodegradation and sedimentation technology. This system shall combine two technologies in a prefabricated, skid mounted standardised tank system with variable length, suitable for transportation in freight containers.
- B. The treatment plant shall take suction from a two chamber wet well with its own feed pump. The pump shall be level controlled and shall have a capacity, which is 2-3 times the average daily flow. The plant shall operate in an intermittent working mode for hydraulic flow, while the air blower supplying air to the bioreactor is continuously running.
- C. The biodegradation reactor shall have three stages to enhance cleaning efficiency. The bioreactor shall degrade the dissolved organic matter by oxidation into carbon dioxide, which escapes into the air, and also produce biomass, which acts as activated sludge. A suspended, free floating biofilm carrier medium shall provide a large, protected biofilm surface as host for the bacteria and simultaneously accumulate the activated biosludge inside the reactor bio chambers. An anoxic chamber shall provide de-nitrification in order to meet total nitrogen requirements.
- D. The biodegraded and de-nitrified water shall flow into a clarification stage where the suspended solids settle by gravity. The water shall be directed through a skim well to a

tube settler system, which shall provide the final clarification of the effluent. Sedimentation shall be enhanced by addition of polymers.

- E. The sewage piping system shall be designed to deliver the wastewater to an in ground equalization tank. The equalization tank shall be of sufficient size to level out the daily peak flows. The combined holding capacity of the system will be 12-16 hours, depending upon the flow profile. The equalization tank should be 1/4 the average daily capacity.
- F. The sludge pump shall be activated on a timed basis, with suction taken from the clarification stage. The pump shall discharge through a hydra-cyclone with the overflow back to the bioreactor, while the under flow shall be discharged to the primary sludge storage tank. When necessary, the sludge shall be emptied by a vacuum truck and hauled away for external treatment.
- G. The System shall be designed based on the following Influent Data:
- Hydraulic Load: 15,000 GPD Maximum
- Quality: BOD = 250 mg/l
TSS = 250 mg/l
TN = 54 mg/l
Alkalinity = 143 mg/l
PH = 6-8
Temperature = 15 C
- H. The system shall be designed based on the following effluent requirements:
- BOD = 30 mg/l
TSS = 30 mg/l
- I. The system shall contain the following equipment:
1. A 1/4 "mild steel tank consisting of a framework of square pipes and vertically stiffened sides and partitions. The tank is internally and externally coated with epoxy. The Coating system for this unit shall be equal to or exceed industry standards.
 2. Free floating plastic bio film carrier medium shall be loaded in each bioreactor. The reactor shall be 2/3 filled as standard, with 100 square feet of bio film surface per cubic foot of reactor volume.
 3. A plate separator system of 60 degree inclined PVC plates shall be in the settling tank. Three plates per foot length, projected area 5 square foot per square foot tank surface or equivalent tube settler arrangement.
 4. One separate drive regenerative blower with air header in galvanised steel and air distribution system in stainless steel. Air filter/silencer on the blower inlet, muffler on the outlet for flow regulation.

5. Two open impeller, stainless steel, close coupled centrifugal process pumps with carbon/ceramic mechanical seal and viton elastomers. Wastewater pipes shall be PVC.
6. Two multifunction chemical dosing pumps for foam control during start up, pH adjustment or nutrient supply as required. One pump shall be used for Carbon addition.
7. One main electrical switchboard/control panel with start/stop buttons and running lights. Automatic start/stop of process pumps on high/low level.

J. The System shall have the following Minimum Capacities

Equipment	Specification	Unit
Tank Container	Overall Length	120 Inches
	Overall Width	88 Inches
	Overall Height	100 Inches
Bio Medium	Quantity	5 m3
Settling Medium	Tube Settlers	34 cu.ft.
Regenerative Blower	Nominal Capacity	120 SCFM
	Back Pressure	120 In WG
	Motor Effect	5 HP
Centrifugal Pumps	Nominal Capacity	20 GPM
	Back Pressure	9 PSI
	Revolutions	1750 RPM
	Motor Size	1 HP
Metering Pump	Nominal Capacity	1-5 GPH
	Back Pressure	60 PSI
	Motor Effect	0.01 HP
Electrical System	System Total	10 Kw, 480V, 3 Phase
Shipping Weight	Dry Weight	14K Lbs
Operation Weight	Water filled	48K Lbs

- K. System shall be Model 10 CON 3 as manufactured by ECC or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Entire installation shall be in conformance with the Manufacturer's recommendations.
- B. Contractor shall be required to obtain all installation and operational approvals from the Agencies having jurisdiction, and shall provide the Owner with copies of approval certificates.

3.2 WORKMANSHIP AND INCIDENTAL ITEMS

- A. All valves shall be installed so as to be easily accessible for cleaning, inspection, maintenance, and operation.
- B. Major control and sectionalizing valves throughout building shall be identified by means of a brass valve tag bracketed to valve handle. Contractor shall prepare schedule of such identifying plates and frame under glass for installation in main equipment room.
- C. All welded piping to be welded by certified welders skilled in the work to be done.
- D. No piping of dissimilar metals placed in contact or in close proximity with each other. Provide bronze valves wherever piping of dissimilar metals is joined.
- E. Run all piping concealed unless specifically noted otherwise, making all necessary offsets, turns, etc., necessary to conceal piping from view.
- F. Provide all necessary steel frame supports, anchor bolts, sleeves, etc., required for safe support of equipment and piping installed under this contract. The Mechanical Contractor shall be completely responsible for the accurate position and dimensions of all foundations and support items.

END OF SECTION

SECTION 15500

FIRE SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work under this Section shall include all labor, material, equipment, transportation, services and facilities necessary to complete the interior Fire Protection System for buildings as shown on drawings and as specified herein without exception.
- B. Applicable provisions of GENERAL AND SUPPLEMENTARY CONDITIONS, DIVISION 1 and SECTION 15050 shall apply to this Section as if written in full herein.
- C. The work shall include but is not necessarily limited to the following:
 - 1. Wet pipe sprinkler system for the building, including Fire Pump, Jockey Pump and Fire Pump Controller, all in accordance with latest revisions of NFPA fire codes.
 - 2. FM 200 suppression system for all Data Areas of the building as indicated on the drawings.
 - 3. Work under this section shall include all labor, materials, engineering, transportation, insurance, taxes and permits required for the complete installation of a wet pipe automatic fire protection system. All work to be in accordance with the requirements of the authority having jurisdiction.
- D. Painting, unless otherwise specified is not included under this Section.

1.2 CODES AND STANDARDS

- A. Final systems design, materials, workmanship and testing shall conform to the following Codes and Standards, when same have jurisdiction.
 - 1. N.F.P.A. Pamphlet No. 13, 101, 24, and 14, and all applicable Codes.
 - 2. Property Insurance Association of Louisiana.
 - 3. Orleans Parish Fire Prevention Bureau.
 - 4. State of Louisiana Fire Marshal.

1.3 QUALIFICATIONS OF FIRE PROTECTION CONTRACTOR

Contractor must be licensed in the State of Louisiana to perform sprinkler work, and must be regularly engaged in making such installation.

1.4 SHOP DRAWINGS AND DATA SHEETS

- A. Contractor to provide Architect with shop drawings and calculations including flow and hydrant tests for Owner's approval prior to commencement of work. Comply with Division 1 Sections' submittal requirements. Work is not to be started until: 1) shop drawings have been corrected to conform to Owner's approval, 2) copies of corrected drawings shall be submitted to the Architect and State Fire Marshall, and 3) drawings have been returned from the State Fire Marshall with review comments. Contractor shall submit Owner's stamped approved drawings to the State Fire Marshall for his review. This Contractor shall pay for all review fees required by the State Fire Marshall. Contractor shall also submit Owner's stamped approved drawings to the New Orleans Fire Prevention Bureau and pay all fees and costs.
- B. The Contractor shall provide written verification as part of the State Fire Marshall submittal package stating that the proposed location of the fire department connection, the outlet diameters, fitting type and thread type comply with the requirements of the local fire department.

1.5 AS-BUILT DRAWINGS

- A. Contractor shall maintain a set of drawings showing exact locations and sizes of all piping, valves and related items, which shall be corrected daily and shown every change from original contract drawings and specifications.
- B. On completion of the work, Contractor shall provide a set of reproducible transparencies corrected to show all changes noted on "As-Build" Drawings, together with two (2) sets of Blue Prints, to the Architect for delivery to the Owner. The corrected transparencies shall bear the approval of the Underwriters, and Property Insurance Association of Louisiana. Refer to Division 1 Sections for record documents procedures.

1.6 CUTTING AND PATCHING

- A. Contractor to provide all opening for proper installation of the work specified, in foundations, walls, floors, ceilings, partitions, stairways, etc., and do all patching and repairing required, except where otherwise noted on drawings.
- B. Cutting structural members for the passageway of sprinkler piping or for pipe hanger fastenings will NOT be permitted.
- C. Holes through walls, floors, and ceilings shall be large enough to accommodate pipe expansion. Suitable plates shall be provided at each hole to insure the effectiveness of the floor or wall as a fire stop.

1.7 INTERFERENCE

The Sprinkler Contractor shall coordinate with other trades so that interference between piping, conduit, ductwork, equipment, apparatus, architectural and structural work will be avoided. In case of interference developing, the Architect or his authorized representative shall decide which equipment, piping, ductwork, etc., must be relocated, regardless of which was first installed.

1.8 TAXES

Contractor shall include all taxes required.

1.9 PERMITS, FEES AND INSPECTION

This Contractor shall obtain and pay for all permits and shall pay all fees required in connection with this work, not covered by permits obtained by General Contractor.

1.10 CERTIFICATE OF APPROVAL

Upon completion of all work, this Contractor shall furnish the Owner a certificate of approval from such authorities as may have jurisdiction.

1.11 CLEANING UP

This Contractor shall at all times during construction keep the premises free from waste materials, or rubbish caused by his employees or work and at completion shall remove all surplus materials leaving the building in a clean swept condition.

PART 2 - PRODUCTS AND INSTALLATION

2.1 WATER CONNECTION

Connection to the SITE water main for the water supply to the fire protection systems shall be provided under this Contract. Verify the connection location as shown on the Civil Drawings. This Contractor shall make all arrangements and pay all costs for this connection. All work shall be in compliance with NFPA - 24.

2.2 MAIN CONTROL VALVE

O.S. & Y gate valve to be installed on the main riser. Provide contactor on valve compatible with fire alarm system to indicate when valve is closed, connection to fire alarm system shall be by fire alarm contractor.

2.3 MAIN DRAIN

Main drain valve and piping to properly drain each system shall be located at each system riser and piped to open air outside the building.

2.4 PIPE AND FITTINGS

- A. All interior pipe shall be ASTM A135 Schedule 40 black steel pipe with malleable iron screw fittings or cut groove fittings similar to Victaulic, Grinnell, or equal, as required. Fittings shall be ASME B16.3 Class 300 standard pattern with threads according to ASME B1.20.1. Provide all required pipe supports under building and above ground in accordance with National Fire Codes.
- B. All piping shall be manufactured in the United States of America.
- C. Underground piping shall be class 150, cement lined and exterior coated, ductile iron water pipe with mechanical joints.
- D. All piping and fittings shall be rated for the hydraulic pressure encountered throughout the system.

2.5 SPRINKLERS

- A. Sprinkler heads in unfinished ceiling areas to be brass upright.
- B. Sprinkler heads in finished areas shall be concealed type heads with white cover.
- C. All heads in acoustical tile areas shall be centered in the tile, both ways.
- D. Contractor shall include, in his bid, any and all heads required to meet all applicable sections of NFPA 13, weather indicated on the drawings or not.
- E. It is the intent of this section that the contractor provide a complete and operational system that shall meet all codes and that all costs shall be included in this bid price.
- F. All heads to be quick response type.

2.6 SPRINKLER SYSTEMS

- A. Wet pipe sprinkler systems shall be provided to all areas of the building to include the roof top equipment rooms, but excluding all Data Areas. See Drawings for sprinkler system area designations. These systems shall be designed for a Light Hazard Occupancy, except as defined below.
- B. All equipment rooms, storage rooms, mechanical rooms and electrical rooms shall be provided with a sprinkler system designed for ordinary hazard group 1 occupancy.

- C. Provide ground level fire department Siamese connection where shown on the drawings. Connections shall be Potter-Romer Series 5100 or Elkhart Brass Company 163, chrome plated, flush type fitted with chained caps. Threads shall match St. Charles Parish Fire Department requirements. Connect Siamese to fire protection system. Siamese connection shall have cast signage to read "sprinkler and manual standpipe system".

2.7 FIRE PUMP

- A. Furnish and install One Aurora Model 383 vertical inline centrifugal fire pump listed by Underwriter's Laboratory and approved by Factory Mutual having a capacity of 500 GPM for a pressure boost of 55 PSIG. Pressure at the pump suction will be 25 PSIG, giving a discharge pressure of 80 PSIG. The pump shall have a bronze impeller, bronze case wear ring, packing gland and shaft sleeve. The pump discharge flange shall be 125 PSI bolt pattern. The pump shall be fitted with a Teflon lantern ring when the suction pressure is 30 PSIG or less. Pump to be directly connected to 25HP, 3550 RPM, vertical, solid shaft, open drip-proof motor, suitable for an electrical supply of 480 volts, 3 phase and 60 hertz with a 1.15 service factor.
- B. The pump shall be subjected to an operation test at rated speed. A performance curve showing the flow, total head, brake horsepower and efficiency is to be plotted. Certified curves shall be supplied to the customer. The pump shall be hydrostatically tested at two times the shut-off pressure or 250 PSIG, whichever is greater.
- C. Provide hose valve header, with hose valves, caps and chains.

2.8 LIMITED SERVICE FIRE PUMP CONTROLLER

- A. The fire pump controller shall be a withstand rated unit listed by Underwriters Laboratories and approved by Factory Mutual Research for fire pump service. The controller shall meet the requirements of NFPA 20. It shall be completely factory wired, assembled and tested prior to shipment.
- B. All controller components shall be UL Listed or UL Recognized, shall be front mounted and wired allowing the controller to mount flush against a wall.
- C. The controller shall be housed in a UL Environmental type 2 Drip-proof enclosure, fabricated from heavy gauge cold rolled steel per the requirements of UL 508. The controller shall be designed for Across-The-Line starting and include the following:
 - 1. Isolation switch: Externally operable, quick break type sized at least 115% of motor full load current.
 - 2. Circuit breaker: Externally operable sized at least 115% of the motor full load current.
 - 3. The locked rotor overcurrent protection shall be provided by a separate overcurrent monitor of the microprocessor type, set at 300 percent of motor full load current and shall have a trip time between 8 and 20 seconds at 600 percent of motor full load current. And shall also have as standard a set of dry contacts and

LED visual indication that activates when the motor current exceeds 125% of normal.

4. The isolation switch and circuit breaker shall be operable via a single operating handle. When moving the handle from the OFF to ON position, the handle shall sequence the isolating switch on first and then the circuit breaker. When the handle is moved from the ON to the Off position, the handle shall sequence the circuit breaker off first and then the isolating switch. This sequencing operation shall prevent the isolating switch from interrupting motor current. The operating handle shall be capable of being padlocked in either the ON or Off position for installation and maintenance safety. The operating handle shall permit normal tripping operation of the circuit breaker.
5. Controllers utilizing a 100-600 amp circuit breaker shall be suitable for use on a circuit capable of delivering 18,000 Amps Symmetrical short circuit current. Controllers utilizing a 800-1200 amp circuit breaker shall be suitable for use on a circuit capable of delivering 50,000 Amps Symmetrical short circuit breaker.
6. Provisions shall be made between the circuit breaker and the isolation switch for using a clamp-on type ammeter to measure motor current draw.
7. Motor contactor: IEC rated, UL listed capable of being operated by an external emergency operating handle. The contactor shall be horsepower rated as determined in UL218 for applicable horsepower and voltage.
8. Pressure switch: With adjustable independent high and low set points. The pressure switch shall be of the bordon tube type and be capable of being sealed to prevent unauthorized adjustment. The switch shall be mounted inside the controller cabinet and plumbed to an external coupling for field connection.
9. Externally mounted pilot lights: To indicate controller primary power is available and phase reversal of normal power.
10. Solid state running period timer: Set for a minimum of ten minutes, per NFPA 20 shall be provided to keep the motor running when started automatically. The timer shall have a pilot light to indicate when the timer is in the timing mode. The timer shall have a pilot light to indicate when the timer is in the timing mode. The controller shall be factory set for manual stop with terminals provided to allow field conversion to automatic stop.
11. Control circuit transformer: Heavy duty type with a minimum rating of 150 VA without integral overcurrent protection per the requirements of NFPA 20.
12. Dry alarm contacts for remote alarm of PUMP RUNNING, PHASE REVERSAL, CONTROLLER POWER AVAILABLE, and MOTOR OVERLOAD shall be supplied. One normally open and one normally closed contact for each alarm shall be supplied. Controller power shall be monitored by a three phase power monitor. The monitor shall trip on either LOW VOLTAGE, SINGLE PHASE, LOSS OF POWER, or PHASE REVERSAL. Normal power shall be indicated by a Green LED on the power monitor and a tripped condition shall be indicated by a Red LED.

13. A circuit for manual remote starting of the controller shall be supplied requiring only a contact closure to initiate. This circuit shall not be capable of stopping the controller remotely per NFPA 20.

14. Shall be front mounted and wired for ease of maintenance and allowing the unit to mounted flush against a wall.

D. The controller shall be capable of the addition of optional control features.

The automatic transfer switch shall conform to the requirements of NFPA chapter 7. It shall be installed in a barriered compartment of the fire pump controller. The complete assembly, controller and transfer switch, shall be shipped as a single unit. The transfer switch shall be supplied with a special circuit to prevent higher than normal starting currents when transferring from one source to the other. This circuit shall deactivate the fire pump motor 5 seconds prior to transfer in either direction.

E. The controller shall be manufactured by Metron, Inc., or approved equal.

2.9 JOCKEY PUMP

A. Furnish and install, as shown on the drawings, approved jockey pump for maintaining full pressure of the fire protection system. Pump shall be turbine type, single-stage, bronze fitted pump, with renewable bronze liners and impellers, furnished with stainless steel shaft.

B. Jockey pump shall be furnished with ¾" circulating relief valve.

C. Jockey pump shall be furnished with combination magnetic across-the-line starter with fusible disconnect switch, hand-off-automatic selector switch with three-leg protection and including pressure switch. All to be mounted in a NEMA 3R enclosure for 3 phase, 60 hertz, 460 volt service.

2.10 FM 200 SYSTEM

A. Scope

1. This specification outlines the requirements for the design and installation of an engineered FM-200 total flooding fire suppression system with automatic detection and control, as manufactured by Great Lakes Chemical Corporation, or approved equal. The work required includes engineering, labor, materials, equipment, and services required to install and test the suppression system.

2. The installing contractor shall be trained by the suppression system hardware supplier to design, install, test and maintain FM-200 fire suppression systems.

3. All devices and equipment employed shall be Underwriters Laboratories (UL) listed and/or Factory Mutual (FM) approved.

4. All devices, components and equipment shall be the products of the same manufacturer. All devices, components and equipment shall be the products of the same manufacturer.
- B. The design, installation, testing and maintenance of a Clean Agent Suppression Systems shall be in accordance with the requirements set forth in the current editions of the following codes and standards. The standards listed, as well as all other applicable codes, standards, and good engineering practices, shall be used as "minimum" design standards.
 1. NFPA 2001 - Standard for Clean Agent Fire Extinguishing Systems
 2. NFPA 70 - National Electrical Code
 3. NFPA 72 - National Fire Alarm Code
 4. UL 2166 - Standard for Halocarbon Clean Agent Extinguishing System Units
 5. Factory Mutual Approval Guide
 6. Requirements of the State of Louisiana Fire Marshall
 7. Requirements of the City of New Orleans Fire Prevention Bureau.
- C. The Contractor shall submit the following design information and drawings for approval prior to commencing work on this project:
 1. Installation layout drawings detailing the quantity, location, and marking of all system components, including, but not limited to, agent storage tanks, nozzles, pipe runs including pipe sizes and lengths, control panels, detectors, manual pull stations, abort stations, audible and visual alarms.
 2. Separate layouts, or drawings, shall be provided for each level, (i.e., room, and above ceiling) and for mechanical and electrical work.
 3. Electrical layout drawings shall show the location of all devices and include point-to-point conduit runs and a description of the methods used for detector mounting.
 4. Hydraulic flow calculations, from a UL listed computer program, shall be provided for all engineered FM-200 suppression systems. Calculation sheets must include the manufacturers name and UL listing number for verification. The flow calculations shall detail pressure changes, flow rates, pipe sizes and lengths, and nozzle sizes. The agent discharge time must be shown and detailed by zone.
 5. A complete sequence of operation shall be submitted detailing all alarm devices, shutdown functions, remote signaling, damper operation, time delay and agent discharge for each zone or system.
 6. Information outlining the operation and maintenance procedures required of the system Owner.
 7. The installing contractor shall submit drawings, calculations and system components data sheets for approval to the architect and all authorities having

jurisdiction before commencing installation. Approved plans should be submitted to the architect for record.

D. System Requirements

1. The system shall provide an FM-200® agent minimum design concentration of 7.0% by volume for Class A hazards and 8.7% by volume for Class B hazards, in all areas and/or protected spaces, at the minimum anticipated temperature within the protected area. System designs shall not exceed 10.5% for normally occupied spaces, adjusted for maximum space temperature anticipated, with provisions for room evacuation prior to agent release.
2. The system discharge time shall not exceed 10 seconds in accordance with the NFPA 2001 Standard For Clean Agent Fire Extinguishing Systems.
3. The suppression system shall include a detection and control system with provision for both pre-alarm and automatic agent release.
4. The system shall be actuated by ionization, photoelectric, heat, or optical flame detectors. The detection system shall employ single zone or cross-zoned detection, as specified by the hardware manufacturer and the appropriate authority having jurisdiction. In the case of cross-zone detection, a single detector activation shall cause an alarm signal to be generated; a second detector activation shall generate a pre-discharge signal and start the predischage condition.
5. The Fire Extinguishing Agent shall be stored in modular or central storage steel alloy containers compliant with DOT Specification 4BA or 4BW. The storage containers shall be equipped with safety rupture disks and each container shall have a pressure gauge to provide visual supervision of the container pressure.

E. Agent Storage And Distribution

1. The fire suppression agent shall be FM-200, and shall meet the requirements of UL Component Recognition and the requirements of NFPA 2001. FM-200 shall be stored in modular or central storage steel alloy containers compliant with DOT Specification 4BA or 4BW, and shall be equipped with safety rupture disks. Containers shall be super-pressurized with dry nitrogen to an operating pressure of 360 psig at 70°F. Each system shall have its own supply of clean agent.
2. Each supply shall be located within the hazard area, or as near as possible, to reduce the amount of pipe and fittings required to install the system.
3. Engineered discharge nozzles shall be provided within the manufacturer's guidelines to distribute the FM-200® agent throughout the protected spaces. The nozzles shall be designed to provide proper agent quantity and distribution and shall be UL listed and/or FM approved. Nozzle spacing shall be in accordance with the UL listing and/or FM approval.

4. Distribution piping and fittings shall be installed in accordance with the manufacturer's requirements, NFPA 2001, and approved piping standards and guidelines. Ferrous piping, black or galvanized, conforming to ASTM A-53 or A-106, or other materials conforming to these strength requirements shall be used. Pipe wall thickness shall be calculated in accordance with ANSI B-31.1, Power Piping Code. All distribution piping shall be installed by qualified individuals using accepted practices and quality procedures. All piping shall be adequately supported and anchored at all directional changes and nozzle locations. All piping shall be thoroughly reamed after cutting, and all oil and/or chips shall be removed. Pipe threads shall be coated with Teflon tape or an appropriate joint compound applied to the male thread only.
5. All agent containers shall be activated by either an electrical manual discharge station, an automatic device or devices, or by direct mechanical actuation.

F. Control Panel

1. The control system and its components shall be UL Listed and/or FM approved, and shall conform to the specifications of the control panel manufacturer.
2. The control panel shall be programmable such that an adequate pre-discharge alarm period can be set.
3. The control system shall perform all functions necessary to operate the system detection, actuation and auxiliary functions.
4. The control system shall include battery standby power to support 24 hours in standby and 5 minutes in alarm.
5. The control system shall be capable of supporting cross-zone detection.

G. Detectors

1. The detectors shall be spaced and installed in accordance with the manufacturer's specifications and the guidelines of NFPA 72.
2. The detection system shall employ single zone or cross-zoned detection, as specified by the hardware manufacturer and the Appropriate Authority Having jurisdiction.
3. In the case of cross-zone detection, a single detector activation shall cause an alarm signal to be generated; a second detector activation shall generate a pre-discharge signal and start the pre-discharge condition.

H. Manual Release

1. A manual release station shall be located at each exit from the protected hazard.
2. The manual release switch or manual pull station shall be a dual action device requiring two distinct operations to initiate a system actuation.

I. Abort Stations

1. An abort switch shall be provided at each exit point.
2. Operation of the abort station shall send a "system aborted" indication to the control panel when a fire condition exists. A separate "trouble" indication shall result if the abort station is operated when no alarm condition exists.

J. Audible And Visual Alarms

1. Electrically actuated fire alarms, both audible and visible, shall be furnished and installed. All alarm devices shall be UL listed and/or FM approved.
2. Alarms shall be adequate to alert personnel located in the protected areas.
3. A strobe device shall be placed outside, and above, each exit door from the protected space. Provide an advisory sign at each location.

K. Caution And Advisory Signs

1. Caution and advisory signs shall be provided at each entrance to a protected space, and at each manual discharge station.
2. A flashing light sign shall be provided over each exit from a protected space.

L. System And Control Wiring

1. All systems wiring shall be furnished and installed by the contractor.
2. All wiring shall be installed by qualified individuals to conform to the
3. National Electric Code, Article 725, and Article 760, except as otherwise permitted for limited energy circuits, as described in NFPA 72. Wiring installation shall meet all local, state, province and/or country codes.
4. The complete system electrical installation, and all auxiliary components, shall be connected to earth ground in accordance with the National Electric Code.

M. The system shall be designed and installed such that it is activated by one detector in alarm for the case of single zone detection, or by two detectors in alarm in the case of cross-zone detection. The automatic operation of each protected area shall be as follows:

N. For single-zone detection, actuation of the detector shall; Illuminate an "ALARM" indicator on the control panel face, Energize an alarm bell and/or visual indicator, Perform necessary control functions such as HVAC equipment shutdown, Close all doors leading into the protected area., Actuate a time delay, Energize a pre-discharge alarm, and enable the system abort sequence, AND After completion of the time-delay sequence, discharge the agent.

- O. In the case of cross-zone detection, actuation of any one detector shall; Illuminate an "ALARM" indicator on control panel face, Energize an alarm bell and/or visual indicator, Perform necessary control functions such as HVAC equipment shutdown, Close all doors leading into the protected area., AND Actuate a time delay.
- P. In the case of cross-zone detection, actuation of a second detector shall; Illuminate a "PREDISCHARGE" indicator on control pane face, Energize a pre-discharge alarm, Perform necessary control functions such as HVAC equipment shutdown, Close all doors leading into the protected area, Actuate a time delay sequence and enable the system abort sequence, AND After completion of the time-delay sequence, discharge the agent.
- Q. System Inspection And Checkout
 - 1. The final test and acceptance shall be conducted in the presence of the system Owner's representative and governing authorities.
 - 2. Tests shall demonstrate that the entire control system functions as intended. Automatic discharge, manual discharge, equipment shutdown, and alarm devices shall be tested.
 - 3. All containers and distribution piping shall be checked for proper mounting and installation, tested for proper connection, continuity and resistance to earth.
 - 4. Room integrity tests shall be conducted in accordance with NFPA 2001.
 - 5. An inspection shall be made to ensure that all required dampers, door bottom seals, weather-stripping, caulking and foam sealant have been installed and that the areas protected shall contain the FM-200 for 10 minutes.
 - 6. The piping shall be pneumatically tested in a closed circuit for a period of 10 minutes at 50 psig; at the end of 10 minutes, the pressure drop shall not exceed 20 percent of the test pressure.
 - 7. A flow test employing nitrogen shall be performed on the piping network to verify that flow is continuous and the piping and nozzles unobstructed.
- R. Prior to final acceptance, the installing contractor shall provide operational training to each shift of the owners personnel. The training shall address emergency procedures, abort functions, control panel operation, troubleshooting and safety requirements.
- S. Prior to final acceptance, the installing contractor shall provide operation and maintenance instruction manuals to the system Owner. Checklists and procedures for emergency situations, troubleshooting techniques, maintenance operations and procedures shall be included in the manual.
- T. Upon completion of each system, the installing contractor shall provide copies of the system "as-built" drawings to the system owner.
- U. The installing contractor shall provide inspections, of each system installed under this contract, during the system hardware manufacturer's warranty period. Inspections shall

be conducted in accordance with the manufacturer's guidelines and the recommendations of NFPA 2001.

2.11 VALVES

- A. All valves used in the fire protection system shall be UL listed and FM approved with 175 psig non shock minimum working pressure rating.
- B. Gate valves, 2 inches and smaller shall be UL 262 cast bronze, threaded ends, solid wedge, outside screw and yoke, rising stem.
- C. Gate valves 2-1/2" and larger shall be 262, iron body bronze mounted, taper wedge, outside screw and yoke, rising stem.
- D. Swing check valves, 2-1/2" and larger shall be UL 312, cast-iron body and bolted cap with bronze or cast iron disc with bronze disc ring.

2.12 MASON AND CARPENTER WORK

Provide all openings for proper installation of work specified, in walls, ceilings, and floors and do all patching of same as required.

2.13 ENGINEERING

Prior to installation of any work, this Contractor is to prepare installation and fabrication drawings and have same approved by the insurance authority having jurisdiction and Owner's representative.

2.14 INSURANCE

This Contractor is to furnish certificates of insurance prior to commencing work.

2.15 PERMITS

This Contractor is to pay for all permits required for this portion of the work.

2.13 HYDROSTATIC TEST

This Contractor is to hydrostatically test the entire interior system to 200 PSI for a period of two (2) hours in accordance with NFPA 13, and show evidence that he has had an authorized representative of the Owner present for the test.

2.15 WARRANTY

This Contractor is to warrant all material and workmanship, free from defects, for a period of one (1) year from date of acceptance of installation.

2.16 WATER FLOW SWITCH

Provide one water flow switch (1) Grinnell Model VSR-D or Potter Model VSRF on the supply pipe to the sprinkler systems of the building, make compatible with fire alarm system, connection shall be by fire alarm contractor.

2.17 CODE COMPLIANCE

- A. The Contractor shall flush all piping as required by NFPA - 13, 14 and 24. Flow rates for flushing shall be as required by these codes.
- B. Thrust blocks and underground supports shall be provided as required by NFPA-24.
- C. All signage including standpipe riser, Siamese connection, shall be provided in accordance with NFPA - 13, 14, and 24.
- D. Flow test and testing of standpipe discharge at roof manifold shall be performed in accordance with NFPA - 14.
- E. All test certificates in NFPA 13, 14, and 24 shall be completed by Contractor and submitted as part of review process.
- F. Contractor shall review reflected ceiling, mechanical, fire protection and electrical plans and include all heads as required by NFPA-13 for complete sprinkler coverage including coverage around obstructions such as ductwork, piping and ceiling features.

END OF SECTION

SECTION 15650

DIESEL SYSTEMS AND PRODUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The General Provisions of the Contract, including General and Supplementary Conditions and General Requirements apply to the work specified in this Section.
- B. Refer to Basic Materials and Methods Section 15050 which shall apply to work in this Section.

1.2 DESCRIPTION OF WORK

- A. The work to be done under this Section includes the furnishing of all labor, tools, materials, equipment and services necessary for and reasonable incidental to the installation of complete diesel systems, equipment and piping as shown on plans and herein specified, excepting only work and/or materials indicated as being done and/or furnished under other sections.
- B. Contractor shall refer to other Sections of the Specifications which may be applicable to or associated with this Section.

1.3 RELATED WORK SPECIFIED IN OTHER SECTION

- A. Electrical Section will provide all power wiring including furnishing and installing of disconnect switches where specified. Control wiring for equipment shall be provided under the Mechanical Section.
- B. Other Sections will provide and install structural supports for equipment. These supports must be checked and coordinated by this Section so that they suit the equipment which is to be supported.
- C. Other Sections will provide all platforms slabs, lintels and curbs, as directed by this Section, to accommodate the mechanical equipment.
- D. Mechanical Contractor shall provide starters for motors furnished under this Section.

1.4 QUALITY ASSURANCE

- A. These specifications with accompanying drawings, require complete apparatus, fully erected and in successful operating condition. Perform all work in best, most substantial manner.
- B. All equipment furnished and installed under this Section shall be U.L. approved and labeled where applicable.
- D. All manufacturer's products shall comply with the requirements of this Section.

1.5 SUBMITTALS

- A. Contractor, before beginning work, shall submit dimensional shop drawings (in accordance with requirements of Division 1), for approval, for all systems, and equipment layout. Contractor is responsible to coordinate all work and electrical to avoid all conflicts. Conflicts encountered after work has started will be corrected at Contractor's expense.
- B. Where the equipment installed is of a different configuration and/or size than that shown on the drawings, Contractor shall assume all responsibility to conform with the intent of the contract documents. The Architect shall be advised of any changes and deviations for his approval. The same shall be true for any field modification required because of "on job" construction conditions.

PART 2 - PRODUCTS

2.1 INSULATED SECONDARY CONTAINED ABOVEGROUND STORAGE TANK

- A. Only new material shall be used in the manufacturing process, and the manufacturer shall ensure that the material used meets all appropriate specifications and quality assurance requirements. Each tank shall bear the U.L. 2085 label for "Insulated Secondary Containment Aboveground Tank for Flammable Liquids." Underwriters Laboratories label "Insulated Secondary Containment Aboveground Tank for Flammable Liquids." shall be affixed to each tank.
- B. The dimensions and capacity of the tank shall be as shown on the drawings. Minimal material thickness of the tank(s) shall be per UL-142 requirements. Minimum annular space insulation thickness material to be 3". Only UL-2085 listed insulation material shall be used.
- C. Tanks shall meet the following design criteria.
 - 1. Internal Load: Rectangular Tank shall withstand an air pressure test of 1.5 to 2 psi.5 psi.
 - 2. Tank shall be designed to support accessory equipment such as ladders, pumps, floating suction, etc. when installed according to manufacturer's instructions and limitations.
 - 3. Tank shall be provided with suitably designed and located lifting lugs which have a 2:1 safety factor.

D. Product Storage Requirements

1. Tank shall be capable of storing liquids with a specific gravity up to 1.0.
 2. Tank shall be designed for operation at atmospheric pressure only. Both inner and outer tanks shall have openings of sufficient size to meet normal and emergency venting requirements stated in U.L. 142, UFC and NFPA.
 3. Tank(s) shall be capable of storing diesel fuel at ambient temperatures.
- E. All threaded fittings shall be of a material of construction consistent with the requirements of the Underwriters Laboratories. All fittings shall be protected using threaded plugs or suitable closure caps.
- F. All flanged nozzles shall be of a material of construction consistent with the requirements of the Underwriters Laboratories. All nozzles shall be protected using suitable closure caps.
- G. Manways shall conform to Underwriters Laboratories 142 standard with regard to construction, bolting and gaskets.
- H. Design of the steel supports shall be per approved UL listing and be able to support the weight of the tank filled to capacity.
- I. Tank shall be installed in strict accordance with the most recent installation instructions provided by the tank manufacturer, UFC, NFPA, local ordinance, recognized engineering procedure, and other applicable codes.
- J. The primary and secondary Rectangular tank shall successfully complete an air pressure test prior to installation. While maintaining pressure of 1.5 psig on the primary tank, the annular space bounded by the primary and secondary containment tank shall be pressurized to 1 psig. The secondary tank shall then be checked for tightness.

2.2. DIESEL TANK PUMP

- A. Pump shall be multi-stage, self-lubricating and easily removed from storage tank without disconnecting discharge piping. The pump and motor assembly shall be readily separable from the pump column pipe to allow for simple field replacement of the pump and motor.
- B. The pump shall be activated on a demand for fuel from either the day tank monitoring system or the fuel dispenser. Upon a call for fuel the appropriate solenoid shall open and allow fuel to be pumped to the demand location. If both fuel stations are requiring fuel the day tank shall have priority and the dispenser solenoid shall not open. The pump shall be set at one operating speed with the flow restrictor in the day tank line limiting the flow to 12 gpm to the day tank.
- C. Impellers shall be either splined or keyed to the pump shaft to provide positive, non-slip rotation. Diffusers shall be tightly secured to prevent rotation.
- D. Pump intake inlet shall be horizontal to prevent drawing sediment from the tank bottom into the pump inlet.
- E. Manifold assembly shall be completely sealed against product leakage into the ground and exterior water leakage into the storage tank. The discharge outlet shall be standard 2"

- NPT on models which install through 4" tank openings. The head shall have a built-in air eliminator, line check valve, adjustable pressure relief valve, and shall contain a built-in siphon primer.
- F. The syphon system shall be capable of drawing 25" of mercury vacuum through a venturi. The syphon shall incorporate a syphon check valve to maintain the siphon action after the pump has been turned off.
 - G. The Quick Set feature shall be capable of varying the overall pump length. The Quick Set shall incorporate a set screw as a locking mechanism.
 - H. The motor shall be 208/230 volt, 60 cycle, single phase, 3450 RPM, permanent split capacitor type continuous duty, rated explosion proof in Class 1, Group D, flammable solvents. The motor windings shall be hermetically sealed against leakage of product or moisture, and shall have a thermal overload device with automatic reset built into the motor windings for motor cut-off when motor temperature reaches a level which may cause damage to the motor.
 - I. Pump and motor shall have an Outer Aluminum Shell; Stainless Steel-type 304 Stator; Stainless Steel Rotorshaft; Celcon® Plastic Impellers & Diffusers; and Carbon Motor Bearings
 - J. The motor shall have a quick-disconnect type male/female connector to be readily separable for servicing without cutting or splicing of conducting wires. Wiring connections to the motor, including the capacitor shall be disconnected by the quick-disconnect. Reconnecting motor to column pipe shall use an alignment dowel pin for positive realignment of electrical male/female connector. Motor shall have a CPT Controller for 208 volts 60 hertz wit max 12 amps.
 - K. All components shall be designed and assembled to facilitate disassembly and servicing from above without disrupting the discharge piping. The pump shall be assembled with the pump inlet and impellers at the bottom for maximum liquid draw. The motor shall be mounted above the pump inlet, so that the motor is both cooled and lubricated by the liquid flow through and past the motor.
 - L. Actual delivery rates shall be within 5% of published performance curves for each pump model.
 - M. Pump shall have a Red Jacket FXV Leak Detector, or approved equal pressure sensing diaphragm operated valve, which shall install directly in a 2" NPT opening in the head of the submerged pump, or as part of a flanged assembly flanged into the discharge piping. Detector shall be Third Party Certified to be capable of detecting any line leak downstream of the leak detector which is greater than three GPH with a 95% probability of detection and a 5% probability of false alarm per EPA test protocol. Reduced flow of two to three GPM shall indicate a line leak is present.

2.4 DAY TANK CONTROLLER AND ACCESSORIES

- A. Provide a Phillips Pump series FS4, or approved equal, multi level day tank level control probe arranged to monitor the fuel oil level. Probe shall be designed for installation in

the top of the tank to control high-level, pump on/off and low-level level, and remote supply pump on/off conditions.

- B. Provide a day tank rupture basin float and vent float switch with alarm and pump shut down which functions upon detection of oil in the rupture basin or vent line.
- C. Provide a Phillips FL, or approved equal, series time delayed flow switch on the discharge of the supply pump. Flow switch shall be vane operated to actuate a single double throw snap switch. Switch will be wired back to the pump control cabinet for alarm and annunciation.
- D. Provide 3/4" day tank supply flow control manifold. Manifold shall include (1) normally closed solenoid valves that shall open when the tank demands fuel, isolation ball valves for solenoids and by-pass tee with ball valve and 5 GPM flow restrictor. All ball valves shall have lockable handles, which can padlocked closed in case of a solenoid removed for service. Piping shall be schedule 40, ASTM Grade A-53 black steel pipe with A-105 forged steel socket welded fittings and A-105 150# forged steel flanges. Manifolds that have threaded fittings and unions will not be acceptable.
- E. Provide pump control cabinet to monitor and control the fuel oil delivery system in response to day tank and dispenser demand. Cabinet shall be completely pre-wired, tested and shipped as an integrated system to insure jobsite reliability and shall be capable of operating on 208 volt, single phase, 60 Hz electrical service. Control strategy shall be microprocessor-based and shall have sufficient I/O to accomplish all necessary control functions. Enclosure shall be constructed of a minimum of 14-gauge steel, constructed to NEMA 3R standards. Cabinet interior and exterior shall be primed and finished in durable chemical-resistant enamel suitable for industrial environments. The control strategy shall be burned into an EPROM at the factory, safeguarded against re-configuration by unauthorized or unqualified personnel with all manual switching wired direct in order to run the system if a processor lost should occur. Black phenolic labels with engraved white lettering shall identify all cabinet front devices and control cabinet shall consist of but not be limited to the following:
 - 1. Microprocessor based PLC control system with supply pump control for float switch and dispenser.
 - 2. Pump self-protected U-line magnetic motor starter with thermo magnetic Protection.
 - 3. Motor circuit breakers
 - 4. Fused control circuit transformer
 - 5. Pump Manual-Off-Auto illuminated mode selector switch
 - 6. Back-lit 4 line LCD display factory programmed for system status and alarm
 - 7. Alarm silence / System reset and system test push-buttons
 - 8. Alarm buzzer
 - 9. Direct MODBUS protocol communication ports.
 - 10. Discrete output for each major alarm to interface with the BMS. The control system shall annunciate the following alarms: pump thermal overload status change, day tank high-level alarm; day tank low-level alarm; day tank rupture basin leak; oil-in-vent alarm, pump not in auto alarm
 - 11. The system controller shall include a LCD display for pump set status, alarm listings, and trouble shooting functions. The display page shall be provided

for viewing the most recent alarms/events with each event and alarm condition time and date stamped.

2.5 DAY TANK FUEL RETURN PUMP

- A. Pump assembly shall be a Bronze Close Coupled 2 GPM Rotary Gear Pump.
- B. Pumps housing and gears shall be made of top quality bronze and the shafts shall be 303 stainless steel. The bearings shall be designed of high performance carbon-graphite material selected for wear resistance and long service life.
- C. Gear pumps shall be positive displacement pumps. Each shaft revolution shall displace a definite amount of liquid relatively unaffected by the back pressure of the discharge line. Shaft Speed and flow shall be directly proportional. The maximum shaft speed is 1750 RPM.
- D. The pump shall be suitable for all liquids that shall be compatible with bronze. For a first start-up, the pump shall be primed to avoid a dry running.
- E. Motor shall be Type Split Phase with an ODP Enclosure; 1/3 HP, 1725 RPM; 120 volt; NEMA/IEC Frame 48YZ. Assembly shall include; Mounting Cradle; Bearings Sleeve; Auto Thermal Protection; Insulation Class B.
- F. The motor shall have a reversible rotation by a simple reconnection. It shall have a specifically designed end shield with an extended hub and a short slotted shaft for close-coupling the carbonator pump to the motor. The motor shall be specifically made for diesel fuel.
- G. Unless otherwise specified, the pump motor unit shall be supplied, by the factory, for shaft rotation counterclockwise from shaft end.. The relief valve shall be on the inlet side of the pump. The factory pressure setting shall be 50 PSIG. With the ability to increase pressure as required in the field after installation.

2.6 DUAL WALL DIESEL PIPING ABOVE GROUND

- A. All secondary-containment piping systems shall be an engineered and totally prefabricated DOUBLE-PIPE type containment system. Carrier pipe shall be protected from the exterior environment by the secondary containment. The system supplier shall have at least 5 years of experience in the manufacture of secondary-contained pipe systems having an integrated sensor cable leak detection/location alarm system. All straight sections, fittings and other accessories shall be factory prefabricated to job dimensions. Secondary-containment joints completed at the factory shall be 100 percent air-tested. The system shall be manufactured to allow the placement of the leak detection cable in the secondary containment. The containment shall be drainable, dryable and air pressure testable. Contractor fabricated systems, whether built on-site or off-site, shall not be acceptable.

- B. The secondary containment shall not be exposed to pressures that exceed the maximum for the selected containment material. When product pipe design pressures exceed the maximum allowable pressure for the secondary containment.
- C. Trained field representatives of the piping supplier shall provide technical field support during critical periods of installation.
- D. The secondary containment manufacturer shall supply a complete design submittal including layout drawings, catalog sheets, material data and pipe stress and end load calculations in accordance with ANSI B31.3 latest edition. The calculations shall be stamped by a registered professional engineer.
- E. Carrier pipe shall be standard weight carbon steel, ASTM A-53 Grade B, ERW or A106 seamless. All joints shall be butt welded for sizes 2 inches and greater, and socket or butt welded for 2 inches and below. Where possible, straight sections shall be supplied in 40-foot random lengths with 6 inches of piping exposed at each end for field joint fabrication.
- F. Secondary-containment material must be compatible with fluids transported. Refer to chemical compatibility chart and material selection guidelines. The secondary containment shall be fabricated out of carbon steel in accordance with ASTM A-135 Grade B or ASTM A-53 Grade B, to the thickness specified below:
 - Diameters-Minimum Thickness
 - 3" - 5" - Schedule 40
 - 6" - 26" - 10 Gauge
 - 28" - 36" - 6 Gauge
 - 38" - 42" - 4 Gauge
- G. Carbon steel secondary containment designed for belowground application shall be protected with PERMA-PIPE's urethane coating. Quality control at the manufacturing facility shall ensure that all coatings are able to pass 5,000 volt holiday test. The coating shall be spray applied onto a shot blasted steel containment to a thickness of 30 mils. All field joints shall be covered with a heat-shrinkable adhesive-backed sleeve. The factory applied coating on the containment fittings shall be either a hand applied urethane coating or a heat-shrinkable sleeve.
- H. Supports shall be carbon steel or stainless .250" thick plate type designed and factory installed by the secondary-containment manufacturer. Support spacing shall be determined by the manufacturer based on pipe diameter, pipe material, and operating temperature of the product pipes. In all cases, pipes within the secondary containment shall be supported at not more than 10-foot intervals. These supports shall be designed to allow for continuous airflow and drainage of the secondary containment in place. When used with a leak detection/location cable, the supports shall have 3/4" ID Type 304 stainless steel guide tubes at every support and changes in direction that facilitate cable pulling and prevent cable damage during pulling operations. No plastic type supports will be allowed.
- I. End seals, pull ports, P-traps, cleanouts and other subassemblies shall be designed and factory prefabricated to prevent the ingress of moisture into the system. All subassemblies shall be designed to allow for complete draining of the secondary containment.

- J. The installing contractor shall install the system in accordance with the directions furnished by the manufacturer and as approved by the architect and engineer. The secondary containment shall be air tested at 10 psig, and the product piping shall be hydrostatically tested to 50 psig or 1.5 times the operating pressure, whichever is greater. The test pressures shall be held for not less than one hour. The contractor shall strictly adhere to the installation guidelines supplied by the system manufacturer and shall keep the secondary containment system clean and dry at all times during the installation process.

2.7 DUAL WALL DIESEL PIPING SYSTEM (UNDERGROUND)

- A. This section covers the use of fiberglass reinforced plastic (FRP) pipe for fuel handling and fuel handling vent and vapor applications including secondary containment.
- B. Material furnished and work performed under this section shall be coordinated with the related work and equipment specified under other sections, i.e. Valves, Flexible Connectors, Equipment. Piping system materials shall be red thread IIA as manufactured by FGS, Smith Fibercast or approved equal.
- C. Except as modified or supplemented herein, all materials and construction methods shall comply with and be tested in accordance with the following standards and test methods:
- UL971-2004 Standard for Nonmetallic Underground Piping for Flammable Liquids
- ASTM D2310 Standard Classification for Machine-Made "Fiberglass" (Glass Fiber Reinforced Thermosetting Resin) Pipe
- ASTM D2992 Standard practice for obtaining Hydrostatic or Pressure Design Basis for "Fiberglass" (Glass Fiber Reinforced Thermosetting Resin) Pipe and Fittings
- D. Pipe manufacturer's quality program shall be in compliance with ISO 9001 and/or API Q1.
- E. Pipe and fittings shall be protected from damage due to impact and point loading. Pipe shall be properly supported to avoid damage due to flexural strain. The contractor shall allow dirt, debris or other extraneous materials to get into pipe and fittings. All factory machined areas shall be protected from sunlight until installed.
- F. Primary Pipe and 3" - 4" Secondary Pipe shall be manufactured by the filament winding process using an amine cured epoxy thermosetting resin to impregnate strands of continuous glass filaments, which are wound around a mandrel at a 54 ¾" winding angle under controlled tension. The pipe shall be heat cured and the cure shall be confirmed using a Differential Scanning Calorimeter. Pipe shall be supplied with T.A.B. (Threaded and Bonded) or plain ends. Pipe shall have a minimum continuous cyclic pressure rating of 125 psig at 150°F in accordance with ASTM D2992, Procedure A or UL 971 pressure rating. All pipe, both primary and secondary, shall be 100% hydrotested at the factory before shipment at a minimum pressure of 265 psig and shall be UL 971-2004 Listed and Labeled.
- G. Piping shall have the following ASTM D2310 Classifications (at 73.4°F)

Primary Pipe

2" - 3" RTRP-11AF
4" RTRP-11AH

Secondary Pipe

3" RTRP-11AF
4" RTRP-11AH

- H. All fittings shall be manufactured using the same type of material as the pipe. Fittings may be manufactured either by compression molding, filament winding, resin transfer molding or contact molding methods. All fittings, adapter, and sump penetrations shall be UL971-2004 Listed. Primary fittings shall be adhesive bonded, matched tapered bell and spigot and rated the same as the pipe. Secondary containment fittings shall be two-piece style to allow for 100% inspection of the primary joint pressure test and be rated to a minimum of 50 psig per UL 971-2004. Should hydrostatic testing be impractical, testing with low pressure air or inert gas may be acceptable. Extreme caution should be used when testing with air. Follow all safety precautions and testing recommendations of the pipe manufacturer.
- I. Connections to flex connectors or other piping materials shall be made by the use of NPT (National Pipe Thread) threaded adapters or flanges bonded to the FRP piping system.
- J. Sump Penetrations shall be made by means of a permanently bonded FRP coupling. The coupling shall be capable of adjusting for the slope of the piping system entering or exiting the sump wall.
- K. Adhesives shall be manufacturer's standard for the piping system specified.
- L. All joints installed or constructed in the field shall be assembled by employees of the contractor who have been trained by the pipe manufacturer. The pipe manufacturer or their authorized representative, shall train the contractor's employees in the proper joining and assembling procedures required for the project, including hands-on participation by the contractor's employees. Each bonder shall fabricate one pipe-to-pipe and one pipe-to-fitting joint that shall pass the minimum pressure test for the application as stated above without leaking. Only bonders that have successfully completed the pressure test shall bond pipe and fittings. Each bonder shall carry a current, manufacturer proof of training card.
- M. Pipe shall be installed as indicated on the drawings. The piping system shall be installed in accordance with the manufacturer's current published installation procedures.
- N. A hydrostatic pressure test shall be conducted on the completed piping system. The piping system shall be subjected to 10 pressurization cycles from 0 psig to 1.5 times the design operating pressure. After the 10 cycles, the pressure shall be held on the system for a minimum of 1 hour and the line inspected for leaks. Test pressures shall not exceed 1.5 times the maximum rated pressure of the lowest rated element in the system. All pipe joints shall be water tight. All joints that are found to leak, by observation or during testing shall be replaced by the contractor and retested. Should hydrostatic testing be impractical, testing with low pressure air or inert gas may be acceptable. Extreme caution should be used when testing with air. Follow all safety precautions and testing recommendations of the pipe manufacturer.

2.8 TANK FILLING SYSTEM

- A. The system shall be a Simplex FuelPort, or approved equal, filling and spill prevention device for above ground storage tank.
- B. System shall contain all valves and fittings necessary for hose connection from a pumper truck to the above ground tank.
- C. The system shall be packaged in a weatherproof lockable cabinet with a minimum of 7 gallon spill containment. Cabinet shall have mounting brackets for post mounting.
- D. The system shall have the following as part of the factory supplied enclosure.
 - 1. Quick disconnect hose coupling with dust plug.
 - 2. Check valve.
 - 3. Shut off valve.
 - 4. Hand pump for spill containment with shutoff and check valve.
 - 5. Ground stud.

2.9 PIPING IDENTIFICATION

All piping at each piece of equipment shall be stencil to show the service and direction of flow. Stencils shall be black on a white background with letters one (1") inch high spaced at approximately forty-eight (48") inches apart. Pressure-sensitive pipe markers ANSI Standard A 13.1 may be used in lieu of stenciling.

2.10 DIESEL DUAL WALL PIPE LEAK DETECTION SYSTEM

- A. Furnish a complete cable-type leak detection and location system consisting of a microprocessor based monitoring unit, sensor cable, probes, system layout map and auxiliary equipment required to provide continuous monitoring of the sensing string(s) for leaks, shorts, breaks and probe activations. If any of these conditions should occur at any point along the cable, an alarm shall sound, type of condition shall be clearly identified and the location clearly displayed. The system shall monitor the interstitial space of double contained piping, tanks and/or trenches.
- B. The system shall be the PAL-AT Leak Detection and Location System manufactured by PermAlert, Niles, Illinois, (847)-966-2190 or approved equal. The manufacturer shall have at least ten years experience in supplying leak detection systems.
- C. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. FACTORY MUTUAL ENGINEERING AND RESEARCH (FM) Class No.3610 -Intrinsically Safe Apparatus and Associated Apparatus UNDERWRITERS LABORATORIES (UL)
UL 913 -Intrinsically Safe Apparatus and Associated Apparatus
- D. The Leak Detection System shall locate the point of origin of the first liquid leak or fault (break/short/probe) within .2% for hydrocarbons of the sensor string length, or 5 feet, whichever is greater. The system shall identify the type of alarm leak/break/short/probe as well as the location. The system shall be able to monitor (detect and locate) with up to

100' of cable wetted without significant inaccuracy in location. The System shall be evaluated by an independent third party according to the Third Party Procedures developed according to the U.S. EPA's "Standard Test Procedure for Evaluating Leak Detection Methods: Liquid-Phase Out-of Tank Product Detectors." The evaluation results shall verify the system manufacturer's claim regarding sensitivity, range and other performance data.

- E. The system shall be capable of monitoring up to 2,000 feet of cable per sensor string from a single monitoring unit.
- F. The system shall be capable of monitoring (detecting and locating) for multiple leaks or additional liquid on the sensor cable. The system shall be able to monitor with up to 100 feet of cable wetted with reduced location accuracy.
- G. The system shall be capable of identifying the location of breaks and shorts on the cable. When either of these faults occurs, an alarm shall sound and a display visible on the front of the monitoring unit shall clearly indicate the type of fault, i.e. BREAK or SHORT and display the location of the fault.
- H. The system shall be capable of detecting hydrocarbon liquids.
- I. The system shall provide relays for remote indication of an alarm condition. The relays shall provide indication that no alarm conditions exist, an alarm condition exists but has not yet been acknowledged, and an alarm condition exists and has been acknowledged. Communications shall be available via RS-232 and ASCII communication protocol to allow central point monitoring and control via a remote computer.
- J. The system shall record significant events in nonvolatile memory. A minimum of 900 events shall be stored. When the memory becomes full, the recorded events shall be deleted from memory on a FIFO basis. Each recorded event shall include the time and date that the event occurred. Archives shall be retrievable through the RS-232 and ASCII communication protocols.
- K. The system shall continuously provide positive indication that it is monitoring the sensing string and the status of the sensing string. The system clock shall provide the time and date on the LCD of the monitoring panel. The system clock shall be programmable by the user. A time and date indication shall be included for all events recorded in memory.
- L. The system shall have assignable password security to provide for varying levels of system access. A minimum of 20 passwords shall be available within the system. The system shall not permit unauthorized modifications to the sensing string to be made (i.e. shortening the cable length) without causing an alarm condition.
- M. The system shall be capable of monitoring sensor cables, probe sensors and switch sensors (such as float switches, pressure switches, etc.) from the same monitoring panel. English language displays shall indicate the status of the sensors.
- N. The system shall not detect incidental liquid contact that is not at least equivalent to a small puddle, 3 inches in diameter. The sensitivity of the system shall be field adjustable to increase or decrease the amount of wetted cable needed to cause an alarm from several inches to several feet.

- O. The monitoring unit shall be microprocessor based and capable of monitoring up to 2,000 feet of sensing string per cable, including sensor cable, probes and jumper cable, depending on cable type. The monitoring unit shall indicate when any liquid comes in contact with the sensor cable by sounding an alarm, actuating the two output relays, displaying a message stating that a leak has been detected and the location of that leak on the sensing string. The monitoring unit shall have a green LED on the front panel to indicate the unit is powered. A 2-line by 40-character backlit LCD shall be visible from the front of the unit to provide system data. A red LED on the front panel shall indicate an alarm condition has occurred. The monitoring unit power requirements shall be 120 VAC, 100 VA, 50/60 Hz, single-phase. Monitoring units shall be equipped with an RS-232 communication port and a minimum of one common and one per cable SPDT output relay, rated for 250 VAC, 10 A. The monitoring unit shall be enclosed in a modified NEMA 12 enclosure. The unit shall be UL Listed and FM approved to provide connections for intrinsically safe sensor circuits for use in Class I, Division I, Groups C and D Hazardous Locations. The ability to locate a leak shall not depend on battery backed up functions. In the event of power failure, system conditions and parameters shall be stored in nonvolatile memory allowing the unit to automatically resume monitoring, without resetting, upon restoration of power. An on-off switch shall be provided in the panel for servicing. [Optional:] [A NEMA 4X outer enclosure shall be furnished with viewing window for mounting outdoors.] [A NEMA 7 explosion proof enclosure shall be furnished.]
- P. The sensor cables shall be suitable for use with the monitoring unit. The sensor cables shall be of coaxial construction consisting of an insulated copper center conductor, a suitable spacer material, and an outer braid. All coaxial sensor center conductors shall not be less than 14 AWG for mechanical strength. All cables must be capable of field installation of connectors by trained technicians. The cable shall be available in lengths up to 1,500 feet in bulk spools. All cables must be field repairable by trained technicians. Cable on flat surfaces shall have hold down clips every 8 feet and cable identification tags every 50 feet.
- Q. The system shall be installed per the manufacturer's recommended installation procedures. All local, state and federal codes and requirements shall be followed. The system shall be installed by properly trained personnel.
- R. A location map shall be provided with the system by the installing contractor; indicating the "As Installed" system configuration and sensing string layout. Footage along the cable shall be provided as references to locate leaks. Footage shall be based upon Calibration Points taken per Section 4.3
- S. The installing contractor shall be responsible for taking and recording calibration points along the sensing string per the manufacturer's recommended procedures. All cable not in containment piping shall have cable tags every 50 feet.
- T. Tests shall be performed to demonstrate the ability of the system to detect and locate breaks, shorts and probes on the sensor string. The cable shall be shorted with the alarm and location verified.
- U. The contractor will provide manufacturer's technical assistance for contractor, training, installation inspection, start up and owner operating and maintenance training.

Contractor is to follow all manufacturer's instructions for installation. A time domain reflectometry graph of the cable installation shall be furnished at time of owner training.

2.11 STORAGE TANK LIQUID MANAGEMENT SYSTEM

- A. The tank monitoring system shall meet all of the applicable performance specifications and regulatory agency requirements set forth by the following organizations:

American Petroleum Institute (API)
American Society for Testing and Materials (ASTM)
Environmental Protection Agency (EPA)
Federal Communications Commission (FCC)
National Electric Code (NEC)
National Fire Protection Agency (NFPA)
Underwriters Laboratories (UL)

- B. The controller shall be microprocessor-based, and shall be designed and constructed with modular architecture easily permitting either factory or field upgrades and servicing. Configuration and set-up data shall be maintained in non-volatile memory having a minimum fifty (50) year data retention without requiring power of any kind. Replacement or substitution of any controller plug-in card shall not require system re-configuration. Real-Time clock and non-critical log data, such as inventory, delivery, alarm, theft, error, and leak reports shall be maintained in battery backed non-volatile memory with a minimum data retention of from (5)-(10) years in the event of a power outage. System shall include digital display for viewing tank information and LED indicators for the alarm conditions.
- C. System shall have the capability to continuously monitor up to two (2) dual-float magnetostrictive in-tank level probes and up to eight (8) secondary containment leak or point-level sensors. Leak and point-level sensor inputs shall support a means to detect sensor open-circuit and short-circuit wiring faults as a standard feature when used in conjunction with fault-reporting sensors. The system shall provide hardcopy 24 column environmental compliance reports, which exit the front panel or are stored internally with optional autowinder take-up spool. The RS-232 serial port shall be standard for communications with a local PC computer. System shall operate on switch selectable 115 VAC, 60 Hz. Maximum power consumption shall be 20 watts.
- D. The console shall be housed in a lockable wall mounted NEMA 12 enclosure and optionally available in NEMA 4X outdoor configurations. The console shall include microprocessor board, probe/sensor card, power supply, control I/O and communications interfaces. Front panel display shall include audible and visual alarms, user-friendly membrane pushbutton controls. The display shall be nine digit, seven segment, quasi-alphanumeric sunlight readable LED type, with LED alarm annunciators for five (5) alarm conditions; leak, three (3) tank product setpoints, and one (1) bottom water setpoint per tank. LED alarm lights shall be visible from at least 60 feet and the seven-segment display data shall be readable from no less than twenty (20) feet. Displays shall include product gross or net, percent of capacity, 90/95/100% usage, product and water level, product temperature, and product type. As a standard, two (2) programmable relay outputs and two (2) contact closure inputs shall be provided. All relays and contact closure inputs shall be user-programmable for activation by the following event types; Theft, Power Fail

Recovery, System Error, Tank Leak, Product Setpoints, Water Setpoints, Leak/Point Level Sensors, Contact Closure inputs and Line Leak. The system shall be supplied with three industrial quality front panel sealed membrane pushbuttons labeled MODE, TANK SELECT, and TEST. Membrane pushbuttons shall be utilized in conjunction with the display screen to select tank quantities, view, set, acknowledge alarm conditions; set/review configuration data, initiate system tests, view inventory and other logged data. The system shall provide hardcopy environmental compliance and status reports via front panel 24-column printer. The RS-232 serial port shall be provided as standard for two-way communications with a PC computer. Microsoft Windows 95 thru XP compatible software shall be provided to retrieve and display current tank statuses, remotely read, write and initialize system setup, clock, and configuration data. An RS-485 port shall be provided as standard for connection to "smart" peripherals, such as remote "slave" display and annunciator panels. The system shall be independently third party certified for UST petroleum storage tanks and have the capability to automatically or manually conduct a static volumetric tank tightness test to an accuracy of 0.2 GPH for monthly monitoring and 0.1 GPH for annual precision testing, with minimum test times of two hours and eight hours respectively. System shall be capable of performing both tests with as little as 20% of tank capacity. Console shall be Pneumercator Model Series TMS2000, or approved equal.

- E. Tank Gauging Probe shall be designed for both AST and UST applications and shall have performance characteristics permitting 0.1 GPH or better in-tank leak test with continuous gauging accuracy of +/- 0.0005 inches for product, +/- 0.001 for water and +/- 0.001 degrees F for (relative) temperature. Probe shall contain an array of at least five (5) temperature sensors along its length for accurate volumetric temperature compensation. Probe to console communication shall employ digital transmission techniques carried over standard, readily available two-conductor, shielded cable, with a maximum cable length restriction of no less than 4000 feet. Probe operating temperature and pressure shall be -40 to +175 degrees F and 150 PSIG respectively. Probes shall be supplied with product float, water float, six (6) foot leader cable with watertight connector, and centering rings for riser mounted applications. Probe shall be UL/CSA approved for use in Class I, Division I, Group C & D hazardous locations. Probe shall be Pneumercator Model MP450S for rigid lengths from 24 to 216 inches, or approved equal.
- F. Secondary Containment Leak Sensors for non-discriminating leak sensors shall be available for liquid detection in interstitial spaces, containment areas, sumps, brine reservoirs, dispenser pans and piping locations. All sensors shall be provided with a wiring fault detection feature.
- G. Non-Discriminating Type Liquid Sensors for dispenser pan and steel tank double-wall sensor shall be a 2-wire type consisting of a magnetic, Buna-N float encased within a 1-1/2 inch diameter, stainless steel outer housing and supplied with twenty-five (25) feet of 2-conductor #22 AWG gage wire. Sensor shall be rated to 50 PSIG at 160F with an accuracy of 1/2-inch of liquid. Optional configuration utilizing 1-3/4 inch diameter stainless steel/Teflon housing, stainless steel float and Teflon-jacketed cables shall be available for solvent/fuel additive applications. Sensors shall have wiring fault detection. Solvent sump, dispenser pan and steel tank double-wall leak sensor shall be Pneumercator Model LS600-LD-SS-[F], or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All equipment and controls shall be installed in accordance with manufacturer's recommendations. Installation, adjustments and starting shall be done under supervision of manufacturer's representative.
- B. All equipment shall be installed in a neat and workmanlike manner in accordance with the best practice of the trade.
- D. This Contractor shall furnish and install any and all mechanical items which are required to complete the temperature controls which are to be provided under this section of the specifications.
- E. All piping as specified under this section shall be tested to the pressures as herein before specified.
- F. Upon completion of the installation of all work and equipment the Contractor shall start all equipment and make all necessary tests and adjustments to place entire heating, ventilating and air conditioning systems in a satisfactory condition for continuous safe operation of facilities.

END OF SECTION

SECTION 15800

HEATING, VENTILATION AND AIR CONDITIONING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The General Provisions of the Contract, including General and Supplementary Conditions and General Requirements apply to the work specified in this Section.
- B. Refer to Basic Materials and Methods Section 15050 which shall apply to work in this Section.

1.2 DESCRIPTION OF WORK

- A. The work to be done under this Section includes the furnishing of all labor, tools, materials, equipment and services necessary for and reasonable incidental to the installation of complete air conditioning and heating and ventilation equipment as shown on plans and herein specified, excepting only work and/or materials indicated as being done and/or furnished under other sections.
- B. Contractor shall refer to other Sections of the Specifications which may be applicable to or associated with this Section.

1.3 RELATED WORK SPECIFIED IN OTHER SECTION

- A. Electrical Section will provide all power wiring including furnishing and installing of disconnect switches where specified. Control wiring for air conditioning equipment shall be provided by Building Automation and Temperature Control Contractor.
- B. Other Sections will provide and install structural supports for equipment. These supports must be checked and coordinated by this Section so that they suit the equipment which is to be supported.
- C. Other Sections will provide all platforms slabs, lintels and curbs, as directed by this Section, to accommodate the mechanical equipment.
- D. Mechanical Contractor shall provide starters for motors furnished under this Section.

1.4 QUALITY ASSURANCE

- A. These specifications with accompanying drawings, require complete apparatus, fully erected and in successful operating condition. Perform all work in best, most substantial manner.
- B. All equipment furnished and installed under this Section shall be U.L. or E.T.L. approved and labeled where applicable.
- C. All unfired pressure vessels furnished under this Section shall be ASME and National Board stamped.
- D. All manufacturers products shall comply with the requirements of this Section.
- E. Employ qualified sheet metal workers in accordance with SMACNA Duct Construction Standards.
- F. Qualify welding/brazing process and welder/brazer performance in accordance with AWS B2.2, Standard for Brazing Procedure and Performance Qualification, or ASME Boiler and Pressure Vessel Code, Section IX (See 15050). Provide copy of certification for welding and brazing processes.
- G. Soldering processes shall conform to ASME B 31.3, Process Piping and Copper Development Association recommended practices.

1.5 SUBMITTALS

- A. Contractor, before beginning work, shall submit dimensional shop drawings (in accordance with requirements of Division 1), for approval, for all duct systems. Contractor is responsible to coordinate all plumbing, piping, sprinkler, ductwork and electrical to avoid all conflicts. Conflicts encountered after work has started will be corrected at Contractor's expense.
- B. Where the equipment installed is of a different configuration and/or size than that shown on the drawings, Contractor shall assume all responsibility to conform with the intent of the contract documents. The Architect shall be advised of any changes and deviations for his approval. The same shall be true for any field modification required because of "on job" construction conditions.

PART 2 - PRODUCTS

2.1 HVAC DUCTWORK

- A. Provide and install a complete system of ductwork as herein specified to include, but not limit to supply, return, exhaust and fresh air with grilles, registers, diffusers and appurtenance to provide a complete functional and operational system. Duct sizes shown on drawings are free area dimensions. Design shall be as described in the latest edition of SMACNA manuals and as per the following:

1. Galvanized sheet metal shall be lock form quality per ASTM A653 with a G90 zinc coating.
2. Outside air and exhaust air ducts shall be galvanized sheetmetal with air-tight seams and as per applicable sections of SMACNA manuals for low velocity ducts. Insulate outside air and exhaust air ducts with internal liner as per SECTION 15250. Isolation room exhaust shall be insulated with 2" exterior duct wrap.
3. Supply and return ducts for low pressure system and, low velocity systems shall be galvanized sheetmetal with airtight seams and as per applicable section of SMACNA manuals for low velocity ducts. All ducts shall be insulated with 2" exterior wrap as per Section 15250.
4. Rectangular ductwork for medium pressure, high velocity systems shall be galvanized sheetmetal with airtight seams and as per applicable section of SMACNA manuals for high velocity ductwork. Insulate with 2" exterior duct wrap as per Section 15250.
5. Concealed Round rigid ductwork shall be all round single wall spiral pipe and fittings, galvanized steel, as per applicable sections of SMACNA manuals for high velocity duct. Insulate with 2" exterior duct wrap as per Section 15250. Seal all seams, joints and wall penetrations with hardcast as herein specified.
6. Round and oval rigid duct, where exposed and/or noted on the drawings, shall be double wall and shall be constructed of perforated inner liner, a 1" layer of fiberglass insulation, and an outer pressure shell. Ductwork shall be of spiral lockseam construction fabricated in accordance with ASTM-A527 Standards. Seal all seams, joints, and wall penetrations with Hardcast elastomeric tape as here-in-before specified. Ductwork shall be paint grip galvanized steel. Provide welded factory insulated supply taps as indicated on the drawings. Minimum steel gauges, hanger spacing, support sizes and attachments, and reinforcement shall be SMACNA Duct Construction Standards. Insulate all register taps.
7. All ducts shall be sealed per SMACNA Seal Class A. All joints, longitudinal seams and wall penetrations of all supply, return outside air and exhaust ducts shall be sealed with an elastomeric tape which shall consist of a pressure sensitive layer of modified butyl rubber sealer laminated to a foil backing material which shall conform to surface variations and irregular areas and shall not harden crack or peel. The sealant shall be waterproof and shall be a minimum of 15 mils thick. All ductwork shall be cleaned and prepared and sealant shall be applied strictly in accordance with manufacturer's instructions and recommendations. Sealant shall be Hardcast FG-1402, Suretape #653 or approved equal, at Contractor's option flanged gasketed duct system may be used for POSITIVE PRESSURE SYSTEM ONLY.
8. Flexible round duct where indicated on plans shall be listed by Underwriters' Laboratories, Inc., under UL-181 standards as Class I flexible Air Duct Material complying with NFPA Standards 90A. Ducts shall be rated on maximum pressure of 6 inches WG positive and 2 inches WG negative. The duct shall be factory fabricated assembly composed of: an inner duct of woven and coated fiberglass providing an air seal and bonded permanently to corrosion resistant coated steel wire helix: a 2" thick fiberglass insulating blanket and low permeably outer vapor barrier of fiberglass reinforced metalized film laminate. Pressure drop not to exceed .15" SP at 500 Fpm

through 6" or larger duct. Maximum length of flexible duct shall not exceed 8'-0". Connect flexible round duct with ½" wide nylon positive locking nylon straps on inner duct and outer duct.

9. Splitter dampers shall be installed where branches take off of main trunk ductwork, where ducts divide or where shown on the drawings. Splitters shall be fitted with nickel plated damper regulators in finished areas. Splitters shall be factory fabricated in accordance with SMACNA Duct Construction Standards.
- B. Flexible connections shall be provided between each fan unit and ductwork on supply side and also on return side. Material shall be flexible fire-resistive material, minimum 4" wide, UL listed, with no metal to metal contact.
- C. Duct supports for rectangular ducts shall be a minimum 1" X 18 gauge galvanized steel bands. Hanger bands shall be bent under lower corners and secured with self-tapping screws at corners and six (6") inch intervals up the sides. Distance between hangers shall be as recommended by SMACNA manual for low and medium ductwork. Ductwork shall be rigidly supported to prevent vibration. Duct attachments to structure, lower hanger attachments, ducts traps and rods and trapeze angles shall be in accordance with SMACNA Low Pressure and High Pressure Duct Standards.
- D. Where the ducts pass through walls, draft stops or partitions, the space shall be packed with non-combustible materials, filling all voids around duct.
- E. Fire dampers with fusible links shall be installed at all points in ductwork where indicated on drawings, and/or as required by NFPA, 90-A, AND MECHANICAL CODE OF THE IBC.
- F. Provide radius elbows unless specifically indicated otherwise or space prohibitive. Rectangular radius elbows shall be factory fabricated with a centerline radius of not less than the width of the duct. Round duct elbows shall have a minimum center line radius of 1-1/2 times the diameter of the duct and shall be smooth where possible. Provide square elbows where indicated or space prohibits the use of radius elbows. Square elbows shall be factory fabricated with double thickness airfoil turning vanes pre-assembled and securely attached to runners.
- G. In general, vertical risers and other duct runs, where the method of support specified above is not applicable, or not specifically detailed on drawings, shall be supported by substantial angle brackets designed to meet field conditions, installed to allow for duct expansion and approved by Architect.
- H. Provide exposed operators for operation of dampers and splitters in inaccessible ceilings, operators shall be chrome plated.
- I. Maximum duct leakage shall be +/- 5%, SMACNA Seal Class A. Ductwork between VAV box and air-handling unit shall be designed for 4.0" static pressure. Ductwork between VAV box and diffuser shall be designed for 2.0" static pressure. Outside air, return air and exhaust air systems shall be designed for 2.0" static pressure. Construct ductwork in accordance with SMACNA Duct Construction Standards for the specified pressure class.

- J. Install Automatic dampers, airflow stations and other duct mounted devices required by Section 15950.
- K. Smoke dampers shall be UL 555S/UL555 combination fire/smoke damper with integral 120V actuator. Dampers shall be automatic reset type. Control and power wiring by Fire Alarm Contractor.
- L. Flanged gasketed exhaust and return ductwork will not be accepted.
- M. Furnish and install a complete kitchen exhaust duct systems from the kitchen hood duct collars to the roof fan, as shown on the drawings.
 - 1. All kitchen exhaust duct work shown on plans shall be constructed of 16 gauge carbon steel with a liquid tight continuous external weld. Ductwork shall conform to NFPA-96 requirements. Duct work shall conform to SMACNA Standards.
 - 2. Provide labeled, gasketed access panels as required by NFPA-96. Spacing of access panels not large enough for personnel entry shall not exceed 12 ft. Access panels shall be grease-tight and rated for 1500 degrees F. On main kitchen duct riser coordinate access panel locations in vertical duct.
 - 3. Ductwork shall be supported by a minimum 16 gauge carbon steel at intervals determined by SMACNA standards. Bolts, screws, rivets, and other mechanical fasteners shall not penetrate duct walls.
 - 4. Dimensions of ductwork, shown on plans, are free area dimensions.
 - 5. Hoods shall be as specified on the drawings and shall be installed under this section of the Specifications.

2.2 RESIDENTIAL RANGE HOOD EXTINGUISHING SYSTEM

- A. The fire extinguishing system shall be capable of detecting a cooking grease fire origination on the range top, extinguish the fire, and prevent reignition, while at the same time, shut-off the gas or electric supply to the surface elements on the kitchen range top. Each system shall be provided with all means to distribute the chemical agent, fire detection components, container for storing the chemical, valve assembly with pressure gauge, mounting bracket for container, and appliance shut-off device. Except for shut-off device, these components shall be provided factory assembled and ready for installation. The fire extinguishing system shall have a current U.L. listing.
- B. Wet Chemical agent shall conform to the requirements of National Fire Protection Association (NFPA) Standard No. 17A for Wet Chemical Fire Extinguishing Systems.
- C. The extinguisher cylinder and valve assembly shall be provided fully charged with chemical and pressurized with dry nitrogen in accordance with Listed requirements. A pressure gauge attached to the valve assembly shall be positioned to allow visual inspection when installed within a kitchen cabinet. Maximum allowable height of container (including valve assembly and mounting bracket) shall exceed 12 inches. The container and valve assembly shall be of the reserviceable type and provide

maintenance requirements synonymous with that required for portable hand-held fire extinguishers, according to National Fire Protection Association (NFPA) Standard 10. The container and valve assembly shall be provided factory assembled to the mounting bracket. Assembly shall include a pre-mounted activation switch for the application shut-off device, actuation spring and necessary attachment for the Fire Detection Unit. The complete extinguisher cylinder and valve assembly shall be installed in a protected area above the range hood. Installations, which expose extinguisher cylinder and valve assembly to direct cooking heat and grease, will not be accepted.

- D. Appliance nozzles shall be constructed of brass, stainless steel or a combination thereof. Appliance nozzles with painted surfaces shall not be accepted. Appliance nozzles shall not extend below the lowest component of the range hood. Design shall provide equal distribution of chemical agent and allow chemical to flow effectively with low velocity to avoid splattering of burning grease.
- E. The fire detection unit shall consist of 1/16-inch stainless steel cable. "S" hooks, cable crimps, corner pulleys and reusable thermal links, plus other necessary hardware for complete installation. These components shall be provided factory assembled as one complete unit. Each fire detection unit, when installed, shall provide a thermal link over each cooking surface burner, have no exposed cable ends protruding under range hood, and prevent detection components from splattering grease during system actuation. Components shall not extend (when installed) below the lowest component of the range hood. The temperature rating of thermal links shall prevent pre-mature system actuation from normal cooking temperatures common with residential type gas and/or electric range top burners. Only those fire extinguishing systems to have passed the "Exposure Temperature Test for Detector Links" in accordance with Underwriters Laboratories Incorporated (U.L.) criteria (Subject 300A) shall be considered. Reusable thermal links shall not require periodic replacement.
- F. Rigid Piping and Flexible Hose for Wet Chemical: Rigid pipe, pipe fittings and flexible hose shall be provided factory assembled and ready for installation into kitchen cabinet space. The use of copper tubing shall not be accepted. Pipe, pipe fittings and flexible hose shall comply with National Fire Protection Association (NFPA) Standard No. 17A for Wet Chemical Extinguishing Systems. The combination of pipe and flexible hose shall have been investigated by Underwriters Laboratories Incorporated (U.L.) and Listed for this service.
- G. Each system shall be provided with a Listed device to automatically shut-off the gas or electric supply to surface burners on the kitchen range top upon actuation of the fire extinguishing system. The gas or electric supply shall remain "off" until manually reset. Electrical power cut-off to kitchen range hood exhaust fan shall not be required for Underwriters Laboratories Incorporated (U.L.) Listed for extinguishing systems.
- H. Each system shall be provided with a comprehensive owner's manual that shall contain procedures to follow in the event of a cooking grease fire, post clean-up procedures, parts identification, complete wiring diagram, system installation with pictorials for step-by-step procedures, system limitation, inspection and maintenance requirements. Reservicing/recharging procedures shall also be contained in the owner's manual or the owner's manual shall reference a recognized reservicing publication.

2.3 DIFFUSERS, GRILLES, REGISTERS AND LOUVERS

- A. All sizes shall be as indicated on drawings.
- B. All outlets shall be balanced to obtain specific air quantities free of all objectionable draft and Noises.
- C. Diffusers, grilles and registers shall be of normal commercial grade as indicated on Schedule on drawings.
- D. Louvers shall be as scheduled and/or detailed on drawings.
- E. Insulate the back of all diffusers, grates and registers with $\frac{3}{4}$ Armaflex or Rubatex.

2.4 FIRE DAMPERS

Fire dampers shall be solid sheet curtain type, dynamic closure type corrosion resistant galvanized steel construction. Dampers mounted in the horizontal position shall be closed by a stainless steel negate spring. Damper to be easily reset through standard access panel for required periodic maintenance. Access panels are required for access to all fire dampers, minimum size 12 X 12 inches. Dampers shall be 100% out of air stream. Provide fusible links rated at 160 degrees F.

2.5 ACCESS DOORS

Access doors shall be installed in ductwork wherever required for ready access to any operating part. Doors shall not be smaller than 12 X 12 inches, with brass hinge and sash type fasteners. Ducts 30" or larger shall be supplied with minimum 18 X 18 inch access doors. Doors shall be double wall insulated type, hinged with sash locks and gaskets.

2.6 PIPING AND FITTINGS

- A. Furnish and install all piping related to air conditioning systems including make-up water piping, air conditioning condensation drains, and other miscellaneous piping.
- B. All piping shall be installed parallel and square with building lines and shall be sloped to permit drainage, with suitable provision for drainage at all low points.
- C. Piping shall be arranged to maintain headroom and keep passageways clear and where necessary shall be offset to maintain the required clearance and conform with the structural features of the building. Contractor shall determine in advance of construction locations for all piping sleeves, hangers, etc. No allowance will be made for extra due to inaccurate location of sleeves, piping or equipment.
- D. All piping shall have provisions for expansion and contraction with anchorage at each point shown on the plans and/or as required.

- E. Full length pipe shall be used where possible, short lengths and couplings will not be permitted. After cutting, all pipes shall be reamed out to full bore and before erection, all cutting and foreign matter shall be removed from the inside of pipes. Screwed joints shall be made tight without caulking or the use of lead or paint and no lubricant shall be used except flake granite and cylinder oil paste, or approved pipe compound applied to make threaded pipe.
- F. Pipe sleeves shall be provided for the passage of all pipe through walls, floors and partitions.
- G. All condensate drain piping shall be installed using ASTM B88 type "L" hard drawn copper with wrought copper sweat fittings. Changes in direction of piping shall be made with short turn tee pattern or 45 degree wye fittings with brass cleanout plug. Insulate drain piping per Section 15250, minimum drain on fan coil units - 3/4", air handling units - 1-1/4".
- H. Make-up water piping shall be installed using copper piping as specified for water piping.
- I. Welding fittings shall be Tube Turn, Midwest, or approved equal. Use welding elbows at all turns in welded piping, except where bent runs are indicated and except that turns and off-setting to a maximum of 15 degrees mitered. At branch connections, either use welding tees or weld the branches directly into the mains. Use extra heavy couplings in all cases where female threaded openings are required, in welding piping.
- J. Chilled water piping, 2-1/2" and larger shall be installed using ASTM A53 Grade B Schedule 40 black steel pipe with malleable iron fittings. At Contractor's option above ground piping size three (3") inches and larger may be flanged or welded. Welded elbows shall be factory made long radius. Provide bronze unions at connections to copper coils. Also, at Contractor's option all water piping, above ground, may be installed using grooved mechanical pipe coupling and fittings, with grade "E" gaskets. Piping 2" and smaller shall be ASTM B88 type "L" hard drawn copper with wrought copper sweat fittings.
- K. Install control valves, sensor wells, sockets, flow meters and DP sensors required by Section 15950.
- L. See Section 15900 for valves, fittings, unions, gaskets, bolts and nuts.
- M. See Section 15050 for hangers.

2.7 PIPING AND PIPING IDENTIFICATION

All piping at each piece of equipment shall be stencil to show the service and direction of flow. Stencils shall be black on a white background with letters one (1") inch high spaced at approximately forty-eight (48") inches apart by equipment or 10 foot intervals along piping runs. Pressure-sensitive pipe markers ANSI Standard A 13.1 may be used in lieu of stenciling.

2.8 EXHAUST FANS AND OUTSIDE AIR INTAKES

- A. Size and quantity shall be provided as indicated on drawings.
- B. All roof exhaust fans and roof outside air intakes shall be provided with factory prefabricated curbs.

2.9 VAV TERMINAL UNITS

- A. Unit performance data must be Rated in Accordance with ARI Standard 880, and must display the ARI Symbol on all standard units. Re-heat terminals shall be U.L. Listed as a room air terminal. All units shall have capacities as scheduled on the drawings. Units shall be furnished with integral NEMA 1 non fused disconnect switch for electric heaters.
- B. Units shall be completely factory assembled, manufactured of corrosion protected welded steel, and fabricated with a minimum of 18-gauge metal on the high pressure (inlet) side of the VAV damper and 22-gauge metal on the low pressure (outlet) side and unit casing.
- C. Interior surface of unit casing acoustically and thermally lined with a minimum of 1/2 inch, R-Value 2.1 - 1.9 lb./cu.ft. density glass fiber with foil facing. Insulation shall be UL listed and meet NFPA-90A and UL 181 and Bacteriological Standard ASTM C-665 requirements. The cut edges on the discharge of the unit shall be covered by a metal flange. All exposed edges shall be sealed to prevent fibers in the air stream.
- D. Air volume damper, and controls in single cabinet. Air volume control damper shall be factory installed and calibrated consisting of air valve with integral actuator. Unit discharge shall have a flange duct connection.
- E. Locate air volume damper assembly inside unit casing. Construct from extruded aluminum or a minimum of 20 gauge (0.9 mm) galvanized steel components. Flow sensor must be provided regardless of control chosen. Air volume control damper shall be factory calibrated assembly consisting of air modulation damper and extension for connection to control actuator. All actuator linkage shall be protected by a sheet metal enclosure.
- F. Terminals shall include an integral hot water coil as scheduled on the drawings. Coil shall be furnished with all controls necessary for safe and complete operation. Terminal shall have a single point power supply.
- G. Controls shall be supplied by the Control Contractor but mounted on VAV units by equipment manufacturer. Mount electrical components in control box with removable cover. Incorporate single point electrical connection to power source. Factory mount transformer for control voltage on fan-powered electronic control units. Provide terminal strip in control box for field wiring of thermostat and power source.
- H. Controls (See Section 15950).

- I. Factory set and check all analog electronic controllers to within 5% of scheduled maximum and minimum setting. Base performance on tests conducted in accordance with ARI 880. Maximum Casing Leakage: 1 percent of nominal air flow at 0.5 in wg inlet static pressure. Maximum damper Leakage: 1 percent of design air flow at 4 in wg inlet static pressure.
- J. See Schedule on drawings for minimum heating and cooling setpoints.
- K. Identify each terminal unit with clearly marked identification label and air flow indicator. Label shall include unit nominal air flow, maximum factory set air flow and minimum factory set air flow.
- L. Electric heating coils shall be UL listed and meet NEC requirements. Electric heaters shall be factory mounted with "S" and drive connections and provide a flanged discharge suitable for field mounted duct connections. Electric Heaters shall include automatic reset thermal cutouts, manual reset thermal cutouts, control line terminal blocks, magnetic contactors, or P/E switch as required by phase, voltage, or KW. All components shall be mounted in a heavy gauge galvanized steel enclosure. Heating elements shall be 80-20 Ni-Ch wire. Air flow switch and sensing probe shall be included.

2.10 AIR HANDLING UNITS

- A. Furnish and install where shown on the drawings, welded frame air handling units with capacity as indicated on the schedule. Air handling units shall be as manufactured by Temtrol, Governair, Huntair, Ventrol, or approved equal. All units shall come completely assembled. Multiple sectioned units shall be shipped as a single factory assembled piece (except where shipping limitations prevent) de-mounted into modular sections in the field by the contractor. Units shall be furnished with sufficient gasket and bolts for reassembly in the field by the contractor. Unit manufacturer shall provide certified ratings conforming to the latest edition of AMCA 210, 310, 500 and ARI 410. All electrical components and assemblies shall comply with NEMA standards. Unit internal insulation shall have a flame spread rating not over 25 and smoke developed rating no higher than 50 complying with NFPA 90A. Units shall comply with NFPA 70, as applicable for installation and electrical connections of ancillary electrical components of air handling units. Units shall be UL or ETL listed.
- B. Units shall have a full perimeter welded base frame manufactured with structural steel tubing and C-Channel cross support members on close centers. Unit frame shall be from 14-gauge carbon tubular steel, welded to form a unitized assembly for support of all internal components. Base and unit frame shall be painted with a lacquer resisting gray phenolic corrosion inhibitive primer. The base shall include a 4-inch thick insulated "double bottom" floor with minimum 20 gauge G-90 galvanized outer and 16 gauge G-90 galvanized inner walk-on surface. All floor seams shall be caulked and sealed for an airtight unit. Where access is provided to the unit interior, floor openings shall be covered with walk on steel safety grating. Single wall floors with glued and pinned insulation are not acceptable. Base frame shall be attached to the unit at the factory.
- C. The exterior panel shall be fabricated from formed 16 gauge G-90 galvanized steel with exterior coating. The air handling unit casing shall be of the "no-through-metal" design. The casing structure shall incorporate insulating thermal breaks, as required, so that,

when fully assembled, there exists no path of continuous unbroken metal to metal conduction from inner to outer surfaces. Panels shall be gasketed and secured to the tubular steel frame. Outer panels shall be removable without affecting the structural integrity of the unit. All panel seams shall be caulked and sealed for an airtight unit. Leakage rates shall be less than 1% at design static pressure. The exterior panel finish shall be galvanized. Each unit shall have double wall construction with 16 gauge solid galvanized liner in the entire unit. The entire double wall panel shall be removable from the outside if the unit without affecting the structural integrity of the unit.

- D. Entire unit will be insulated with a full 2" thick non-compressed fiberglass insulation. The insulation shall have an effective thermal conductivity (C) of .24 (BTU in./sq.ft.Fdegrees) and a noise reduction coefficient (NRC) of 0.70 / per inch thick (based on a type "A" mounting). The coefficients shall meet or exceed a 3.0 P.C.F. density material rating. Insulation shall meet the erosion requirements of UL 181 facing the air stream and fire hazard classification of 25/50 (per ASTM-84 and UL 723 and CAN/ULC S102-M88). All insulation edges shall be encapsulated within the panel. All perforated sections or single wall units shall have Tuf-Skin insulation with black acrylic coating.
- E. The unit shall be equipped with a solid double wall insulated, hinged access doors. The doorframe shall be extruded aluminum with a built in thermal break barrier and full perimeter gasket. The door hinge assembly shall be die cast zinc with stainless steel pivot mechanism, completely adjustable. There shall be a minimum of two heavy duty cast nylon handles per door. Provide ETL, UL 1995, and CAL-OSHA approved tool operated safety latch on all fan section access doors.
- F. The Fan Wall System, as manufactured by The CES Group, or approved equal, shall consist of multiple, direct driven, arrangement 4 plenum fans constructed per AMCA requirements for the duty specified. All fans shall be selected to deliver the specified airflow quantity at the specified operating Total Static Pressure and specified fan/motor speed. The Fan Wall Array shall be selected to operate at a system Total Static Pressure that does not exceed 90% of the specified fan's peak static pressure producing capability at the specified fan/motor speed. Each fan/motor "cube" shall include an 11 gauge, A60 Galvanized steel intake wall, 14 gauge spun steel inlet funnel, and an 11 gauge G90 Galvanized steel motor support plate and structure. The fan intake wall, inlet funnel, and motor support structure shall be powder coated for superior corrosion resistance. All motors shall be standard pedestal mounted type, TEFC, T-frame motors selected at the specified operating voltage, RPM, and efficiency as scheduled on the drawings. All motors shall include isolated bearings or shaft grounding. Each fan/motor cartridge shall be dynamically balanced to meet AMCA standard 204-96, category BV-5, to meet or exceed Grade 2.5 residual unbalance.
 - 1. The FWT array shall be provided with acoustical silencers that reduce the bare fan discharge sound power levels by a minimum of 15 db re 10^{-12} watts throughout the eight octave bands with center frequencies of 125, 250, 500, 1000, 2000, 4000, and 8000 HZ when compared to the same unit without the silencers. The silencers shall not increase the fan total static pressure, nor shall it increase the airway tunnel length of the Air Handling Unit when compared to the same FWT unit without the silencer array.

2. The fan array shall consist of multiple fan and motor "cubes", spaced in the air way tunnel cross section to provide a uniform air flow and velocity profile across the entire air way tunnel cross section and components contained therein. Each fan cube shall be (individually wired to a control panel containing a single VFD, as specified elsewhere, for the total connected HP for all fan motors contained in the FWT array.
 3. The Fan Wall array shall produce a uniform air flow profile and velocity profile within the airway tunnel of the air handling unit not to exceed the specified cooling coil and/or filter bank face velocity when measured at a point 12" from the intake side of the Fan Wall array intake plenum wall, and at a distance of 48" from the discharge side of the Fan Wall intake plenum wall.
 4. Each fan/motor assembly shall be removable through a 30" wide, free area, access door located on the discharge side of the fan wall array.
 5. Each fan/motor "cube" will be provided with an individual back-draft damper similar to a Ruskin BD6 Heavy Duty 6063T5 extruded aluminum frame, .125" wall thickness. Frame shall have galvanized steel braces on all corners. Blades shall be minimum .070" wall thickness 6063T5 extruded aluminum. Bearings shall be corrosion resistant long life synthetic. Linkage shall be ½" tie bar with stainless steel pivot pins.
 6. The manufacturer shall provide a complete spare FWT fan/motor assembly for emergency replacement, one for each type of assembly provided on the project.
- G. Water Cooling coils shall be mounted on stainless steel support rack to permit coils to slide out individually from the unit. Provide intermediate drain pans on all stacked cooling coils. The intermediate pan shall drain to the main drain pan through a copper downspout. Water coils shall be constructed of seamless 5/8" o.d. x .020" wall copper tubing mechanically expanded into .008" aluminum fin collars. All fins shall be continuous within the coil casing to eliminate carryover inherent with a split fin design. Fins are die formed Plate type. Headers are to be seamless copper with die formed tube holes. Connections shall be male pipe thread (MPT) Schedule 40 Red Brass with 1/8" vent and drain provided for complete coil drainage. All coil connections shall be extended to the exterior of the unit casing by the manufacturer. Coils shall be suitable for 250 PSIG working pressure. Intermediate tube supports shall be supplied on coils over 44" fin length with an additional support every 42" multiple thereafter.
- H. IAQ style drain pans shall be provided under all cooling coils as shown on the drawings. The drain pan shall be fabricated from 16 gauge 304 stainless steel. All pans are to be triple pitched for complete drainage with no standing water in the unit. They shall be insulated minimum 3-inch "Double Bottom" construction with welded corners. Provide stainless steel, 1-1/4" MPT drain connection extended to the exterior of the unit base rail. Units in excess of 160 inches shall have drain connections on both sides. All drain connections shall be piped and trapped separately for proper drainage.
- I. Factory fabricated filter sections shall be of the same construction and finish as the unit. Face loaded pre and final filters shall have Type 8 frames as manufactured by FARR. Side service filter sections shall include hinged access doors on both sides of the unit. Internal blank-offs shall be provided by the air unit manufacturer as required to prevent air bypass around the filters. The filters shall be as manufactured by Farr,

Purolator, AAF or equal. Each Filter bank shall be furnished with Magnehelic filter gage (Dwyer Series 2000, or approved equal) Air filter gage.

- J. All unit dampers shall be Low leakage type and shall have airfoil blades. Flat or formed metal blades are not acceptable. The damper blade shall incorporate santoprene rubber edge seals and zinc plated tubular steel shaft for a non-slip operation. Shaft bearings holes shall be N.C. machine punched and fitted with one inch O.D. heavy duty nylon bearings to eliminate friction and any metal to metal contact. Damper jamb seals shall be stainless steel spring arcs designed for a minimum air leakage and smooth operation. Damper linkage shall be concealed within a 16 gauge G-90 galvanized steel frame.

2.11 PUMPS

- A. The pumps shall be horizontal flexible-coupled end suction, as manufactured by Aurora, B & G, or approved equal.
- B. The pump shall be constructed of the following materials:
- Casing.....Cast Iron (ASTM A48)
 - Impeller.....Bronze (ASTM B584)
 - Shaft.....Steel (AISI C1045)
 - Case Wear Ring.....Bronze (ASTM B62)
 - Shaft Sleeve.....Bronze (ASTM B62)
 - Base Suction Elbow.....Cast Iron (ASTM A48)
- C. The casing shall be of the end suction design with tangential discharge outlet. For suction piping diameters of 2" or less and discharge piping diameters of 1.5" or less, the suction and discharge connections shall be NPT threaded. For suction piping diameters of 2" or greater, the suction inlet shall be a flat-faced flange connection and the discharge outlet shall be a bolt through flange connection. Flange connections shall be ANSI 125 PSI rated. The casing shall have tapped and plugged holes for priming and draining. The casing bore shall be large enough to allow "back pullout" of the impeller without disturbing the casing or suction and discharge piping. The casing shall be supported by the power frame.
- D. The impeller shall be of the enclosed type, vacuum cast in one piece. It shall be finished all over, the exterior being turned and the interior being finished smooth and cleaned of all burrs, trimmings, and irregularities. The impeller shall be dynamically balanced. The impeller will be keyed to the shaft, and fastened with a washer, gasket and cap screw.
- E. The pump casing shall be fitted with a case wear ring to minimize abrasive and corrosive wear to the casing. The case wear ring shall be of the radial type, press fitted into the casing.
- F. The stuffing box shall be integrally cast with a mounting bracket, and shall provide an adequate area for internal recirculation of the pumped fluid around the sealing medium.
- G. Shaft sealing shall be accomplished by means of a mechanical seal with a Ni-Resist seat, carbon washer, Buna-N elastomers, and stainless steel metal parts.

- H. The impeller shall be direct-coupled to the motor shaft. The motor shaft shall be machined to provide a keyway, and drilled and tapped to accept the impeller fastener. Stub shafts are not acceptable. The outboard shaft extension shall be machined with a keyway to accept a coupling to the driving unit. Water slingers shall be furnished on both the inboard and outboard shaft extensions.
- I. The pump shaft shall be fitted with a shaft sleeve to minimize shaft wear. The sleeve shall be sealed to the impeller hub by an O-ring, and shall be positively driven by a pin to the keyway. The use of adhesive compounds to fasten the sleeve to the shaft shall not be accepted.
- J. The power frame shall house a single-row outboard re-greaseable thrust bearing. Both bearings shall be selected for a 3 year minimum life at maximum load. The outboard bearing shall be locked in place by a retaining ring. The inboard bearing shall not be locked in order to accommodate thermal expansion of the shaft. Lubrication fittings shall be provided in convenient location. A bearing cartridge end cap shall be provided on the outboard side of the power frame to allow inspection and replacement of the thrust bearing without the need for disassembling the power frame housing.
- K. The pump unit shall be supported from beneath the mounting bracket and the power frame by mounting feet.
- L. The pump and motor shall be mounted on a groutable formed steel baseplate with integral drip channels incorporated on each side. Each channel shall include an NPT drain connection and plug. The base shall be sufficiently rigid to support the pump and the motor without the use of additional supports or members.
- M. A flexible coupling shall be provided to connect the pump shaft to the motor shaft. The coupling shall be of an all metal type with a flexible rubber insert. The entire rotating coupling element shall be enclosed by a coupling guard.
- N. The motor shall be a NEMA-JM configuration in accordance with the latest NEMA Standards.
- O. Each motor shall have a sufficient horsepower rating to operate the pump at any point on the pump's head-capacity curve without overloading the nameplate horsepower rating of the motor, regardless of service factor. The motor shall have a service factor of at least 1.15. The service factor is reserved for variations in voltage and frequency.
- P. The pumping units shall be installed in accordance with the instructions of the manufacturer and as shown on the drawings by the Contractor.
- Q. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations.

2.12 COMBINATION MOTOR STARTERS

- A. This Contractor shall provide motor starters for all motors furnished under this section.

- B. Starters shall be NEMA ICS 2, AC general-purpose Class A magnetic controllers for induction motors rated in horsepower. Size shall be as for the motors connected. Two-speed starters with time delay relays shall be used for two-speed motors. All motors over 25 HP shall use solid state reduced voltage starters.
- C. Coils shall have the operating voltage required for the motors connected. Coils shall be of the encapsulated type with the required poles.
- D. Windings shall be straight-through type with all terminals clearly marked.
- E. Overload relays shall be NEMA ISC with one piece thermal unit construction, and shall be interchangeable. Overload relay control circuit contacts shall also be replaceable. Thermal units shall be required for starter to operate. Starters shall have phase loss, phase reversal, three phase, under-voltage relay motor protection.
- F. Starters shall have HOA, located in the cover. Starters shall also have a 150VA control transformer and auxiliary contacts as required for controls. Coordinate these with the requirements of the building automation system, Section 15950.
- G. Starter enclosures shall be ANSI/NEMA ICSG, type 1 or 3R as required to meet conditions of installation.
- H. Full voltage starters shall be G. E. Model 300 Series or ABB Series B. Solid state reduced voltage starters shall be GE Model ASTAT-CD.
- I. Starters shall be combination type with thermal magnetic circuit breakers.

2.13 VIBRATION ISOLATION SYSTEMS

- A. Work shall include furnishing, installing and testing all material required and hereinafter called for complete execution of the vibration isolation system. Isolation materials shall not be limited to compressors, convertors, air units, pumps, piping, duct work, fans, etc. All motor-connected equipment shall be considered a source of vibration and shall be isolated to prevent vibration and sound transmission. Isolation equipment, as manufactured by Kinetics, Mason Industries or prior approval equal, shall be used. Specific reference to isolation under equipment headings is to provide additional information by which proper selection of the required isolation may be made. Equipment specification data showing physical size, bearing points, weights per point, rotating speeds and sound power levels generated shall be furnished by the respective equipment supplier to the vibration isolation supplier after equipment submittals have been approved.
- B. All mechanical and sound isolation materials specified herein or shown on drawings shall be provided by a single manufacturer to assure singular responsibility for proper selection, application, installation and performance. Substitution for isolation material specified incorporating non-permanent materials, such as cork, rubber, wood pulp, or thermal fiberglass will not be acceptable. Should no specific material be called out for particular use, all mechanical vibration isolation shall be based upon Chapter 46, 1999 A.S.H.R.A.E. Guide-Table 45, "Guide for Selection of Vibration Isolators". Bases, mounts and hangers furnished shall have a nominal deflection equal to the minimum deflection

as shown in this guide and shall be furnished on all motor driven equipment requiring isolation as well as piping and duct connected to same.

- C. To assure stability, the spring element to be a large diameter laterally stable spring with load plate and have a lateral stiffness greater than 0.8 times the rated vertical stiffness and be designed to provide up to 50% overload capacity. Each base mount spring shall have a 1" isolation sound pad of elasomeric material.
- D. Isolation shall be stable during starting and stopping of equipment without any transverse or eccentric movement that could damage or adversely affect the equipment or attachments. Isolation systems for floor or ceiling-mounted equipment shall have a maximum lateral motion under start up and shut down of 3/8". Motion in excess shall be corrected by restrained spring-type mounts. Isolators shall be selected for the lowest operating speed of the equipment isolated and shall be located to produce uniform loading and deflection even when equipment weight is not evenly distributed. Static deflection on grade up to 3/8" shall use nominal 1" deflection springs on isolation pads. Static deflection above grade shall use spring isolators with spring deflection based upon 1999 Guide Deflection data. The static deflection of the isolation system shall be selected to avoid being in resonance with the disturbing frequency. All spring isolators shall have neoprene sound damping pads separating isolator from structure.
- E. Submittals shall contain a complete schedule of all equipment to be isolated along with the type of isolator, loading per isolator, static deflection, spring diameters and maximum deflection. Should isolation installed fail to perform satisfactorily in preventing the transmission of vibration, the isolation shall be replaced without cost to owner and properly selected isolators shall be installed.
- F. Chilled water pump bases shall consist of a concrete slab cast into a prefabricated inertia base frame assembly designed and supplied by the isolation materials supplier such as CPF inertia base. Frames shall be welded steel channels with a depth greater than 8% of the longest span between isolators, a minimum of 6" thick or as indicated on the drawings, and shall include 1/2" steel re-enforcing rods on maximum 8" centers each way. Prelocated equipment anchor bolts shall be included. Spring isolator support brackets shall be welded at the corners of the perimeter channel frame with 1/2" reinforcing rods welded 1-1/2" above bottom of bracket running continuously in two directions between all isolator brackets. Inertia bases used to support horizontally split case pumps shall be wide enough to support pipe elbows and may be rectangular or "T" shaped at manufacturers option.
- G. Vertically hung air handling units and fans shall be isolated with large diameter laterally stable steel spring in series with a molded neoprene insert, assembled into a stamped or welded hanger bracket with load transfer plates for both the spring and neoprene insert. Hangers to allow a support rod misalignment thru a 30 degree arc. Mason Model 30N or Kinetics Model SFH.
- H. All piping over 1" in diameter and connected to motor-driven equipment shall be spring hung for a minimum of 3 hangers in each direction. The spring deflection for the hanger shall be the same as the spring deflection for the equipment isolated. Mason Model 30N or Kinetics Model SFH.

- I. Duct Work - All supply duct work shall be hung on neoprene or spring hangers for a minimum of 3 hangers from air handling unit to prevent the transmission of duct vibration into the structure. Mason Model 30N or Model HD or Kinetics Model SFH or Model RH.

2.14 ELECTRIC UNIT HEATERS

- A. The unit heaters shall be propeller type completely packaged and arranged for ceiling suspension with directional louvers. Capacities shall be as listed in the schedule on the drawings.
- B. Elements shall be low temperature, enclosed style made of steel and monel with spiral fins copper-brazed to the element.
- C. Controls shall be provided with unit heater and shall consist of unit mounted thermostat, automatic high limit and fan time delay relay. This contractor shall install controls and make operational.
- D. Motors shall be permanently lubricated with internal overloads.
- E. Each unit shall be U.L. listed.

2.15 VARIABLE FREQUENCY DRIVES

- A. This specification is to cover a complete Adjustable (Variable) Frequency motor Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use on a standard NEMA Design B induction motor. It is required that the drive manufacturer have an existing Sales representative exclusively for HVAC products, with expertise in HVAC systems and controls and An independent service organization. The drive manufacturer shall supply the drive and all necessary controls as herein specified. The manufacturer shall have been engaged in the production of this type of equipment for a minimum of twenty years. Drives shall be manufactured by ABB model ACH series 550, or approved equal. VFD's that are manufactured by a third party and "brand labeled" shall not be acceptable.
- B. The following Referenced Standards shall apply:
 1. Institute of Electrical and Electronic Engineers Standard 519-1992, IEEE Guide for Harmonic Content and Control.
 2. Underwriters laboratories UL508C.
 3. National Electrical Manufacturer's Association (NEMA) ICS 7.0, AC Adjustable Speed Drives.
 4. IEC 16800 Parts 1 and 2.

5. VFDs and options shall be UL listed as a complete assembly. VFD's that require the customer to supply external fuses for the VFD to be UL listed are not acceptable. The base VFD shall be UL.

C. Submittals shall include the following information:

1. Outline dimensions, conduit entry locations and weight.
2. Customer connection and power wiring diagrams.
3. Complete technical product description include a complete list of options provided.
4. Compliance to IEEE 519 - harmonic analysis for particular jobsite including total harmonic voltage distortion and total harmonic current distortion (TDD). The VFD manufacturer shall provide calculations; specific to this installation, showing total harmonic voltage distortion is less than 5%. Input line filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with IEEE standard 519. All VFD's shall include a minimum of 5% impedance reactors, no exceptions.

D. The VFD package as specified herein shall be enclosed in a UL Listed Type 12 enclosure, completely assembled and tested by the manufacturer in an ISO9001 facility. The VFD tolerated voltage window shall allow the VFD to operate from a line of +30% nominal, and -35% nominal voltage as a minimum.

E. The VFD package as specified herein shall operate between 32 to 104°F continuous, and less than 95% humidity, non-condensing. VFD's that can operate at 104° F intermittently (during a 24 hour period) are not acceptable and must be oversized. Enclosure shall be rated UL type 12 and shall be UL listed as a plenum rated VFD. VFD's without these ratings are not acceptable.

F. All VFDs shall have the following standard features:

1. VFDs shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.
2. The keypad shall include Hand-Off-Auto selections and manual speed control. The drive shall incorporate "bumpless transfer" of speed reference when switching between "Hand" and "Auto" modes. There shall be fault reset and "Help" buttons on the keypad. The Help button shall include "on-line" assistance for programming and troubleshooting.
3. There shall be a built-in time clock in the VFD keypad. The clock shall have a battery back up with 10 years minimum life span. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault. If the battery fails, the VFD shall automatically revert to hours of operation since initial power up. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter sets and output relays. The VFD shall have a digital input that allows an override to the time clock (when in the off mode) for a

- programmable time frame. There shall be four (4) separate, independent timer functions that have both weekday and weekend settings.
4. The VFD's shall utilize pre-programmed application macro's specifically designed to facilitate start-up. The Application Macros shall provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time. The VFD shall have two user macros to allow the end-user to create and save custom settings.
 5. The VFD shall have cooling fans that are designed for easy replacement. The fans shall be designed for replacement without requiring removing the VFD from the wall or removal of circuit boards. The VFD cooling fans shall operate only when required. To extend the fan and bearing operating life, operating temperature will be monitored and used to cycle the fans on and off as required.
 6. The VFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).
 7. The VFD shall have the ability to automatically restart after an over-current, over-voltage, under-voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between attempts shall be programmable.
 8. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430-150 for 4-pole motors.
 9. The VFD shall have an integral 5% impedance line reactors to reduce the harmonics to the power line and to add protection from AC line transients. The 5% impedance may be from dual (positive and negative DC bus) reactors, or 5% AC line reactors. VFD's with only one DC reactor shall add AC line reactors.
 10. The input current rating of the VFD shall be no more than 3% greater than the output current rating. VFD's with higher input current ratings require the upstream wiring, protection devices and source transformers to be oversized per NEC 430-2.
 11. The VFD shall include a coordinated AC transient protection system consisting of 4-120 joule rated MOV's (phase to phase and phase to ground), a capacitor clamp, and 5% impedance reactors.
 12. The VFD shall be capable of sensing a loss of load (broken belt / broken coupling) and signal the loss of load condition. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. Relay outputs shall include programmable time delays that will allow for drive acceleration from zero speed without signaling a false underload condition.
 13. If the input reference (4-20mA or 2-10V) is lost, the VFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The drive shall be

programmable to signal this condition via a keypad warning, relay output and/or over the serial communication bus.

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

G. All VFDs to have the following adjustments:

1. Three (3) programmable critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed.
2. Two (2) PID Setpoint controllers shall be standard in the drive, allowing pressure or flow signals to be connected to the VFD, using the microprocessor in the VFD for the closed loop control. The VFD shall have 250 ma of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others. The PID setpoint shall be adjustable from the VFD keypad, analog inputs, or over the communications bus. There shall be two parameter sets for the first PID that allow the sets to be switched via a digital input, serial communications or from the keypad for night setback, summer/winter setpoints, etc. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain setpoint of an independent process (i.e. valves, dampers, etc.). All setpoints, process variables, etc. to be accessible from the serial communication network. The setpoints shall be set in Engineering units and not require a percentage of the transducer input.
3. Two (2) programmable analog inputs shall accept current or voltage signals.
4. Two (2) programmable analog outputs (0-20ma or 4-20 ma). The outputs may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, and other data.
5. Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices, typically programmed as here-in-after described. There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad, input contact closure, time-clock control, or serial communications) the VFD shall provide a dry contact closure that will signal the damper to open (VFD motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to an VFD digital input and allows VFD motor operation. Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop, and the damper shall be commanded to close. The keypad shall display "start enable 1 (or 2) missing". The safety status shall also be transmitted over the serial communications bus. All digital inputs shall be programmable to initiate upon an application or removal of 24VDC.
6. Three (3) programmable digital Form-C relay outputs. The relays shall include programmable on and off delay times and adjustable hysteresis. Default settings shall be for run, not faulted (fail safe), and run permissive. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; Maximum

voltage 300 VDC and 250 VAC; continuous current rating 2 amps RMS. Outputs shall be true form C type contacts; open collector outputs are not acceptable.

7. Seven (7) programmable preset speeds.
 8. Two independently adjustable accel and decel ramps with 1 - 1800 seconds adjustable time ramps.
 9. The VFD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and audible motor noise.
 10. The VFD shall include a carrier frequency control circuit that reduces the carrier frequency based on actual VFD temperature that allows the highest carrier frequency without derating the VFD or operating at high carrier frequency only at low speeds.
 11. The VFD shall include password protection against parameter changes.
- H. The Keypad shall include a backlit LCD display. The display shall be in complete English words for programming and fault diagnostics (alpha-numeric codes are not acceptable). The keypad shall utilize the following assistants:
1. Start-up assistants.
 2. Parameter assistants
 3. Maintenance assistant
 4. Troubleshooting assistant
- I. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable):
1. Output Frequency
 2. Motor Speed (RPM, %, or Engineering units)
 3. Motor Current
 4. Calculated Motor Torque
 5. Calculated Motor Power (kW)
 6. DC Bus Voltage
 7. Output Voltage

- J. The VFD shall include a fireman's override input. Upon receipt of a contact closure from the fireman's control station, the VFD shall operate at an adjustable preset speed. The mode shall override all other inputs (analog/digital, serial communication, and all keypad commands) and force the motor to run at the adjustable, preset speed. "Override Mode" shall be displayed on the keypad. Upon removal of the override signal, the VFD shall resume normal operation.

K. Serial Communications

1. The VFD shall have an RS-485 port as standard. The standard protocols shall be Modbus, Johnson Controls N2 bus, and Siemens Building Technologies FLN. Optional protocols for LonWorks, BACnet, Profibus, Ethernet, and DeviceNet shall be available. Each individual drive shall have the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority. Use of non-certified protocols is not allowed.
2. The BACnet connection shall be an RS485, MSTP interface operating at 9.6, 19.2, 38.4, or 76.8 Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC including, but not limited to:
 - a. Data Sharing - Read Property - B.
 - b. Data Sharing - Write Property - B.
 - c. Device Management - Dynamic Device Binding (Who-Is; I-AM).
 - d. Device Management - Dynamic Object Binding (Who-Has; I-Have).
 - e. Device Management - Communication Control - B.

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

3. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus - keypad "Hand" or "Auto" selected, bypass selected, the ability to change the PID setpoint, and the ability to force the unit to bypass (if bypass is specified). The DDC system shall also be able to monitor if the motor is running in the VFD mode or bypass mode over serial communications. A minimum of 15 field parameters shall be capable of being monitored.

4. The VFD shall allow the DDC to control the drive's digital and analog outputs via the serial interface. This control shall be independent of any VFD function. For example, the analog outputs may be used for modulating chilled water valves or cooling tower bypass valves. The drive's digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the drive's digital and analog inputs shall be capable of being monitored by the DDC system.
5. The VFD shall include an independent PID loop for customer use. The independent PID loop may be used for cooling tower bypass value control, chilled water value control, etc. Both the VFD control PID loop and the independent PID loop shall continue functioning even if the serial communications connection is lost. The VFD shall keep the last good set-point command and last good DO & AO commands in memory in the event the serial communications connection is lost.
- L. All VFD's shall include EMI/RFI filters. The onboard filters shall allow the VFD assemble to be CE Marked and the VFD shall meet product standard EN 61800-3 for the First Environment restricted level.
- M. All VFD's through 50HP shall be protected from input and output power mis-wiring. The VFD shall sense this condition and display an alarm on the keypad.
- N. The following additional features shall be furnished and mounted by the drive manufacturer. All additional features shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label.
 1. A complete factory wired and tested bypass system consisting of an output contactor and bypass contactor. Overload protection and shall be provided in both drive and bypass modes.
 2. Door interlocked, padlockable circuit breaker that will disconnect all input power from the drive and all internally mounted options.
 3. Fused VFD only disconnect (service switch). Fast acting fuses exclusive to the VFD - fast acting fuses allow the VFD to disconnect from the line prior to clearing upstream branch circuit protection, maintaining bypass capability. Bypass designs, which have no such fuses, or that incorporate fuses common to both the VFD and the bypass will not be accepted. Three contactor bypass schemes are not acceptable.
 4. The drive / bypass shall provide single-phase motor protection in both the VFD and bypass modes.
 5. The following operators shall be provided:
 - a. Bypass Hand-Off-Auto
 - b. Drive mode selector
 - c. Bypass mode selector
 - d. Bypass fault reset
 6. The following indicating lights (LED type) shall be provided. A test mode or push to test feature shall be provided.

- a. Power-on (Ready)
 - b. Run enable (safeties) open
 - c. Drive mode select damper opening
 - d. Bypass mode selected
 - e. Drive running
 - f. Bypass running
 - g. Drive fault
 - h. Bypass fault
 - i. Bypass H-O-A mode
 - j. Automatic transfer to bypass selected
 - k. Safety open
 - l. Damper opening
 - m. Damper end-switch made
7. The following relay (form C) outputs from the bypass shall be provided:
 - a. System started
 - b. System running
 - c. Bypass override enabled
 - d. Drive fault
 - e. Bypass fault (motor overload or underload (broken belt))
 - f. Bypass H-O-A position
8. The digital inputs for the system shall accept 24V or 115VAC (selectable). The bypass shall incorporate internally sourced power supply and not require an external control power source.
9. Customer Interlock Terminal Strip - provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in Hand, Auto, or Bypass modes (not functional in Fireman's Override 2). The remote start/stop contact shall operate in VFD and bypass modes.
10. Dedicated digital input that will transfer motor from VFD mode to bypass mode upon dry contact closure for fireman's override. Two modes of operation are required.
 - a. One mode forces the motor to bypass operation and overrides both the VFD and bypass H-O-A switches and forces the motor to operate across the line (test mode). The system will only respond to the digital inputs and motor protections.
 - b. The second fireman's override mode remains as above, but will also defeat the overload and single-phase protection for bypass and ignore all keypad and digital inputs to the system (run until destruction).
11. The VFD shall include a "run permissive circuit" that will provide a normally open contact whenever a run command is provided (local or remote start command in VFD or bypass mode). The VFD system (VFD or bypass) shall not operate the motor until it receives a dry contact closure from a damper or valve end-switch. When the VFD system safety interlock (fire detector, freeze stat, high static pressure

switch, etc) opens, the motor shall coast to a stop and the run permissive contact shall open, closing the damper or valve.

12. Class 20 or 30 (selectable) electronic motor overload protection shall be included.
 13. There shall be an internal switch to select manual or automatic bypass.
 14. There shall be an adjustable current sensing circuit for the bypass to provide loss of load indication (broken belt) when in the bypass mode.
- O. Installation shall be the responsibility of the mechanical contractor. The contractor shall install the drive in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual. Power wiring shall be completed by the electrical contractor. The contractor shall complete all wiring in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.
- P. Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file at the manufacturer.
- Q. Factory trained application engineering and service personnel that are thoroughly familiar with the VFD products offered shall be locally available. A 24/365 technical support line shall be available on a toll-free line. A computer based training CD or 8-hour professionally generated video (VCR format) shall be provided to the owner at the time of project closeout. The training shall include installation, programming and operation of the VFD, bypass and serial communication.

2.17 CHILLERS

- A. Provide and install as shown on the drawings factory-assembled, factory-charged, and factory-tested air-cooled scroll compressor packaged chillers. Each chiller shall consist of hermetic tandem or triple scroll compressor sets, direct expansion evaporator, air-cooled condenser section, microprocessor-based control system and all components necessary for controlled unit operation. Chillers shall have the capacities and characteristics as shown on the drawings. Each chiller shall be capable of stable operation to a minimum of 50 percent of full load without hot gas bypass. Performance shall be in accordance with ARI Standard 550/590. Chillers shall be as manufactured by McQuay, or approved equal.
- B. The compressors shall be sealed hermetic, scroll type with crankcase oil heater and suction strainer. Compressor shall have a forced-feed lubrication system with a reversible oil pump and oil charge. The compressor motor shall be refrigerant gas cooled, high torque, hermetic induction type, two-pole, with inherent thermal protection on all three phases and shall be mounted on RIS vibration isolator pads.
- C. The evaporator shall be a compact, high efficiency, dual circuit, brazed plate-to-plate type heat exchanger consisting of parallel stainless steel plates. The evaporator shall be protected with an electric resistance heater and insulated with 3/4" thick closed-cell polyurethane insulation. This combination shall provide freeze protection down to -20°F

ambient air temperature. The water-side working pressure shall be a minimum of 650 psig . Vent and drain connections shall be provided in the inlet and outlet chilled water piping by the installing contractor. Evaporators shall be designed and constructed according to, and listed by, Underwriters Laboratories (UL).

- D. The condenser coils shall consist of 3/8 inch seamless copper tubes mechanically bonded into plate-type fins. The fins shall have full drawn collars to completely cover the tubes. A subcooling coil shall be an integral part of the main condenser coil. Condenser fans shall be propeller type arranged for vertical air discharge and individually driven by direct-drive fan motors. They shall be equipped with a heavy-gauge fan guard. Fan motors shall be TEAO, three-phase, direct-drive, 1140 rpm.
- E. The refrigerant circuit shall include a refrigerant filter-drier, sight glass with moisture indicator, liquid line solenoid valve, thermal expansion valve, and insulated suction line.
- F. Unit casing and all structural members and rails shall be fabricated of continuous G90 galvanized steel and painted .
- G. A centrally located weatherproof control panel shall contain the field power connection points, control interlock terminals, and control system. Power and starting components shall include factory circuit breaker of fan motors and control circuit, individual contactors for each fan motor, solid-state compressor three-phase motor overload protection, inherent fan motor overload protection and unit power terminal blocks for connection to remote disconnect switch. Terminals shall also be provided for power supply to the evaporator heater circuit. Hinged access doors shall be lockable. Barrier panels or separate enclosures are required to protect against accidental contact with line voltage when accessing the control system.
- H. An advanced DDC microprocessor unit controller with a 4-line by 20-character liquid crystal display shall provide the operating and protection functions. The controller shall take pre-emptive limiting action in case of high discharge pressure or low evaporator pressure. The controller shall contain the following features as a minimum:
 - 1. The unit shall be protected in two ways: (1) by alarms that shut the unit down and require manual reset to restore unit operation and (2) by limit alarms that reduce unit operation in response to some out-of-limit condition. Shut down alarms shall activate an alarm signal.
 - 2. The following Shutdown Alarms shall be included :

No evaporator water flow	Sensor failures
Low evaporator pressure	Evaporator freeze protection
High condenser pressure	Outside ambient temperature
Motor protection system	Phase voltage protection
 - 3. Factory mounted DDC controllers shall support the operation of the existing Building Automation System (BAS) Interface. The information communicated between the BAS and the factory mounted unit controllers shall include the reading and writing of data to allow unit monitoring, control and alarm notification as specified in the unit sequence of operation and the unit points list.
- I. The following chiller accessories shall be included:

1. Hot gas bypass to allow unit operation to 10 percent of full load
 2. Low ambient head pressure control to 0°F.
 3. Non-fused disconnect switch with through-the-door handle
 4. Chilled water differential pressure switch to be field mounted in the chilled water line and field wired to terminals in the control panel.
 5. Spring vibration isolators for field installation
- J. The chillers shall be installed in strict accordance with manufacturer's requirements, shop drawings, and contract documents. Chillers shall be adjusted and leveled in alignment on supports. Installing Contractor shall Coordinate electrical installation with electrical contractor and coordinate controls with BAS contractor. Installing Contractor shall Install proper charge of refrigerant and oil and provide testing and starting of machine, and instruct the Owner in its proper operation and maintenance.

2.20 UVC FIXTURE

- A. Lamps and fixtures shall be installed, on the units as scheduled on the drawings, in sufficient quantity and in such a manner so as to provide an equal distribution of UVC energy. When installed, the average intensity striking the intended surface shall not be less than 200 microwatts per square centimeter. The applied energy and its distribution average shall be verified using third party math modeling and that verification shall be included with the submittal.
- B. The minimal UVC energy striking a surface shall be sufficient to continuously destroy a mono-layer of mold and bacteria as typically found in HVAC systems in less than six hours. The third party mathematical modeling shall include the destruction time for at least four of the most common HVAC microbes and an energy distribution map.
- C. Fixture rows shall be electrically terminated to factory supplied Hard Wire Boxes to meet UL and local electrical codes. Fixtures shall be mounted to irradiate the intended surfaces as well as all of the available line of sight airstream by proper placement and incident angle reflection. Third party irradiation and intensity calculations (modeling) shall determine fixture placement and energy distribution and shall be provided in the submittal.
- D. Fixtures shall be track mounted to the appropriate factory supplied hardware to form horizontal rows that provide for the proper fixture support. Fixtures shall be equipped with UL approved fixture-to-fixture mechanical and electrical connections that facilitate proper installation and coupling to A/C power from one end. Fixtures shall be capable of being mounted anywhere in the system and/or as shown on the plans.
- E. When used for surface irradiation, the fixture assembly shall be designed and installed such that the sum of the lamp arc lengths in a row shall be equal to a minimum of 90% of the surfaces total width.
- F. Fixtures shall meet the "UL" drip proof design and each fixture shall be equipped with an electrical interlock, which will not allow the fixture to energize unless it's properly installed to its factory supplied mounting track.
- G. Fixtures shall be constructed of type 304 stainless steel to preclude corrosion.

- H. Power supplies shall be of the high efficiency electronic type, matched to the lamp and designed to maximize UVC photon production, radiance and reliability. They shall be UL Listed and labeled for use in air-streams of 55-135° F. They shall be capable of producing the specified output and organism destruction as specified under Irradiation and Intensity at no more than 13 Watts of power consumption for each square foot of treated, cross sectional plane.
- I. Each lamp shall contain no more than 8 milligrams of mercury, consistent with current environmental practices, while producing the specified output at 500 fpm in temperatures of 55-135° F. Useful lamp life shall be 9000 hours with no more than a 20% output loss at the end of one year of continuous use. They shall be constructed with UVC proof metal bases and shall not produce ozone.
- J. UVC Fixtures shall be stored in a clean, dry place and protect from weather and construction traffic. UVC Fixtures shall be handled carefully to avoid damage to components, enclosures and finish. Factory-shipping covers shall be left in place until installation is complete. Damaged components shall not be installed, instead replace them and return damaged components to equipment manufacturer.
- K. Installation of UVC fixtures
 - 1. Coordinate with installation of HVAC equipment and install Fixtures as indicated above after such equipment is properly installed.
 - 2. Comply with manufacturers' installation instructions regarding wiring and testing and to the drawings and/or specification regarding exact fixture placement for proper energy distribution.
 - 3. Provide an interlock switch on all access panels and doors leading to the UVC assembly and/or within view of the fixtures to assure that the UVC assembly will be de-energized when any of these accesses are opened.
 - 4. When specified and/or called out on the drawings, install a relative indicating radiometer and adjust and set in accordance with manufacturer recommendations.
 - 5. Caution Labels shall be installed on all accesses to the Fixtures.
 - 6. Install UVC system on all air handling units.
- L. Fixtures shall be as manufactured by UltraViolet Devices, Inc., ALTRU•V Products or approved equal.

2.21 COMPRESSION TANKS

- A. Furnish and install tanks of the size and type as shown on the plans. Tanks shall be, bladder type.
- B. Tanks shall be designed and constructed per ASME Section VIII, Division I and rated for a maximum working pressure of 125 PSI at 240 F. Units shall be furnished with lifting

rings, and have the system connection and charging valve at the tank top and a tank drain connection at the bottom. Tanks shall have an internal replaceable elastomer bladder with the minimum acceptance volume and factory precharge pressure as shown on the plans. The bladder shall be suitable for a maximum system operating temperature of 240 F. Bladder type tanks shall be furnished with a steel base

- C. Tanks shall be furnished with galvanized coating for corrosion resistance.

2.22 AIR SEPARATOR

- A. Furnish and install air separation devices of a size and capacities as shown on the plans.
- B. Air separators shall be constructed of steel designed and fabricated per ASME Section VIII Division I with a maximum working pressure rating of 125 PSIG at 375 F. Units up to 2-1/2" connection sizes shall have threaded connections and units 3" and above connection sizes shall have flanged connections. Units shall have separate top connections for system expansion tank and air venting, and bottom connection for blowdown cleaning.
- C. Air separators shall be furnished with a removal stainless steel strainer with a free area not less than five times the cross-sectional area of the connecting pipe.

2.23 WATER TREATMENT

- A. Contractor to furnish and install necessary equipment to properly treat the chilled water circulating system. Manufacturers shall be Olin, Deady, Nalco, or equal.
- B. Furnish and install high pressure "pot type" feeders interconnected across chilled water circulating pumps. Treatment film forming type capable of maintaining adequate corrosion and sludging protection. Include 55 gallons Closed System Treatment in highly concentrated liquid form, basically Nitrite-Metallic Polyphosphate formulated to meet local water conditions.
- C. Flush out system and remove pipe scale and oily residue, furnish Pre-Start-Up chemical to be used under direct supervision of chemical company representative. This shall be done after all pipe is completed and tested, prior to operation and initiation of regular chemical feeding.
- D. Provide complete printed instructions for chemical dosages, bleed rates, operation, to simplify operation and set a standard for treatment. Services of factory trained Engineer shall be included for setting up procedures and instructing personnel in proper handling of chemicals based on actual analysis of water supply. Complete test sets for checking PH, Alkalinity, Chloride, Hardness, Nitrite, Organic Phosphonate shall be included with all required reagents and instructions. Factory check analysis and supervision of chemical use and test shall be included for first year's operation.
- E. This Contractor shall furnish and install all piping connections, taps and shut off valves to accommodate all the equipment and piping. Contractor shall certify piping is clean and free of air.

2.24 DIESEL PIPING AND FITTINGS

- A. Above-Ground Pipe and Fittings shall be ASTM A53 Schedule 40 black steel, threaded pipe with threaded steel fittings. Coat piping on or under piers with two coats of Mil. Spec. MIL-C-18480 solvent base coal tar coating and a topcoat of Mil. Spec. MIL-C-15203 coal tar emulsion coating.
- B. Buried fuel piping shall be a factory-fabricated composite system consisting of ASTM A83 Schedule 40 black steel, threaded pipe with threaded steel fittings surrounded or encased in a welded steel or fiberglass conduit or jacket to provide a secondary means of protection against fuel leakage into the surrounding soil. Steel or fiberglass conduit or jacket shall meet all Federal, State, and local environmental requirements and guidelines for secondary containment of underground fuel piping systems. Provide annular carrier pipe supports. Provide cable type leak detection system capable of monitoring entire length of piping. See drawings for diesel pipe and conduit requirements relative to number of carrier pipes.
- C. Vent Piping shall be ASTM A53 Schedule 40 galvanized steel piping with galvanized malleable iron fittings.
- D. Dielectric Unions shall consist of steel female pipe thread end and copper solder-joint end meeting the dimensional, strength, and pressure requirements of ASME 816.39. Steel parts shall be galvanized or plated. Union shall have a water-impervious insulation barrier capable of limiting galvanic current to one percent of the short-circuit current in a corresponding bimetallic joint. When dry, it shall also be able to withstand a 600 von breakdown test.
- E. Design, selection, fabrication, installation, and spacing of Pipe Hangers and Supports shall meet MSS-SP-58 and MSS-SP-69. Hangers, supports, rods, anchors, nuts, bolts and washers shall be hot-dip galvanized. Hangers and supports shall be the adjustable type.
- F. For Concrete Inserts provide Type 316 stainless steel inserts threaded to receive galvanized steel hanger rod.
- G. Provide non-asbestos composition gaskets for flanged and bolted connections suitable for the intended service.
- H. Pipe Sleeves shall be Schedule 40 galvanized steel pipe.
- I. Provide one-piece or split hinge type metal Escutcheon plates for pipes passing through walls, floors, and ceilings in exposed spaces. Anchor plates in place with set screws or other positive means.
- J. Valves shall be suitable for use with diesel fuel as required by piping layout detailed on plans.
- K. Gate Valves shall be Wedge disc type, union bonnet, inside screw, rising stem, threaded ends, all- steel, Class 150.

- L. Check Valves shall be Bronze body, synthetic disc, swing check type, threaded ends, Class 150.
- M. Solenoid Valve shall be Electrically-operated, normally closed valve, laboratory listed and labeled for use in gasoline and diesel fuel systems as required on plans. Solenoid coil shall operate on 115-volt AC, 60 Hertz. Provide watertight enclosure for coil.
- N. Relief Valves shall be Laboratory listed and labeled, steel or bronze bodies, corrosion-resistant valve seats, and positive closing so that no leakage will occur.

0.25 STEAM HUMIDIFIER

- A. Humidifier shall be Vaporstream Electric Evaporative Steam Humidification System, or approved equal, with capacities as scheduled on the drawings, and accessories, controls and appurtancies as here in after specified. Tank and cover shall be 14- and 12-gauge 304-stainless steel with Heli-arc welded seams. Cover shall be Quick removable with threaded knobs and gasketed flanges. A factory-mounted and wired interlock safety switch shall de-energize the heaters when the heater cover is removed. Terminal strip shall be provided to allow all control wiring connections at the humidifier to be made in a single location. System shall have easily accessible cleanout plate with steam outlet(s) on top of tank cover to connect to hose, pipe or flange connection(s). Entire System shall be Installed per manufacturer's printed instructions and as indicated on drawings. Contractor shall coordinate electrical connections as required for a complete operational system.
- B. Immersion Heater(s) shall be Incoloy alloy-sheathed resistance type designed for no more than 86 watts per square inch. Two threaded ends of each heater element shall pass through the top of the evaporating chamber and be secured and sealed with washer and threaded nuts to evaporating chamber.
- C. A factory mounted Temperature sensor, with a temperature range of -40 to 248 °F shall be mounted on the humidifier to enable the following functions:
 - 1. Maintain the evaporating chamber water temperature above freezing
 - 2. Maintain a user-defined preset evaporating chamber water temperature
 - 3. Allow rapid warm-up of water in evaporating chamber after a call for humidity, providing 100% operation until steam production occurs
 - 4. Provide backup over-temperature protection for the over-temperature switch
- D. A factory-mounted and -wired UL-listed limit control sensor with manual reset shall sense an over-temperature condition and de-energize heater circuit controls.
- E. The humidifier shall be capable of generating steam from normal building water.
- F. An electric drain valve shall be mounted on humidifier assembly to allow tank to drain automatically at the end of a humidification season.
- G. Factory insulation: Humidifier shall be covered with 1"-thick (25 mm), rigid, foil-faced fiberglass insulation. All surfaces except front face panel and heater terminal cover shall have insulation.
- H. Humidifier shall have four painted angle-iron support legs that provide 24" (610 mm) minimum clearance between underside of humidifier and floor (not available for single-heater models).

- I. Time-proportioning (TP) modulation control: The humidifier shall cycle a single output on and off corresponding to an input demand signal. Demand signals may be 4 to 20 mA, 0 to 135 ohm, 0 to 10 VDC, or 6 to 9 VDC.
- J. Control cabinet: NEMA-12 control cabinet shall be factory mounted. An ETL/C-ETL listed control cabinet assembly comprising control devices shall be mounted on a subpanel. Control devices shall include a Vapor-logic3[®] microprocessor control system, a magnetic contactor for each heating stage, a control circuit transformer, a fuse set for each heating stage (for multiple heat stages only), a numbered terminal strip, and all interconnecting wiring. All wiring diagrams shall be included in the control cabinet.
- K. Vapor-logic3 microprocessor controller shall be interoperable with any LonTalk[®] network. The system shall, through the use of Standard Network Variable Types (SNVTs), allow communication with a LonTalk building automation system using the following inputs and outputs; Makeup water switch control and low water safety shutdown; Fully modulating (0% to 100%) control of humidifier outputs; PID control capability; Self-diagnostic test at start-up; Integral fault relay for remote signaling of alarms;
- L. A keypad, capable of either unit or remote mounting with a 5' (1.5 m) cable, and able to operate within a temperature range of 32 to 122 °F (0 to 50 °C); A keypad that provides text backlighting and allows personal password codes; and A keypad capable of monitoring and/or controlling the following parameters:
 - 1. Relative humidity (RH) set point and actual conditions in the space (from humidity transmitter)
 - 2. Relative humidity (RH) set point and actual conditions in the duct for variable air volume applications (from duct humidity transmitter)
 - 3. Relative humidity (RH) high limit set point and actual conditions
 - 4. Total system demand in % of humidifier capacity
 - 5. Total system output in lbs/hour (kg/h)
 - 6. Drain/flush frequency interval and duration
 - 7. End-of-season drain status (on standard water systems and if ordered as a DI water option)
 - 8. Window glass surface temperature (in % RH offset application and if ordered as an option)
 - 9. System alarms
 - 10. Previous fault messages
 - 11. Up to 20 humidifier functions, depending on programming
 - 12. Operating temperature
 - 13. User-adjustable water surface skim duration
 - 14. Water level control for softened or hard water:
- M. System shall provide for automatic refill, low water cutoff, field adjustable skimmer bleedoff functions and automatic drain-down of humidifier. System shall consist of:
 - 1. A water level sensing unit comprised of three metallic probes screwed into a threaded probe head. Probe head shall incorporate probe isolation chamber to eliminate short-circuiting between probes caused by mineral coating of probe head. Probe head shall be mounted on the humidifier assembly.
 - 2. A solenoid operated fill valve factory mounted on the humidifier assembly
 - 3. End-of-season drain
- N. Humidity transmitter, duct: Humidity transmitter shall be a duct-mounted device that measures from 0% to 100% RH range and provides a linear output (10% to 90% RH) from 4 to 20 mA. Accuracy $\pm 2\%$ RH. Supply voltage 21 VDC. Operating temperature range: -4 to 140 °F (-20 to 60 °C).

- O. Dew point transmitter: A dew point transmitter (duct- or room-mounted) shall measure the humidity and temperature in the environment and then compute the dew point. Output 4 to 20 mA (700 ohms maximum). Supply voltage 24 VDC. Operating temperature range when duct-mounted: -40 to 185 °F (-40 to 85 °C). Operating temperature range when room-mounted: 32 to 122 °F (0 to 50 °C).
- P. Cold snap offset transmitter: A window surface temperature transmitter, operating temperature range -20 to 160 °F (-29 to 71 °C), shall be provided for field installation. Transmitter shall supply its signal (4 to 20 mA) to the microprocessor control system, which shall lower the indoor RH set point to a level 5% or more below the dew point temperature during a cold spell, thus preventing window condensation. The indoor RH shall be automatically returned to the normal setting when the glass temperature rises.
- Q. Airflow proving switch, pressure type: Airflow proving switch shall be diaphragm-operated with pitot tube for field installation. Switch shall have an adjustable control point range of 0.05" to 12" wc (12.5 to 2988 Pa) Operating temperature range -40 to 180 °F (-40 to 82 °C). Compatible with 24, 120, and 240 VAC.
- R. Drane-kooler: A thermostatically controlled water valve shall meter an amount of cold water into a stainless steel mixing chamber to temper 212 °F (100 °C) water with a 6 gpm (0.38 l/s) in-flow rate to a 140 °F (60 °C) discharge temperature to sanitary system.
- S. The factory-assembled steam dispersion panel shall include the following components:
1. Steam supply header/separator
 2. Condensate collection header
 3. Closely-spaced stainless steel steam dispersion tubes spanning the distance between the two headers. Each dispersion tube shall be fitted with two rows of steam discharge tubelets inserted into the tube wall, centered on the diametric line, and spaced 1-1/2" (38 mm) apart. Each tubelet shall be made of a thermal-resin material designed for high steam temperatures. The two rows of tubelets in each dispersion tube shall discharge steam in diametrically opposite directions, perpendicular to airflow. Each tubelet shall extend through the wall of and into the center of the dispersion tube and contain a steam orifice sized for its required steam capacity.
- T. The humidifier shall provide absorption characteristics that preclude water accumulation on any in-duct surface within 6" of the humidifier tube panel while maintaining conditions of 85% maximum relative humidity at a minimum of 58°F in the duct airstream. Air pressure loss across the humidifier panel shall not exceed 0.377" water column at a duct air velocity of 2059fpm.
- U. Each packaged humidifier panel assembly of tubes and headers shall be contained within a 304 stainless steel casing to allow convenient duct mounting, or to facilitate the end-to-end mounting of multiple humidifier panels in ducts or air handler casings. When so designated, the humidifier panel shall be shipped unassembled. All tubes and headers shall be 304 stainless steel and be Heli-arc welded. Tubes shall be joined to headers with EPDM hose cuffs with nylon clamps.
- V. High-efficiency dispersion tubes shall be insulated with a plenum-approved insulating material for in-duct installation and have an R-value not less than 0.5 at a thickness not more than 0.125" (3.2 mm), for minimal increase in dispersion tube diameter.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All equipment and controls shall be installed in accordance with manufacturer's recommendations. Installation, adjustments and starting shall be done under supervision of manufacturer's representative.
 - B. All ductwork and equipment shall be installed in a neat and workmanlike manner in accordance with the guidelines of NFPA 90-A, SMACNA and the best practice of the trade.
 - C. Provide manual firestats, set at 125 degrees F, in return inlets of all fans and blowers and all exhaust fans of 600 cfm and over. SEE SECTION 15950 for additional requirements.
 - D. For requirements of the temperature control system SEE SECTION 15950. This Contractor shall furnish and install any and all mechanical items which are required to complete the temperature controls which are to be provided under other sections of the specifications. Read SECTION 15950 for requirements.
 - E. All piping as specified under this section shall be tested to the following pressures:

Chilled water	-	100 psi	
Condensate drain			- 10 psi
- The method of application of tests and duration shall be as described in SECTION 15050. Maximum of 5% pressure loss during the duration will be acceptable.
- F. Upon completion of the installation of all work and equipment the Contractor shall start all equipment and make all necessary tests and adjustments to place entire heating, ventilating and air conditioning systems in a satisfactory condition for continuous safe operation of facilities.
 - G. All filters shall be replaced with specified type after period of test and adjustment.

END OF SECTION

SECTION 15850

TESTING AND BALANCING OF AIR AND HYDRONIC SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The Contractor shall furnish all labor, equipment and services necessary for and incidental to Air and Water Systems Testing and Balancing.
- B. The Contractor shall procure the services of an independent testing and balancing agency. The Testing and Balancing Agency (TBA) specializes in testing and balancing of heating, ventilating, air-moving equipment, air-conditioning system and Hydronic systems. The Mechanical Contractor shall award the test and balance contract to the above agency as soon as possible after receipt of contract.
- C. Testing and Balancing shall not begin until the systems have been completed and are in full working order.
- D. Shop drawings must be provided to the TAB firm no later than 30 days after the final, approved shop drawings have been returned by the Architect to the Contractor.
- E. Duct leakage testing shall be the responsibility of the TBA subcontractor.
- F. Fire and smoke damper testing shall be done by the contractor and witnessed by the TAB firm.
- G. The final and complete Test and Balance Report shall be submitted, for approval, not less than two weeks before a final inspection of the Project is requested by the General Contractor. Failure to provide the Report shall be cause to delay the final inspection until the Report is Approved .
- H. Contractor is cautioned that test and Balance Report shall include both Grille counts, and Supply, Return, Outside Air and Exhaust Duct Traverses so that duct leakage can be calculated.

1.2 REFERENCES

- A. AABC - National Standards for Total System Balance.
- B. NEBB - Procedural Standards for Testing, Adjusting, and Balancing.

1.3 SUBMITTALS

- A. Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
- B. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect/Engineer and for inclusion in operating and maintenance manuals.
- C. Provide reports in soft cover, letter size, binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating, thermostat locations.

1.4 QUALITY ASSURANCE

Perform total system balance in accordance with AABC National Standards for Field Measurement and Instrumentation, Total System Balance or NEBB Standards - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems or Testing Adjusting and Balancing Bureau (TABB)-National Standards for Environmental Systems Balance.

1.5 QUALIFICATIONS

TBA shall be a Company specializing in the testing, adjusting, and balancing of systems specified in this Section with minimum three years experience.

PART 2 - PRODUCTS

2.1 ADJUSTMENT DEVICES

Replacement of adjustable pulleys, additional balancing dampers, additional fan belts, pressure taps and fitting, hydronic balancing valves and any other devices or equipment required to effect proper testing, adjusting and balancing shall be provided shall be provided by the Contractor at no additional cost to the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 - 1. Systems are started and operating in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.

4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Fans are rotating correctly.
7. Fire and volume dampers are in place and open.
8. Air coil fins are cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage is minimized.
12. Hydronic systems are flushed, filled, and vented.
13. Pumps are rotating correctly.
14. Proper strainer baskets are clean and in place.
15. Service and balance valves are open.

B. Beginning of work means acceptance of existing HVAC conditions.

3.2 INSTALLATION TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 5 percent of design for return and exhaust systems.
- B. Air Outlets and Inlets; Adjust total to within plus 5 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 5 percent of design.
- C. Hydronic Systems: Adjust to within plus or minus 5 percent of design.

3.3 ADJUSTING - GENERAL

- A. Ensure recorded data represents actual measured or observed conditions.
- B. Permanently mark setting of valves, dampers, and other adjustment devices allowing setting to be restored. Set and lock memory stops.
- C. After adjustment, take measurement to verify balance has not been disrupted or that such disruption has been rectified.
- D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- E. At the time of final inspection the TAB agency may be required to recheck, in the presence of the Owner's Representative, specific and random selections of data, air quantities, and air motion recorded in the certified report. Points and areas for recheck shall be selected by the Architect. Measurements and test procedures shall be the same

as approved for the initial work for the certified report. Selections for recheck, specific plus random, shall not exceed 10% of the total number tabulated in the report.

3.4 AIR SYSTEMS PROCEDURE (MINIMUM REQUIREMENTS)

- A. Test and adjust fan RPM to design requirements.
- B. Test and record motor full load nameplate rating and actual ampere draw.
- C. Test and record system static pressures, fan suction and discharge.
- D. Adjust all main supply and return air duct to proper design CFM.
- E. Test and adjust each diffuser, grille and register (new and existing as indicated on drawings). Reading and tests of diffusers, grilles and registers shall include design velocity (FPM) and as adjusted velocity, design CFM and adjusted CFM.
- F. Test and record outside, mixed air and discharge temperatures (D.B. for heating cycle, D.B. and W.B. for cooling cycle).
- G. In coordination with the ATC contractor, set adjustments of automatically operated dampers to operate as specified, indicated and/or noted.
- H. Test and adjust air handling and distribution systems to provide required or design supply, return, outside and exhaust air quantities.
- I. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- J. Measure air quantities at air inlets and outlets.
- K. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- L. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- M. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- N. Provide system schematic with required and actual air quantities recorded at each outlet or inlet
- O. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- P. Adjust outside air automatic dampers, outside air, return air and exhaust dampers for design conditions.

- Q. Measure temperature conditions across air, return air, and exhaust dampers to check leakage.
- R. Where modulating dampers are provided, take measurement and balance at extreme conditions.
- S. Measure and record pressure differentials between designated spaces.

3.5 WATER SYSTEM PROCEDURE (MINIMUM REQUIREMENTS)

- A. Prepare itemized equipment schedules, listing all heating and/or cooling elements and equipment in the systems to be balanced. List in order on equipment schedules, by pump or zone according to the design, all heating or cooling elements all zone balancing valves circuit pump and ending with the last items of equipment or transfer element in the respective zone or circuit. Include on schedule sheet column titles listing the location, type of element or apparatus, design conditions and measured conditions. Prepare individual pump report sheets for each zone or circuit.
- B. Adjust water systems (new and existing as indicated on drawings) to provide required or design quantities.
- C. Use calibrated Venturi tubes, orifices, or other metered fitting and pressure gages to determine flow rates for system balance. Where flow-metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- D. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- E. Effect system balance with automatic control valves fully open to heat transfer elements.
- F. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- G. Test pumps and adjust flow. Record the following on pumps report sheets: (a) suction and discharge pressure, (b) running amps and brake horsepower of pump motor under full flow and no flow conditions, (c) pressure drop across pump in feet of water and total GMP pump is handling under full flow conditions.
- H. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.6 REQUIRED REPORTS TO BE SUBMITTED

The following reports shall be submitted, as a minimum, with a complete Title Page, Summary, and Instrument List. All data and nomenclature shall be provided, as required by AABC and/or NEBB Procedure manuals, for each device tested and balanced.

1. Electric Motors.
2. V-Belt Motors.
3. VFD Drives.
4. Pump Data.
5. Heating and Cooling Coils Data.
6. Air Moving Equipment.
7. Return Air/ Outside Air Data.
8. Exhaust Air Data.
9. Duct Traverses.
10. Air Distribution Test Sheets.

3.7 COMMISSIONING

- A. Balancing Agency shall coordinate with the Mechanical Contractor the Commissioning requirements as here-in-before specified.
- B. Contractor is cautioned that the Owner, thru the Architect, reserves the right to check and verify any and all points and readings of the Test and Balance report. If 15% or more of the points do not agree with the report, then the Contractor shall re-test and re-balance the entire project and submit a complete new Report. If 15% or more of this new Data is independently verified and still does not agree with the Contractor's new Report, then the Owner has the right to hire an Independent Test and Balance Contractor and the Original Contractor shall be held responsible to pay these costs.
- C. All TAB deficiencies shall be corrected when found. Any deficiencies that are (for whatever reason) not corrected immediately shall be shown in the TAB report and listed on a summary sheet in the front of the TAB report. The TAB report must be completed and accepted by the Mechanical Engineer before the project is accepted and all items on the summary sheet shall become punch list items with dollar values assigned to them.

END OF SECTION

SECTION 15900

VALVES, STRAINERS, UNIONS AND FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

The work under this heading includes the furnishing and installing of all required appurtenances incidental to the piping systems as indicated on the drawings. Refer to BASIC MATERIALS AND METHODS SECTION which shall apply to all work in this Section.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide factory-fabricated valves for use in service indicated. Provide valves of types and pressure ratings indicated; provide proper selection to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is installer's option. Valves shall be of same make for all these services.
- B. Valves shall comply with the following:
 - Gate - cast iron - MSS SP-70
 - Gate - bronze - MSS SP-80
 - Globe - cast iron - MSS SP-85
 - Globe - bronze - MSS SP-80
 - Ball - MSS SP-110
 - Butterfly - MSS SP-67
 - Check - cast iron - MSS SP-71
 - Check - bronze - MSS SP-80
- C. Gate valves shall be equipped with packing suitable for intended service. (Under no circumstances is asbestos acceptable.) Valves shall be designed so back seating protects packing and stem threads from media when valve is fully opened, and equipped with gland follower. Guides for disc on rising stem valves shall be machined for accurate fit.
- D. Globe valves shall be equipped with packing suitable for intended service. (Under no circumstances is asbestos acceptable.) Globe valves shall be designed so back seating protects packing and stem threads from media when valve is fully opened, and equipped with gland follower.
- E. Ball valves shall have FULL port opening blow out proof stem: hard chrome plated forged brass ball, rated not less than 600# W.O.G. for sizes 3" or smaller.

- F. Provide gear operators on butterfly valves 8" and larger. Valve bodies shall have extended necks to provide for 2-1/4" insulation.
- G. Provide valves with features indicated and where not otherwise indicated, provide proper valve features as outlined in this specification. Comply with ANSI B31.1.
- H. Valve flanges shall comply to ANSI B16.1 (cast iron), ANSI B16.5(steel), ANSI B16.24 (bronze). Steel flanges shall be Class 150.
- I. Threaded valve ends shall comply with ANSI B2.1.
- J. Butt-Weld valve ends shall comply with ANSI B16.25.
- K. Solder Joint valve ends shall comply with ANSI B16.18.
- L. Flangeless valve bodies shall be manufactured to fit between flanges and shall comply with ANSI B16.1 (cast iron), ANSI B16.5 (steel), or ANSI B16.24 (bronze).
- M. Fabricate pressure-containing components of valves, including stems and seats from brass or bronze materials, of standard alloy recognized in valve manufacturing that resist de-zincification.
- N. Design seat of valve with removable disc, and assemble valve so disc can be replaced when worn.
- O. Butterfly valves shall be designed for flow regulation, and manufactured to be tight in closed position. Test pressures in accordance with MSS SP-67 as follows: Seat 2-12" 220psi. No leakage shall be permitted under test.

2.2 GLOBE VALVES FOR STEEL PIPING

- A. Threaded Ends 2" and Smaller: Class 125, bronze body, union bonnet, rising stem, Teflon disc: Nibco T-211-Y.
- B. Flanged Ends 2-1/2" and Larger: Class 125, iron body, bolted bonnet, rising stem, OS&Y, renewable seat and disc: Nibco F718-B.

2.3 GATE VALVES FOR STEEL PIPING

- A. Threaded Ends 2" and Smaller: Class 125, bronze body, union bonnet, rising stem, solid wedge: Nibco T-124.
- B. Flanged Ends 2-1/2" and Larger: Class 125, iron body, bronze mounted, bolted bonnet, rising stem, OS&Y, solid wedge: Nibco F617-0.

2.4 GLOBE VALVES FOR COPPER PIPING

- A. Soldered Ends 2" and Smaller: Class 125, bronze body, screwed bonnet, rising stem, bronze disc (swivel type): Nibco S211-B.
- B. Flanged Ends 2-1/2" and Larger: Class 125, iron body, bolted bonnet, rising stem, OS&Y, renewable seat and disc: Nibco F718-B. Provide dielectric gasket and bolt isolators.

2.5 GATE VALVE FOR COPPER PIPING

- A. Flanged Ends 2-1/2" and Larger: Class 125, iron body, bronze mounted, bolted bonnet, rising stem, OS&Y, solid wedge: Nibco F617-0.
Provide dielectric gasket and bolt isolators.
- B. Solder Ends 2" and Smaller: Class 125, bronze body, screwed bonnet, rising stem, solid wedge: Nibco S-111. (Non-rising stem gate valves may be used where headroom prevents full extension of rising stems: Nibco S-113.)

2.6 BALL VALVES

- A. Threaded Ends 3" and Smaller: 600# W.O.G., forged brass two piece body, hard chrome plated forged brass ball, blow-out proof stem: Nibco T-FP-600.
- B. Soldered Ends 2" and Smaller: 600# W.O.G., forged brass two piece body, hard chrome plated forged brass ball, true adjustable packing nut ("O"-ring only type stem seal not acceptable), blow-out proof stem: Nibco S-585-70.
- C. Flanged Ends 2-1/2" and larger: Class 150, flanged ends, carbon steel body with 316 s.s. trim, uni-body design, full port, blowout proof s.s. stem and ball, telfon seat: Nibco F-510-CS-R-66-FS.

2.7 BUTTERFLY VALVES

- A. For chilled/hot water system provide lug type with rated working pressure of 200 psi on sizes 2" thru 12". Valve shall be cast iron, drilled and tapped bug body, lever operated, 10 position throttling handle, memory plate, type 410 stainless steel stem with EPDM seat.
- B. Manufacturer shall be Nibco LD-2000.

2.8 SWING CHECK VALVE IN COPPER PIPING

- A. Soldered Ends 2" and Smaller: Class 125, bronze body, screwed cap, "Y" pattern swing, bronze disc: Nibco S-413B.
- B. Flanged Ends 2-1/2" and Larger: Class 125, iron body, bronze mounted, horizontal swing, cast-iron disc: Nibco F918-B. Provide dielectric gasket with insulated bolts.

2.9 SWING CHECK VALVES IN STEEL PIPING

- A. Threaded Ends 2" and Smaller: Class 125, bronze body, screwed cap, "Y" pattern swing, Teflon disc: Nibco T-413Y.
- B. Flanged Ends 2-1/2" and Larger: Class 125, iron, bronze mounted, horizontal swing, cast-iron disc: Nibco F918-B.

2.10 UNIONS IN COPPER LINES

Cast Bronze Unions.

2.11 UNIONS IN BLACK STEEL, WROUGHT IRON OR GALVANIZED STEEL PIPING

Ground joint malleable iron galvanized Class 300 for 2" nominal pipe sizes or below. For pipe sizes 2-1/2" and larger use forged steel welding flanges (Galvanized for galvanized piping).

2.12 UNIONS IN CONNECTION BETWEEN COPPER AND STEEL OR IRON PIPING

Provide bronze valves or Victaulic dielectric waterways.

2.13 BALANCING COCKS (SERVICES UNDER 200 DEGREES F)

Nibco T/S1710.

2.14 STRAINERS

Through 2-1/2" Metraflex Style S - Screwed; Zurn Model YSBR 20 mesh monel screen through 2"; .045 stainless steel on 2-1/2"; Strainers on 3" and above Metraflex Style M1 - flanged; Zurn Model FS 3" to have .045 mesh, ss screws; 3-1/2" and above .125 mesh, ss screws.

2.15 GAGE COCK

Crane No. 744, or Weiss TC-14, all bronze.

2.16 AIR VENT

Automatic air vents where indicated on drawings shall be Bell & Gossett No. 7, or Taco 417, with copper discharge line piped to closet floor drain.

2.17 MANUAL AIR VENTS

Where installed shall be Crane No. 744, or Weiss TC-14, with 1/4" tap into line to be vented.

2.18 GAUGES

Furnish and install where shown on the plans or where good practice required, pressure gauges with 4-1/2 glass dial face, corrosion resistant stainless steel case and ring, balanced adjustable black pointer guaranteed accurate to 1% of range, easy read dial - white background with bold black numerals and graduations, 270 degree ARG, 1/4" N.P.T. bottom connection.

2.19 THERMOMETERS

Shall be Adjustable Angle type with 9" case, lens front reading mercury tube, with angle satin finish aluminum scales, bold black numerals, bold scale graduations, thick glass windows, and die cast aluminum case with baked bronze finish. Thermometer shall rotate 180 degrees and stem swivels 180 degrees in 10 degree increments separable wells to suit insulation. For chilled water 20 degrees to 120 degrees. For hot water 30 degrees to 240 degrees.

2.20 T.A.P. PLUGS

Furnish where shown on plans or where good practice requires 1/2" IPS plug. The Contractor shall leave with the Owner one kit consisting of (1) 1/8" thermometer, (1) pressure gauge and (1) gauge adaptor, 1/8" diameter with stainless steel probe, 1/4" FPT gauge connection.

2.21 AUTOMATIC FLOW CONTROL VALVES

- A. Furnish and install where shown on the plans automatic flow control valves (FCV). Valves shall be sized based on minimum pressure loss as recommended by manufacturer. Contractor shall submit schedule of values showing flow and operational pressure drop for approval prior to ordering and/or installation.
- B. Flow control valves shall automatically control flow rates with plus or minus 5% accuracy. Valve control mechanism shall consist of a stainless steel cartridge with a ported cup and coil/helical spring to avoid corrosion. Four operating ranges shall be available with the minimum range requiring less than 2 PSID to actuate the mechanism. Manufacturer shall provide independent laboratory tests verifying accuracy of performance. All FCVs shall be of one manufacturer and conform to the above specifications.

2.22 BALANCING VALVES

Valves 1/2" to 2" pipe size (NPT or Sweat) to be of dezincification brass or bronze construction. Valves 2-1/2" to 12" pipe size shall be cast iron for flanged models or ductile

iron for grooved models. Valves shall be globe type rated 175 psi for iron and 240 psi for brass/bronze at 250 degrees F. Valves to have concealed memory stop feature and visual position readout. Each valve shall have two metering/test ports with internal check valves and protective caps. Valves to be leak-tight at full rated working pressure. All valves to be provided with molded insulation to permit access for balance and read-out. Nibco model T or S1710 (1/2" to 2"), F or G737 (2-1/2" to 12").

2.23 GASKETS

Material shall be of compressed sheet suitable for the operating conditions. Group 1a or 1b as listed in ASTM B16.5.

2.24 BOLTS AND NUTS

Bolts shall conform to ASTM A193/A193M Rev B, Grade B7, nuts shall conform to ASTM A194/A194M Rev A, Grade 2H.

PART 3 - EXECUTION

3.1 WORKMANSHIP AND INCIDENTAL ITEMS

- A. All valves shall be installed so as to be easily accessible for cleaning, inspection, maintenance, and operation.
- B. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward for horizontal plane unless unavoidable. Provide chain operators on all valves over 6' above floor in mechanical rooms.
- C. Except as otherwise indicated, install valves with the following ends or types of pipe/tube connections:
 - Tube Size 2" and smaller - Soldered-joint valves
 - Pipe Size 2" and smaller - Threaded valves
 - Pipe Size 2-1/2" and larger - Flanged end valves
- D. Install swing check valves in horizontal position, unless otherwise shown on drawings, with hinge pin horizontally perpendicular to centerline of pipe. Install for proper direction of flow.
- E. Provide access panels at all concealed valves.
- F. Major control and sectionalizing valves throughout building shall be identified by means of a brass valve tag bracketed to valve handle. Contractor shall prepare schedule of such identifying plates and frame under glass for installation in main equipment room.
- G. All welded piping to be welded by certified welders skilled in the work to be done.

- H. No piping of dissimilar metals placed in contact or in close proximity with each other. Provide bronze valves wherever piping of dissimilar metals is joined.
- I. Run all piping concealed unless specifically noted otherwise, making all necessary offsets, turns, etc., necessary to conceal piping from view.
- J. Provide all necessary steel frame supports, anchor bolts, sleeves, etc., required for safe support of equipment and piping installed under this contract. The Mechanical Contractor shall be completely responsible for the accurate position and dimensions of all foundations and support items.

END OF SECTION

SECTION 15950

BUILDING TEMPERATURE CONTROL AND ENERGY MANAGEMENT SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS: Refer to Section 15010 - BASIC MECHANICAL

1.2 SCOPE

- A. Furnish and install a complete system of electric, electronic, and direct digital temperature controls as necessary to accomplish the sequences as specified. The control manufacturer shall be TAC I/A Series or approved equal. Other manufacturers wishing to submit bids must have experience in other 911 Emergency Facilities in the local area. A list of current local 911 Emergency Operations Facilities projects with project descriptions and contact names shall be submitted for review. Also, a detailed description including data sheets, hardware and software capabilities, hardware and software specifications, and control diagrams shall be submitted for review. Manufacturers granted approval to bid will be listed in an addendum at least seven days prior to bid.
- B. The temperature controls shall include electrical interlocking of motor starters and other equipment, which is supplied as part of the heating, ventilation, and air conditioning system.
- C. Individual components of the system shall be electric/electronic. The control system shall consist of all thermostats, temperature transmitters, controllers, automatic valves and dampers, damper operators, control panels, relays, accessory control equipment, and a complete system of electric wiring to fill the intent of the specification and provide for a complete operable system.
- D. Workmen regularly employed by the approved control manufacturers listed herein shall install the control system. No other workmen to install the control system will be approved. The system shall be guaranteed free of defects in workmanship and material for a period of one (1) year. The control supplier shall furnish complete control drawings, showing the operation of the air conditioning and mechanical control system.
- E. Submit ten (10) copies of manufacturers' drawings to the Architect Engineer for all equipment and controls. Drawings shall include detailed dimensions, capacities.
- F. The control contractor shall be an established firm engaged in the design and installation of temperature control systems similar to that specified herein for the last ten (10) years.

- G. Control contractor shall calibrate and verify proper operation of all control devices before the Architect will accept control system.

PART 2 - PRODUCTS

2.1 ELECTRICAL

- A. The Electrical Division (16000) shall provide all power wiring to the starters and from the starters to the motors.
- B. All connection into the power circuit shall be done by the electrical.
- C. The electrical work included in this section includes furnishing, installing, and wiring the temperature control devices as necessary to comply with the sequence of operation.
- D. All wiring shall be new and done in accordance with all governing codes. The maximum allowable control and interlocking voltage shall be 120 volts. All 120 volt wiring shall be installed in electrical raceways in accordance with requirements of Division 16000. All wiring in Mechanical Equipment Rooms shall be installed in electrical raceways. All exposed conduits shall be run parallel to the lines of the building.

2.2 AUTOMATIC CONTROL DAMPERS

- A. Automatic control dampers shall be opposed blade type with sizes as indicated on the plans. All damper blades shall not be less than 16 gauge galvanized steel roll formed for high velocity performance. Blades on all dampers must not be over 8" wide. All blade linkage hardware shall be of corrosive resistant finish and readily accessible for maintenance after installation. Dampers shall have minimum leakage rate of 1% for all applications.

2.3 DUCT SMOKE DETECTORS

- A. Shall be of the dual ionization chamber type and shall be installed in the return air stream of every air handling system over 2000 CFM. The smoke detectors shall be interlocked to stop air handler when the presence of smoke is detected. Where smoke detectors are provided, high limits may be eliminated. Smoke detectors and installation shall conform to U.L. 268, NFPA 90A, and the NEC. Smoke detectors are to be furnished and installed by the Fire Alarm Contractor. The Fire Alarm Contractor shall furnish and install a fire alarm module near each starter. This contractor shall wire from the fire alarm module into the safety shutdown circuit as required.

2.4 DIFFERENTIAL PRESSURE SWITCHES

- A. Unit for fluid flow proof shall be JCI P74, United Electric J.Series, or equal.

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

- B. Unit for air flow proof shall be P32, Robertshaw PC-301, or equal.

Set point ranges	.05" WG to 1.0" WG
	1.0" WG to 12.0" WG

2.5 THERMOSTATS

- A. Room and duct thermostats for control of line voltage devices shall be of the snap-acting type with contacts rated for applied service. On-off differential shall not exceed 2 degrees F., except where required by the sequence of operation.

2.6 CONTROL VALVES

- A. All modulating straight-through water valves shall be provided with equal percentage contoured throttling plugs. All three-way valves shall be provided with linear throttling plugs such that the total flow through the valve shall remain constant regardless of valve's position.
- B. Valves 3" and smaller shall be screwed type; valves 4" and larger shall be flanged type. Valves shall be factory-rated to withstand the pressures encountered. Valves shall have stainless steel stems and spring-loaded teflon packing.
- C. Water valves shall be sized for a pressure drop equal to the coil they serve, but not to exceed 10 feet. Valves shall have replacement seats and discs.
- D. Where two or more actuators are to be operated simultaneously or sequentially with each other, provide sequencing devices for accuracy and non-overlapping operation.
- E. Control valve pressure drop shall be no greater than 10 feet in the full open position. Provide adjustable valve stem stops to insure this actual pressure drop when the valve actuator is fully extended.

2.7 VALVE AND DAMPER ACTUATORS

- A. Units shall be quiet in operation and shall be sized to operate the control devices to which they are connected.

- B. In two position applications, in the event of a power failure, operator shall be provided with spring return so it will "fail safe" in either the normally open or closed position as required per the application.
- C. In modulating applications, the actuator shall accept a 4-20ma, 0-10Vdc, or floating input as required per the application.

2.8 TEMPERATURE SENSORS

- A. Temperature accuracy shall be as herein specified. Three (3) or four (4) wire shielded shall be utilized for all temperature sensing to reduce electrical noise. Thermistor temperature sensors are not approved for any application.

2.9 SPACE TEMPERATURE

- A. Sensors shall be RTDs or solid state devices with a temperature range 20 to 120 degrees F. The sensor shall be complete with a decorative cover and suitable for mounting at any angle over a standard electrical utility box.
- B.
 - The ILC Sensor shall connect directly to the ILC and shall not utilize any of the I/O points of the controller. The ILC Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive. The ILC Sensor shall provide a communications jack for connection to the LON communication trunk to which the ILC controller is connected. The ILC Sensor, the Connected controller, and all other devices on the LON bus shall be accessible by the Graphical Programming tool. The ILC Sensor shall be supplied in the following variations;
 - Tamper-resistant (no display)
 - Tamper-resistant with tenant override
 - Basic user functions (LCD display and setpoint adjustment and tenant override)
 - Full user functions (LCD display and network-variable access and tenant override)
 - ASHRAE 95 compliance (LCD display and sub-base functionality)
- C. The ILC Sensor shall be provided in a modular configuration that allows for the rough in of all wiring without the presence of the electronics or esthetic covering. The ILC Sensor shall allow for the customization of the color on the esthetic covering as a standard offering. User interface with the ILC Sensor shall be provided as a configurable function by the FMCS, and shall offer password protection for access to network variable editing. Multiple network variables shall be accessible and editable by the ILC Sensor. Icons shall be utilized to represent sensor and controller function status, affording independence from a single language for use interface

2.10 DUCT TEMPERATURE

- A. Sensors shall be insertion measuring probe 18 inches long with a temperature range of 20 to 120 degrees F. The sensor shall include a utility box gasket to prevent air leakage and vibration noise. For all mixed air and preheat air applications, install bendable averaging duct sensors with a minimum 12 feet long sensor element.

2.11 LIQUID IMMERSION TEMPERATURE

- A. Sensors shall be RD devices for all hot and chilled water temperature applications. The temperature range shall be 32 to 212 degrees F. Provide brass thermowells and install sensor probe with heat conductive grease. Probe and sensor head shall be removable without breaking fluid seal. In-install sensors in top of pipe for horizontal runs and at a positive slope on vertical runs to prevent condensation from flowing to sensor head.

2.12 OUTSIDE AIR TEMPERATURE

- A. Sensor shall be RTD or solid state device mounted in the outdoors where airflow occurs. The temperature range shall be -20 to 180 degrees F. Provide a sun shield and weatherproof assembly for mounting to ½ inch rigid conduit.

2.13 LOCAL CONTROL CABINETS

- A. A control cabinet shall be provided in each mechanical room which will contain all pressure-electric switches, receiver-controller, high-low pressure selectors, temperature and pressure indication, etc. as described under PART 3 - EXECUTION.
- B. This panel shall be constructed of extruded aluminum alloy frames with all corners securely riveted and supported by angle brackets. The panel is to have removable face and back panels that are to be made of aluminum bonnet on both sides over a plywood core. The panel door is to be supported by a non-removable piano-type hinge that spans the entire height of the panel. A keylocking latch is to be provided on all panels to insure only authorized access.

2.14 NETWORK

- A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system. The FMCS requires the incorporation of LonWorks Technologies using Free Topology Transceivers (FTT-10), and specific conformance to the LONMARK Interoperability Association's v3.0 Physical and logical Layer guidelines in all unitary, terminal unit and other devices.
- B. The FMCS shall provide a standard available test kit for development of additional interfaces by others, in addition to the FMCS manufacturer.

2.15 NETWORK AREA CONTROLLER (NAC)

- A. The Network Area Controller (NAC) shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NAC. It shall be capable of executing application control programs to provide:
 - 1. Calendar functions
 - 2. Scheduling
 - 3. Trending
 - 4. Alarm monitoring and routing
 - 5. Time synchronization
 - 6. Integration of LonWorks controller data and BACnet controller data
 - 7. Network Management functions for all LonWorks based devices

- B. The Network Area Controller must provide the following hardware features as a minimum:
 - 1. One Ethernet Port - 10Mbps
 - 2. One RS-232 port
 - 3. One LonWorks Interface Port - 78KB FTT - 10A
 - 4. Battery Backup
 - 5. Flash memory for long term data backup (If battery or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity)
 - 6. The NAC must be capable of operation over a temperature range of 0 to 55C
 - 7. The NAC must be capable of withstanding storage temperatures of between 0 and 70C
 - 8. The NAC must be capable of operation over a humidity range of 5 to 95% RH, non-condensing
 - 9. The NAC shall provide multiple user access to the system and support for ODBC or SQL. A database resident on the NAC shall be an ODBC-compliant database or must provide an ODBC data mechanism to read and write data stored within it.
 - 10. The NAC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 16 simultaneous users.

- C. Event Alarm Notification and actions:
 - 1. The NAC shall provide alarm recognition, storage, routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.

2. The NAC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up telephone connection, or wide-area network.
 3. Alarm generation shall be selectable for annunciation type and acknowledgment requirements including but limited to:
 - a. To alarm
 - b. Return to normal
 - c. To fault
 4. Provide for the creation of a minimum of eight alarm classes for the purpose of routing types and/or classes of alarms, i.e: security, HVAC, Fire, etc.
 5. Provide timed (schedule) routing of alarms by class, object, group, or node.
 6. Provide alarm generation from binary object "runtime" and/or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.
 7. Control equipment and network failures shall be treated as alarms and annunciated.
- D. Alarms shall be annunciated in any of the following manners as defined by the user:
1. Screen message text
 2. Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:
 - a. Day of week
 - b. Time of day
 - c. Recipient
 3. Pagers via paging services that initiate a page on receipt of email message
 4. Graphic with flashing alarm object(s)
 5. Printed message, routed directly to a dedicated alarm printer
- E. The following shall be recorded by the NAC for each alarm (at a minimum):
1. Time and date
 2. Location (building, floor, zone, office number, etc.)
 3. Equipment (air handler#, accessway, etc.)
 4. Acknowledgment time, date and user who issued acknowledgment.
 5. Number of occurrences since last acknowledgment.
- F. Alarm actions may be initiated by user defined programmable objects created for that purpose.

- G. Defined users shall be given proper access to acknowledgment any alarm, or specific types or classes of alarms defined by the user.
- H. A log of all alarms shall be maintained by the NAC and/or a server (if configured in the system) and shall be available for review by the user.
- I. Provide a "query" feature to allow review of specific alarms by user defined parameters.
- J. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.
- K. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

2.16 DATA COLLECTION AND STORAGE

- A. The NAC shall have the ability to collect data for any property of any object and store this data for future use.
- B. The data collection shall be performed by log objects, resident in the NAC that shall have, at a minimum, the following configurable properties:
 - 1. Designating the log as interval or deviation.
 - 2. For interval logs, the object shall be configured for the time of day, day of week and the sample collection interval.
 - 3. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
 - 4. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
 - 5. Each log shall have the ability to have its data cleared on a timed-based event or by a user-defined event or action.
- C. All log data shall be stored in a relational database in the NAC and the data shall be accessed from a server (if the system is so configured) or a standard Web Browser.
- D. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.
- E. All log data shall be available to the user in the following data formats:
 - 1. HTML
 - 2. XML
 - 3. Plain Text
 - 4. Comma or tab separated values

- F. Systems that do not provide log data in HTML and XML formats at a minimum shall not be acceptable.
- G. The NAC shall have the ability to archive its log data either locally (to itself), or remotely to a server or other NAC on the network. Provide the ability to configure the following archiving properties, at a minimum:
 - 1. Archive on time of day
 - 2. Archive on user-defined number of data stores in the log (buffer size)
 - 3. Archive when log has reached it's user-defined capacity of data stores
 - 4. Provide ability to clear logs once archived.

2.17 DATABASE BACKUP AND STORAGE

- A. The NAC shall have the ability to automatically backup its database. The database shall be backed up based on a user defined time interval.
- B. Copies of the current database and, at the most recently saved database shall be stored in the NAC. The age of the most recently saved database is dependent on the user-defined database save interval.
- C. The NAC database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.

2.18 GRAPHICAL USER INTERFACE SOFTWARE

- A. Operating System:
 - 1. The GUI shall run on Microsoft Windows NT Workstation 4.0, Service Pack 4 or later.
- B. The GUI shall employ browser-like functionality for ease of navigation. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu-pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and basic computing skills. These shall include, but are limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification.
- C. Real-Time Displays. The GUI shall at a minimum, support the following graphical features and functions:
 - 1. Graphic screens shall be developed using any drawing package capable of generating a GIF, BMP, or JPG file format. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of a graphical background, the GUI shall support the use of scanned pictures.
 - 2. Graphic screens shall have the capability to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document

- links, schedule objects, hyperlinks to other URL's, and links to other graphic screens.
3. Graphics shall support layering and each graphic object shall be configurable for assignment to one a layer. A minimum of six layers shall be supported.
 4. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
 - a. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
 - b. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
 5. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
 6. Adjustments to analog objects, such as set points, shall be done by right-clicking the selected object and using a graphical slider to adjust the value. No entry of text shall be required.
- D. System Configuration. At a minimum, the GUI shall permit the operator to perform the following tasks, with proper password access:
1. Create, delete or modify control strategies.
 2. Add/delete objects to the system.
 3. Tune control loops through the adjustment of control loop parameters.
 4. Enable or disable control strategies.
 5. Generate hard copy records or control strategies on a printer.
 6. Select points to be alarmable and define the alarm state.
 7. Select points to be trended over a period of time and initiate the recording of values automatically.
- E. On-Line Help. Provide a context sensitive, on-line system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext. All system documentation and help files shall be in HTML format.
- F. Security. Each operator shall be required to logon to that system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system administrator shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.
- G. System Diagnostics. The system shall monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.

H. Alarm Console

1. The system will be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm. The use of the Alarm Console can be enabled or disabled by the system administrator.
2. When the Alarm Console is enabled, a separate alarm notification window will supersede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and un-acknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.

2.19 WEB BROWSER CLIENTS

- A. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer or Netscape Navigator. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable.
- B. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the FMCS, shall not be acceptable
- C. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology by the Graphical User Interface. Systems that require different views or that require means of interfacing with objects such as schedules, or logs, shall not be permitted.
- D. The Web browser client shall support at a minimum, the following functions:
 1. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
 2. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.
 3. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.

4. Storage of the graphical screens shall be in the Network Area Controller (NACS), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
5. Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page.
6. User's shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
 - a. Modify common application objects, such as schedules, calendars, and set points in a graphical manner.
 - i. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
 - ii. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
 - b. Commands to start and stop binary objects shall be done by right-clicking the selecting the appropriate command from the pop-up menu. No entry of text shall be required.
 - c. View logs and charts.
 - d. View and acknowledge alarms.
 - e. Setup and execute SQL queries on log and archive information.
7. The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
8. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

2.20 SYSTEM PROGRAMMING

- A. The Graphical User Interface software (GUI) shall provide the ability to perform system programming and graphic display engineering as part of a complete software package. Access to the programming functions and features of the GUI shall be through access as assigned by the system administrator.
- B. A library of control, application, and graphic objects shall be provided to enable the creation of all applications and interface screens. Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the

screen, and linking them together using a built in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property may be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface displays shall not be acceptable.

C. Programming Methods

1. Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user's application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, or one-to-one relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in color depending on the type of link; i.e., internal, external, hardware, etc.
2. Configuration of each object will be done through the object's property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.
3. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.
4. All programming shall be done in real-time . Systems requiring the uploading, editing and downloading of database objects shall not be allowed.
5. The system shall support object duplication within a customer's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

2.21 LONWORKS NETWORK MANAGEMENT

- A. The Graphical User Interface software (GUI) shall provide a complete set of integrated LonWorks network management tools for working with LonWorks networks. These tools shall manage a database for all LonWorks devices by type and revision, and shall provide a software mechanism for identifying each device on the network. These tools shall also be capable of defining network data connections between LonWorks devices, known as "binding". Systems requiring the use of third party LonWorks network management tools shall not be accepted.
- B. Network management shall include the following services: device identification, device installation, device configuration, device diagnostics, device maintenance and network variable binding.

- C. The Network configuration tool shall also provide diagnostics to identify devices on the network, to reset devices, and to view health and status counters within devices.
- D. These tools shall provide the ability to “learn” an existing LonWorks network, regardless of what network management tool(s) were used to install the existing LonWorks devices and newly added devices are part of a single network management database.
- E. The network management database shall be resident in the Network Area Controller (NACS), ensuring that anyone with proper authorization has access to the network management database at all times. Systems employing network management databases that are not resident, at all times, within the control system, shall not be accepted.

2.22 OBJECT LIBRARIES

- A. A standard library of objects shall be included for development and setup of application logic, user interface displays, system services, and communication networks.
- B. The objects in this library shall be capable of being copied and pasted into the user’s database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.
- C. In addition to the standard libraries specified here, the supplier of the system shall maintain an on-line accessible (over the Internet) library, available to all registered users to provide new or updated objects and applications as they are developed.
- D. All control objects shall conform to the control objects specified in the BACnet specification.
- E. The library shall include applications or objects for the following functions, at a minimum:
 - 1. Scheduling Object. The schedule must conform to the schedule object as defined in the BACnet specification, providing 7-day plus holiday and temporary scheduling features and a minimum of 10 on/off events per day. Data entry to be by graphical sliders to speed creation and selection of on/off events.
 - 2. Calendar Object. The calendar must conform to the calendar object as defined in the BACnet specification, providing 12-month calendar features to allow for holiday or special event data entry. Data entry to be by graphical “point-and-click” selection. This object must be “linkable” to any or all scheduling objects for effective event control.

3. **Duty Cycling Object.** Provide a universal duty cycle object to allow repetitive on/off time control of equipment as an energy conserving measure. Any number of these objects may be created to control equipment at varying intervals.
 4. **Temperature Override Object.** Provide a temperature override that is capable of overriding equipment turned off by other energy saving programs (scheduling, duty cycling etc.) To maintain occupant comfort or for equipment freeze protection.
 5. **Start-Stop Optimization Object.** Provide a start-stop time optimization object to provide the capability of starting equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled un-occupancy time just far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of all start-stop time object properties based on the previous day's performance.
 6. **Demand Limiting Object.** Provide a comprehensive demand-limiting object that is capable of controlling demand for any selected energy utility (electric, oil, and gas). The object shall provide the capability of monitoring a demand value and predicting (by use of a sliding window prediction algorithm) the demand at the end of the user defined interval period (1-60 minutes). This object shall also accommodate a utility meter time sync pulse for fixed interval demand control. Upon a prediction that will exceed the user defined demand limit (supply a minimum of 6 per day), the demand limiting object shall issue shed commands to either turn off user specified loads or modify equipment set points to effect the desired energy reduction. If the list of sheddable equipment is not enough to reduce the demand to below the set point, a message shall be displayed on the users screen (as an alarm) instructing the user to take manual actions to maintain the desired demand. The shed lists are specified by the user and shall be selectable to be shed in either a fixed or rotating order to control which equipment is shed the most often. Upon suitable reductions in demand, the demand-limiting object shall restore the equipment that was shed in the reverse order in which it was shed. Each sheddable object shall have a minimum and maximum shed time property to effect both equipment protection and occupant comfort.
- F. The object library shall include objects to support the integration of devices connected to the Network Area Controller (NACS). At a minimum, provide the following as part of the standard library included with the programming software:
1. **LonMark/LonWorks devices.** These devices shall include, but not be limited to , devices for control of lighting, access, and metering. Provide LonMark manufacturer-specific objects to facilitate simple integration of these devices. All network variables defined in the LonMark profile shall be supported. Information (type and function) regarding network variables not defined in the LonMark profile shall be provided by the device manufacturer.

2. For devices not conforming to the LonMark standard, provide a dynamic object that can be assigned to the device based on network variable information provided by the device manufacturer. Device manufacturer shall provide an XIF file and documentation for the device to facilitate device integration.

2.23 GRAPHICAL USER INTERFACE COMPUTER HARDWARE (DESKTOP)

- A. The computer shall be an Intel Pentium based computer (minimum processing speed of 400 Mhz with 256 MB RAM and a 10-gigabyte minimum hard drive). It shall include a 32X CD-RW drive, 3.5" floppy drive, 2-parallel ports, 2-asynchronous serial ports and 2-USB ports. A minimum 17" 28-dot pitch SVGA (1024 x 768) color monitor with a minimum 80 Hz refresh rate shall also be included.
- B. The operating system shall be Microsoft Windows XP Professional . Include Microsoft Internet Explorer 4.0 or later or Netscape Navigator 4.5 or later.
- C. Connection to the FMCS network shall be via an Ethernet network interface card, 10 Mbps.
- D. A system printer shall be provided. Printer shall be laser type with a minimum 600 x 600-dpi resolution and rated for 8-PPM print speed minimum.

2.21 INTEROPERABLE LonMARK CONTROLLERS (ILC)

A. GENERAL

1. Controls shall be microprocessor based Interoperable LonMark Controllers (ILC), bearing the applicable LonMark interoperability logo on each product delivered. ILC's shall be provided for AHU's, Fan Coils, VAV Terminal Boxes and other applications as shown on the drawings. ILC's shall be based on the Echelon Neuron 3150 microprocessor working from software program memory which is physically located in the ILC. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals.
2. To simplify controls and mechanical service troubleshooting, the ILC shall be mounted directly in the control compartment of the unitary system. The ILC shall be provided with a sheet metal or polymeric enclosure that is constructed of material allowing for the direct mounting within the primary air stream, as defined by UL-465. The direct mounting shall allow all controls maintenance and troubleshooting to be made while at the unitary equipment.
3. The ILC's shall communicate with the SDC at a baud rate of not less than 78.8K baud. The ILC shall provide LED indication of communication and controller performance to the technician without cover removal.

4. The ILC's shall be fully supported and communicate with any and all GUI(s) on the bus.

B. ILC SENSOR

1. The ILC Sensor shall connect directly to the ILC and shall not utilize any of the I/O points of the controller. The ILC Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive. The ILC Sensor shall provide a communications jack for connection to the LON communication trunk to which the ILC controller is connected. The ILC Sensor, the Connected controller, and all other devices on the LON bus shall be accessible by the Graphical Programming tool.
2. The ILC Sensor shall be supplied in the following variations;
3. Tamper-resistant (no display)
4. Tamper-resistant with tenant override
5. Basic user functions (LCD display and setpoint adjustment and tenant override)
6. Full user functions (LCD display and network-variable access and tenant override)
7. ASHRAE 95 compliance (LCD display and sub-base functionality)
8. The ILC Sensor shall be provided in a modular configuration that allows for the rough in of all wiring without the presence of the electronics or esthetic covering. The ILC Sensor shall allow for the customization of the color on the esthetic covering as a standard offering. User interface with the ILC Sensor shall be provided as a configurable function by the FMCS, and shall offer password protection for access to network variable editing. Multiple network variables shall be accessible and editable by the ILC Sensor. Icons shall be utilized to represent sensor and controller function status, affording independence from a single language for use interface.

C. ILC FUNCTIONALITY

1. The ILC shall provide a -40 to 140 degree F ambient operating temperature range. The ILC shall be provided in a modular configuration that allows for the rough in of all wiring without the presence of any of the ILC electronics. ILC devices that require the electronics to be present at the time of wiring, will require an additional controller to be provided for every 10 devices on the drawings, to allow for the preconfiguration and storing for service purposes.
2. All input/output signals shall be directly hardwired to the ILC. For all-non-VAV terminal applications, a minimum of two input points of the ILC shall employ a universal configuration that allows for flexibility in application ranging from dry

contact, resistive, to voltage/current sourced inputs. If universal points are not available, a minimum of two input points (each) of the dry contact, resistive and analog voltage/current types must be provided on every controller. The outputs of the ILC shall be of the relay and type. ILC devices utilizing non-relay outputs shall provide an interface relay for all points. All analog outputs shall be programmable for their start points and span to accommodate the control devices. Configuration of all I/O points shall be accomplished without physical hardware jumpers, switches or settings. Troubleshooting of input/output signals shall be easily executed with the Graphical Programming tool (GP) or a volt-ohm meter (VOM). All I/O points shall be utilized by the local ILC or shall be available as I/O points for other controllers throughout the network.

3. All ILC's shall be fully application programmable and shall at all times maintain their LonMark certification. Controllers offering application selection only (non-programmable), require a 10% spare point capacity to be provided for all applications. All control sequences within or programmed into the ILC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.
4. The ILC shall be provided with the ability to interface with the Graphical Programming tool. The interface port shall be provided at the wall sensor or within the unitary equipment, as specified on the plans. The interface port shall allow the GP to have full functionality as described in GP section of this specification. Through the connected controller all ILC device son the LON bus shall be accessible by the Graphical Programming tool.

D. ILC - VAV CONTROLLER FUNCTIONALITY

1. Controls shall be microprocessor based Pressure Independent Variable Air Volume Digital Controllers, as shown in the drawings. The VAV ILC shall be a single integrated package consisting of a microprocessor, power supply, damper actuator, differential pressure transducer, field terminations, and application software. An alternate model shall be offered that allows for direct connectivity to an external actuator for those applications that employ a non-butterfly style damper configuration. All input/output signals shall be directly hardwired to the VAV ILC controller. The internal actuator shall employ a manual override that allows for powered or non-powered adjustment of the damper position. In al cases, the controller shall automatically resume proper operation following the return of power to, or control by the ILC. Programming, configuring and/or troubleshooting of input/output signals shall be easily executed through the ILC sensor or GP tool connected at the wall sensor location.
2. The VAV ILC control algorithms shall be designed to limit the frequency of damper repositioning, to assure a minimum 10-year life from all components. The VAV ILC shall provide internal differential pressure transducer for pressure independent applications with an accuracy of 5%. Flows through transducers requiring filter

maintenance are not acceptable. The VAV ILC shall provide zone control accuracy equal to or better than ± 1 degree F. Systems providing control accuracy's greater than ± 1 degrees F are not acceptable. With the submittal package, contractor shall provide performance data that verifies control accuracy of the VAV ILC.

3. All input/output signals shall be directly hardwired to the VAV ILC. A minimum of one input point of the VAV ILC shall employ a universal configuration that allows for flexibility in application ranging from dry contact, resistive, to voltage/current sourced inputs. If a universal point is not available, a minimum of one input point (each) of the dry contact, resistive and analog voltage/current types must be provided on every controller. The outputs of the ILC shall be of the relay and universal analog form. All digital outputs shall be relay type. ILC devices utilizing non-relay outputs shall provide an interface relay for all points. All analog outputs be programmable for their start points and span to accommodate the control devices. Configuration of all I/O points shall be accomplished without physical hardware jumpers, switches or settings. Troubleshooting of input/output signals shall be easily executed with the Graphical Programming tool or a volt-ohm meter (VOM). All I/O points shall be utilized by the local ILC or shall be available as I/O points for other controllers throughout the network.
4. The FMCS contractor shall provide VAV ILC to the VAV box manufacturer, for factory mounting. The VAV terminal unit supplier shall include in its price all costs for mounting of VAV ILC controller, and connection of actuator to damper shaft.
5. The VAV terminal manufacturer shall provide a multi-point, averaging, differential pressure sensor mounted on the inlet to each VAV box. The VAV terminal unit manufacturer shall supply a line to low voltage transformer, of sufficient capacity, to power the VAV ILC plus all reheat valves and/or contractors and fan circuits associated with the VAV terminal and actuator assemblies. The FMCS contractor shall provide all reheat control valves to the mechanical contractor for mounting and piping. The FMCS contractor shall provide and install all wiring between the valve and VAV ILC controller and between the room sensor and the VAV ILC controller. FMCS contractor shall provide and install power to the VAV controller and interconnecting wiring between controllers.

E. ILC VAV - AIR BALANCING

1. Through the portable GP tool, the VAV ILC shall support a fully prompted Air Balance sequence. The GP tool shall, when connected through the wall sensor, access the connected VAV ILC unit. The air balance sequence shall step the balancing contractor through the checkout and calibration of the VAV ILC. Upon completion of the balancing sequence, the flow values presented by the VAV ILC shall match those observed by the balancing contractor's measurement equipment. Additionally, upon completion of the air balance, the SDC shall automatically archive the balance settings for future use if the controller were to require replacement. Systems not

able to provide a formatted air balance GP tool shall provide an individual full time during the air-balancing process to assure full balance compliance.

2.27 INTEROPERABLE DIGITAL CONTROLLERS (IDC)

- A. Controls shall be microprocessor based Interoperable LonWorks Digital Controllers (IDC), providing interoperability with all LonMark and LonWorks devices. IDC's shall be provided for any equipment applications as required, as shown on the drawings. IDC's shall be based on the Echelon Neuron Hosted microprocessor architecture, working from software program memory that is physically located in the IDC. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals.
- B. All IDC's shall be fully application programmable utilizing graphical objects. All control sequences programmed into the IDC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained. Systems that only allow selection of sequences from a library or table are not acceptable.
- C. The IDC shall be provided with the ability to interface with the Graphical Programming tool. The interface port shall allow the GP to have functionality as described in GP section of this specification. Through the interface port all IDC devices on the Lon bus shall be accessible by the Graphical Programming tool.
- D. The IDC's shall communicate with the SDC at a baud rate of not less than 78.8K baud. The IDC shall have as a minimum ambient operating temperature range of 32 to 122 degrees F.
- E. The IDC shall be dully supported by the Graphical User Interface (GUI).
- F. All input/output signals shall be directly hardwired to the IDC. All controllers shall employ a universal input configuration that allows for flexibility in application ranging from dry contact, resistive, to voltage/current-sourced inputs. If universal points are not available, a minimum of one spare input point (each) of the dry contact, resistive and analog voltage/current types must be provided for each input point utilized. IDC devices shall provide digital and analog output types and quantities consistent with the requirements of the application requirements. Troubleshooting of input/output signals shall be easily executed with the Graphical Programming tool or a volt-ohm meter (VOM). All I/O points shall be utilized by the local ILC or shall available as I/O points for other controllers throughout the network.
- G. To simplify controls and mechanical service troubleshooting, the IDC shall be mounted directly in or on the control compartment of the air handling system. The IDC shall be provided in a NEMA 1 enclosure to accommodate direct mounting on the equipment to be controlled. The IDC shall be constructed in a modular orientation such that service of the failed components can be done quickly and easily. The modular construction should

limit the quantities of printed circuit boards to a maximum of two. All logic, control system, power supply and input/output circuitry shall be contained on a single plug-in circuit board. All wiring terminations shall be made to serviceable connections allowing controller reconfiguration without the removal of any terminal wires. This shall allow all controls maintenance and troubleshooting to be made while at the air handling unit. The IDC shall be directly wired to sensory devices, staging relays or modulating valves for heating and cooling.

- H. The FMCS contractor shall provide and field install all IDC's specified under this section. All controllers, sensors, etc. mounted outside shall be installed in NEMA 4 control panels. Valve actuators shall be designed for outdoor mounting.
- I. Wall Mount Room Thermostats: Each room thermostat shall provide temperature indication to the digital controller, provide the capability for a software-limited set point adjustment and operation override capability. And integral LCD shall annunciate current room temperature and set point as well as override status indication. In addition, the thermostat shall include a port for connection of the portable operator's terminal described elsewhere in this specification.
- J. Duct Mount, Pipe and Outside Air Temperature Sensors: 1000ohm RTD temperature sensors with an accuracy of 0.2 degrees C. Outside air sensors shall include an integral sun shield.
- K. Current Sensitive Switches: Solid state, split core current switch that operates when the current level (Sensed by the internal current transformer) exceeds the adjustable trip point. Current switch to include an integral LED for indication of trip condition and a current level below trip set point.
- L. Temperature Control Panels: Furnish temperature control panels of code gauge steel with locking doors for mounting all devices as shown. All electrical devices within a control panel shall be factory wired. All external wiring shall be connected to terminal strips mounted within the panel. Provide engraved phenolic nameplates identifying all devices mounted on the face of control panels. A complete set of "as-built" control drawings (relating to the controls within that panel) shall be furnished within each control panel.
- M. FMCS contractor shall furnish and install all interconnecting cabling, programming, graphic screens, etc. for duplicate information provided via LON port output for each chiller and fume hood.

2.28 IAQ SENSOR

- A. The IAQ sensor shall contain a minimum of 5 values on one sensor platform. The minimum values shall be: temperature, humidity, CO, CO2 and odors and gasses (O&G).

- B. The Odors & Gases (O&G) sensor shall be responsive to organic and inorganic gases. At a minimum, repeatable response should be to hydrocarbon gases with similar chemical structures such as toluene, isobutylene and isopropyl alcohol as well as ammonia, ethanol and hydrogen sulfide. Output to this group of gases shall be in a 0-100% range to indicate a relative increase or decrease in O&G concentration.

C. ACCURACY AND RESOLUTION

Value	Minimum Accuracy	Minimum Resolution
Temperature	±.5° C (0.8°F)	0.1°C (0.18°F)
Humidity	±10% of reading or 5% rh whichever is greater	1% rh
CO	±10% of reading or 5 ppm whichever is greater	1 ppm
CO2	±5% of reading or 100 ppm whichever is greater	10 ppm
O&G	±10% of reading or 5% O&G whichever is greater	1% O&G

D. RANGE

Value	Minimum Range
Temperature	0-38°C (32 to 100°F)
Humidity	0-100% rh non-condensing
CO	0-200 ppm
CO2	0-2,000 ppm
O&G	0-100%

D. CONSTRUCTION AND MOUNTING

1. The IAQ sensor shall be wall mounted. A mounting plate shall be provided which will allow for all power and communication wiring terminations to be completed before installation of the sensors.
2. All sensors shall be mounted on a separate circuit board that can be easily connected and removed from the mounting plate.

E. CALIBRATION AND RE-CALIBRATION

1. The IAQ sensor shall come pre-calibrated from the factory to maintain the minimum accuracies for a period of no less than three years.

2. The IAQ sensor shall be capable of factory re-calibration.

F. COMMUNICATIONS

1. The IAQ sensor shall be LonMark® certified and provide 5 SNVT values over a single twisted pair of wires.
2. The IAQ sensor manufacturer shall provide an accompanying .xif file and/or plug-in.

- G. The IAQ sensor shall be powered by 24 to 41vdc or 24vac and not exceed 4 watts.

2.29 GUARANTEE

- A. All components, parts and assemblies shall be guaranteed against defects in material and workmanship for a period of one year after acceptance. Expressed warranting are conditionally based on the requirement that items covered within manufacturer's recommendations. Guarantee commences at time of acceptance and continues for the previously indicated duration.

2.30 SOFTWARE LICENSE AGREEMENT

- A. The Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software.

2.31 EMERGENCY SHUTDOWN SYSTEM

- A. For each air handling unit and exhaust fan capable of handling 600 cfm or more, provide a firestat in the pure return air stream which shall stop the fan when its setpoint is reached. A smoke detector located in unit supply and return of every unit over 2000 cfm shall stop the unit fan when products of combustion are detected. An additional smoke detector located in the return air of each air handling unit handling 15000 cfm or more shall be interlocked through the supply detector to stop unit fan.

PART 3 - SEQUENCE OF OPERATION

3.1 CHILLED WATER SYSTEM

- A. Chilled water pump 1 shall be started and stopped from the BAS system through the "Auto" position of the Hand-Off-Auto selector switch of the magnetic motor starter. Once the isolation valve is opened, the pump shall be energized. After pump run status has been proven via a current sensing relay and a differential pressure switch, the chiller shall be energized. Isolation valve status, pump status and chilled water flow status shall be displayed at the BAS, and. The chiller shall cycle around its internal controls to maintain supply setpoint of 45 F (adjustable).
- B. Should Air cooled chiller 1 not be able to handle the building load, Chilled water pump 2 and its associated air cooled chiller shall be energized. Chilled water pump 2 shall be started through the "Auto" position of the Hand-Off-Auto selector switch of the magnetic motor starter. Once the isolation valve is opened, the pump shall be energized. After pump run status has been proven via a current sensing relay and a differential pressure switch, the chiller shall be energized. Isolation valve status, pump status and chilled water flow status shall be displayed at the BAS, and. The chiller shall cycle around its internal controls to maintain supply setpoint of 45 F (adjustable).
- C. An air cooled chiller alarm status indication shall be provided for each chiller, chiller run status for each chiller, chilled water pump status, chilled water supply temperature for each chiller, chilled water return temperature for each chiller, outside air temperature, chilled water common supply temperature, and chilled water common return temperature shall all be displayed at the BAS. Chiller 1 and Chiller 2 shall alternate on a monthly basis as the lead chiller.
- D. A dynamic graphic of the Chiller shall be depicted on the BAS.

3.2 VARIABLE AIR VOLUME AIR HANDLING UNIT

- A. Unit fan shall be started and stopped through the Hand-Off-Auto switch on the cover of the variable frequency drive on a time schedule from the BAS. Once the unit fan is energized the automatic temperature control system shall be placed in operation and the unit fan status via current sensing relay shall be displayed at the BAS and the outside air damper shall open to its predetermined setpoint.
- B. Duct mounted smoke detectors provided by division 16000 and located in the pure supply air and return streams shall de-energize the unit fan when particles of combustion are sensed. On units above 15000 cfm, a duct mounted smoke detector shall also be located in the return air stream in addition to the one in the supply air.
- C. A chilled water coil discharge temperature sensor shall modulate the normally closed chilled water valve to maintain a setpoint of 55 degrees F.
- D. A manual reset, low limit thermostat shall deenergize the unit fan and close the outside damper if the temperature falls below 35 degrees F. An individual alarm status of the low limit thermostat shall be displayed at the BAS.

- E. A static pressure sensor located 2/3 down the supply air duct shall modulate the variable frequency drive to maintain a setpoint of 1.5" wg. (adj.) Should one of the "wall of fans" fail, an alarm shall be displayed at the BAS and also emailed to appropriate emergency personnel.
- F. A manual reset, static pressure high limit controller shall de-energize the unit fan if the static pressure in the supply air duct reaches 3" wg. (adj.) An individual alarm status of the static high limit sensor shall be displayed at the BAS.
- G. An IAQ (Temp, Rh%, CO, CO2, and VOC's) sensor located in the pure return air stream shall close the outside air damper should the odors and gases rise above setpoint. The AHU shall then be operating with 100% return air.
- H. Individual room temperature sensors shall maintain the room temperature setpoint of 74 degrees F cooling (adj.) and 70 degrees F heating (adj.) by modulating the variable air volume (VAV) box damper actuator and the electric reheat coil.
- I. When the unit fan is deenergized, the automatic control system shall be inoperable, and the outside air damper and the chilled water valve shall close to the coil.
- J. All analog and digital inputs and outputs shall be displayed at the BAS.
- K. A dynamic graphic of the AHU shall be depicted on the BAS.
- L. Install and wire ultra violet lights for AHU coil as required.

3.3 CONSTANT VOLUME AIR HANDLING UNIT

- A. Unit fan shall be started and stopped through the Hand-Off-Auto switch on the cover of the magnetic motor starter based on a time schedule from the BAS. Once the unit fan is energized the automatic temperature control system shall be placed in operation and the unit fan status via current sensing relay shall be displayed at the BAS and the outside air damper shall open to its predetermined setpoint.
- B. Duct mounted smoke detectors provided by division 16000 and located in the pure supply air and return streams shall de-energize the unit fan when particles of combustion are sensed. On units above 15000 cfm, a duct mounted smoke detector shall also be located in the return air stream in addition to the one in the supply air.
- C. A manual reset, low limit thermostat shall deenergize the unit fan and close the outside damper if the temperature falls below 35 degrees F. An individual alarm status of the low limit thermostat shall be displayed at the BAS.
- D. A space temperature sensor shall maintain the room temperature setpoint of 74 degrees F cooling (adj.) and 70 degrees F heating (adj.) by modulating the 3-way chilled water valve and the electric reheat coil in sequence. A space mounted humidistat shall control

the unit humidifier such that if the room humidity drops below 40% (adj.) the humidifier shall operate and inject moisture into the supply air. When the room humidity reaches 55% (adj.) the humidifier shall be turned off.

- E. An IAQ (Temp, Rh%, CO, CO₂, and VOC's) sensor located in the pure return air stream shall close the outside air damper should the odors and gases rise above setpoint. The AHU shall then be operating with 100% return air.
- F. When the unit fan is deenergized, the automatic control system shall be inoperable, the outside air damper and chilled water valve shall close, and the electric reheat coil shall be deenergized.
- G. All analog and digital inputs and outputs shall be displayed at the BAS.
- H. A dynamic graphic of the AHU shall be depicted on the BAS.
- I. Install and wire ultra violet lights for AHU coil as required.

3.4 VARIABLE AIR VOLUME BOXES (VAV BOXES)

- A. Each VAV box shall be controlled by its own terminal equipment controller. The terminal equipment controller shall modulate the supply air damper or electric reheat coil as required to maintain temperature setpoint. The supply air volume will be limited by the minimum and maximum air volume settings.
- B. When commanded to change over to the Unoccupied Mode, the terminal equipment controller shall raise the cooling setpoint and decrease the heating setpoint as required.
- C. During the Unoccupied Mode, the terminal equipment controller shall be reset to Occupied Mode for an operator determined time period. This reset shall be activated by a signal from a local override switch on each room temperature sensor or by command from the operator's terminal. If each room sensor does not include this override switch capacity, an override switch shall be provided and installed at each room sensor location. At the end of the operator determined time period, the terminal equipment controller shall return to the Unoccupied Mode.
- D. All parameters (minimum/maximum velocity setpoint, space temperature) shall be obtainable and updated from the operator's terminal by plugging into the local thermostat. In addition, all this information shall be obtainable and undated at the BAS terminal.

3.5 DIESEL FUEL TANK

- A. Furnish all necessary conduit, wiring, etc. for fuel tank system. Generate alarms for low fuel, fuel leak, pump failure, etc. The alarms shall be sent to the BAS and also emailed to appropriate emergency personnel.

3.6 EXHAUST FANS

- A. A manual reset high limit thermostat set at 125 degrees F shall de-energize all fans above 600CFM on a temperature rise above setpoint.

3.7 POINT LIST

CHILLED WATER SYSTEM

	<u>Digital Output</u>	<u>Digital Input</u>	<u>Analog Output</u>	<u>Analog Input</u>
CHW Pump 1 Start/Stop	X			
CHW Pump 1 Status		X		
CHW Pump 2 Start/Stop	X			
CHW Pump 2 Status		X		
Chiller 1 Start/Stop	X			
Chiller 2 Start/Stop	X			
Chiller 1 Alarm		X		
Chiller 2 Alarm		X		
Chiller 1 Flow		X		
Chiller 2 Flow		X		
CHWS 1 Temperature				X
CHWR 1 Temperature				X
CHWS 1 Temperature				X
CHWR 1 Temperature				X
Chiller 1 Isolation Valve	X			
Chiller 1 Isolation Valve		X		
Chiller 2 Isolation Valve	X			
Chiller 2 Isolation Valve		X		

VAV AHU'S

	<u>Digital Output</u>	<u>Digital Input</u>	<u>Analog Output</u>	<u>Analog Input</u>
Fan Start/Stop	X			
Fan Status		X		
Fan Speed			X	
Static pressure				X
Drain Pan Safety Switch		X		
Chilled water valve			X	
Outside Air Damper			X	
CO2/Gases/Odors				X
Discharge Temperature				X
Low limit Safety		X		
Space Humidity				X

CV AHU

	<u>Digital Output</u>	<u>Digital Input</u>	<u>Analog Output</u>	<u>Analog Input</u>
Fan Start/Stop	X			
Fan Status		X		
Drain Pan Safety Switch		X		
Chilled water valve			X	
Electric Reheat	X			
Outside Air Damper			X	
CO2/Gases/Odors				X
Cooling Discharge Temperature				X
Reheat Discharge Temperature				X
Low limit Safety		X		
Space Temperature				X
Space Humidity				X

TYPICAL VAV BOXES

	<u>Digital Output</u>	<u>Digital Input</u>	<u>Analog Output</u>	<u>Analog Input</u>
Cooling Setpoint				X
Heating Setpoint				X
Space Temperature				X
Discharge Temperature				X
Damper Control			X	
Electric Heat	X			
CFM				X
Min CFM Setting				X
Max CFM Setting				X

END OF SECTION

DIVISION 16

ELECTRICAL

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SECTION 16010

ELECTRICAL GENERAL

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish all labor, tools, materials, fixtures, equipment, accessories, transportation, etc., required for complete electrical lighting and power systems, complete with necessary auxiliaries as indicated on drawings and as hereinafter specified.
- B. The GENERAL CONDITIONS of the Contract and Architectural Drawings and Specifications shall apply to all work under this Section. Separation of Specifications into Sections is for convenience only and is not intended to establish limits of work or liability. The following are the Sections that apply to this project.

- 16010 - Electrical General
- 16050 - Electrical Materials and Methods
- 16400 - Electrical Service
- 16500 - Lighting Fixtures
- 16550 - Dimming System
- 16650 - Fire Alarm System
- 16670 - Lightning Protection System
- 16700 - Emergency Generators
- 16740 - Remote Power Panel
- 16760 - Surge Protection Devices
- 16780 - Static Uninterruptible Power Supply
- 16900 - Electrical Equipment Connections

- C. In general, the work shall consist of the following installations:
 - 1. New Electrical Service with electrical distribution system.
 - 2. Panelboards, feeders, switches and complete systems per plans.
 - 3. Power wiring to all mechanical and air conditioning equipment.
 - 4. Electrical lighting and appliance systems complete with wiring, fixtures and lamps.
 - 5. Wiring and connections for equipment indicated on Architectural drawings.
 - 6. Complete and operational fire alarm system
 - 7. New diesel emergency generators and emergency power distribution.
 - 8. Complete and operational Static Uninterruptible Power Supply, with Remote Power Panel.
 - 9. Complete and operational lightning protection system.
 - 10. Conduit and back boxes for the data, voice, video and security systems, as shown on the drawings. Systems shall be installed by Owner.
 - 11. Coordination with Building Automation and Temperature Control System Contractor. See 15950 for requirements.

- D. Prior to submitting quotation for electrical work, Contractor shall visit and examine the job site in order to become familiar with all existing conditions pertinent to the work to be performed thereon. No additional compensation will be allowed for failure to be so informed.
- E. It is the intent of these specifications that in all particulars, the materials and workmanship shall conform to the best practice and that the equipment and accessories as furnished and installed shall be complete and ready to operate.
- F. All materials shall be new, except where otherwise indicated, and shall conform with the standards of underwriters' Laboratories in every case where such a standard has been established for the particular type of material in question.
- G. The drawings showing the layout of electrical work indicate approximate location of the outlets, receptacles, panelboards and other electrical equipment, unless noted otherwise. The runs of feeders and branches are schematic only and are not intended to show the exact routing of conduits. The final determination of the routing shall be governed by structural conditions, other conditions and other construction. The electrical Contractor shall consult all drawings which may affect the location of any outlet, apparatus, or equipment to avoid possible interference and any reasonable changes in the location of an outlet, apparatus or equipment, up to the time of rough-in, is reserved by the Architect, and any minor deviations shall be made without additional cost. It shall be the Electrical Contractor's responsibility to see that all equipment such as junction boxes, panelboards, switches, and other apparatus, as may require maintenance from time to time, are made easily accessible. Although the location of the equipment may be shown on the drawings, the construction may disclose the fact that such location does not make its position readily accessible, in which case the Electrical Contractor shall call the Architect's attention to the condition before advancing the construction to a point where a change in location would require additional cost.

1.2 MEASUREMENTS

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories necessary. The Contractor shall carefully investigate structural conditions, walls, furring and chase locations and room finishes and shall make actual measurements on the job so that the panelboards, switches, receptacles, lighting fixtures and accessories shall fit.

1.3 LAWS, CODES AND PERMITS

- A. Latest edition of the following listed established standards constitute part of the specification requirements.

- National Electrical Code, 2005 (NFPA No. 70)
 - Applicable State Requirements
 - Underwriters' Laboratories (UL)
 - Electrical Testing Laboratories (ETL)
 - American National Standard Institute (ANSI)

- B. The Contractor shall apply for all permits and pay all fees incidental to the carrying on of the electrical work. This Contractor shall give notice to the Architect in ample time for the work to be inspected and approved as it progresses and no work shall be concealed until inspected and approved by Architect, should the plans or these specifications in any way conflict with the Code, or State Rules, these latter are to be followed, without expense to the Owner, but the Architect shall be notified of this condition and approval secured before changes are made.
- C. Upon completion of the installation, a certificate of approval from the Electrical Inspection Department having jurisdiction thereon shall be furnished to the Owner, and all fees paid by the Contractor. The certificate of inspection shall not release the contractor from any defects to material, workmanship or installation, should any develop within one (1) year after final acceptance of the work.

1.4 JOB CONDITIONS

- A. Accompanying drawings, including plans, details, diagrams, notes, etc., are shown to limit and explain structural conditions, construction requirements, sizes, capacities and method of installation and erection. Structural and other conditions may require certain modifications and adjustments from conditions shown. Such deviations are permissible; however, specific sizes capacities and requirements affecting the satisfactory performance and operation of the installation shall remain unchanged. Make allowance for normal job conditions and interferences.
- B. Ask for details whenever uncertain about method of installation. Lack of details not requested shall not excuse improper installation and correction shall be responsibility of the Contractor.
- C. Schedule and perform all electrical work to avoid delays to the Contractor and other trades.
- D. In addition to the basic work covered under this contract, the Contractor shall plan and schedule the work to permit continuous operation of essential services of existing facilities. Planning shall also include scheduling necessary interruptions of electrical service to existing buildings at times when such interruptions will cause minimum interference with existing routine and services. All such interruptions shall be made only after consultation with the Owner. This is extremely important since included in the work is a relocation and rerouting of and connecting to existing facilities. No additional compensation will be allowed for failure to be so informed.
- E. It is essential that all adjacent buildings be kept in operation at all times, except when specific permission is given to contrary. Before any power or equipment is shut down for disconnecting, tie-ins, or rearranging of services, make arrangements with Owner to do this work at night, or Sunday, or at special time of day or year with length of shutdown agreed upon before work is begun. Contractor to bear any overtime or work costs in this connection.
- F. All piping, conduits, conductors and other electrical items in way of construction, shall be rerouted, relocated or otherwise adjusted to work out with such construction or

changes shown or specified in any or all of various sections of specifications. Unknown electrical devices that are encountered will be referred immediately to Architect for method of disposition before continuation of work.

- G. The Contractor shall review the architectural drawings to become familiar with the phasing of construction required for this project.

PART 2 - PRODUCTS AND INSTALLATION

2.1 APPROVALS

- A. Name of manufacturer or catalog numbers are mentioned herein in order to establish a standard as to design and quality. Other products similar in design and of equal quality may be used if submitted to the Architect and approved by him.
- B. Within thirty (30) days after award of General Contract, Contractor shall submit complete dimensional shop drawings and descriptive literature covering the following equipment and materials. Written approval thereof must be obtained before ordering or installation.

Panelboards
Lightning Protection System
Fire Alarm System
Lighting Fixtures
Voice/Data Cable & Hardware

Switch Boards
Conductors
TVSS
Emergency Generator

Wiring Devices and Plates
Safety Switches

- C. Comply with requirements of Division 1 Sections regarding submittals, number of copies, and procedures.

2.2 PROTECTION OF FIXTURES, MATERIAL AND EQUIPMENT

- A. Contractor shall continuously maintain adequate protection of all his work from damage and shall protect the Owner's property from injury or loss, except as may be caused by agents or employees of the Owner. He shall adequately protect adjacent property as provided by law.
- B. Conduit openings shall be capped or plugged during installation. Fixtures and equipment shall be tightly covered and protected against dirt, moisture, chemical and mechanical injury. At the completion of the work, the fixtures, material and equipment shall be thoroughly cleaned and delivered in condition satisfactory to the Architect.

2.3 CUTTING, PATCHING, AND SEALING

- A. All cutting and patching for the work of this Section shall be in accordance with the requirements of the GENERAL CONDITIONS. The Contractor shall perform all necessary cutting and patching required for the installation of work. Where floor or roof is cut or

penetrated the structural integrity shall be maintained or restored. Cutting of structural members is prohibited except with prior approval of the Architect.

- B. Penetrations of all walls, floors, and ceilings shall be sealed with a material capable of preventing the passage of flames and gases in accordance with the requirements of the test standard ASTM-E-814 for fire stops. The integrity of the fire rating, as indicated on the architectural drawings, shall be maintained. See Sealant Specification for materials.

2.4 CLEANING UP

- A. This Contractor shall promptly remove from the jobsite all debris, surplus and waste materials, empty crates and cartons resulting from his work.
- B. This Contractor shall remove all oil, grease or other stains resulting from his work performed in the building or the exterior thereof.

2.5 TESTING AND BALANCING

- A. Make tests which may be required by the Owner or the Architect in connection with the operation of the electrical system in the building.
- B. Balance all single phase loads connected to the panelboards in the building to insure an approximate equal division of these loads on main secondary power supply serving building.
- C. All tests shall be made in accordance with the latest standards of the IEEE and the NEC.
- D. The installation shall be tested for performance, grounds, and insulation resistance. "Megger" type instrument shall be used. Circuit continuity tests and operational tests on all equipment furnished and/or connected by him shall be made by the Contractor after such equipment has been installed.
- E. The tests shall be made in the presence of the Architect or his representative. The Contractor shall notify the Owner or his representative. The Contractor shall notify the Owner and the Architect at least seventy-two (72) hours in advance of tests. The Contractor shall provide all testing equipment and all costs shall be borne by him. Written reports shall be made of all tests. All faults shall be corrected immediately.
- F. Refer to the Electrical Feeder Diagram on the drawings and the NEC section 517 for additional testing required.

2.6 PAINTING

- A. Contractor shall touch-up or refinish all items of electrical equipment furnished with a factory finish coat of paint and which may have been damaged regardless of cause.
- B. All electrical equipment such as switches, panelboards, motor controllers, etc., shall be suitably identified with micarta nameplates.

C. See PAINTING SECTION for painting by others.

2.7 GUARANTEE

Upon completion of all tests and acceptance, the Contractor shall furnish the Owner a written guarantee covering all electrical work under this Contract for a period of one (1) year from date of final acceptance. Upon notice from the Owner, Architect or the Consulting Engineer during the Guarantee period, the Contractor shall replace defective materials and correct faults of workmanship and repair any damage caused thereby promptly and free of any charge. Fuses and lamps are excluded from the guarantee.

2.8 CONTRACTOR'S QUALIFICATIONS

The Electrical Contractor, bidding on this portion (Electrical Division) must be licensed to perform such work as required by State and Local laws.

2.9 DIRECTORY CARDS, NAMEPLATES AND EQUIPMENT LABELS

Provide in the directory frame of each panelboard and for each feeder switch or circuit breaker, neatly typed directory cards indicating the general area and type of electrical load.

2.10 SUBSTITUTION

- A. All specified material, equipment, fixtures, etc., entering into the work under this section of contract are subject to the prior approval or disapproval of the Architect. Refer to Division 1 Sections for approval procedures.
- B. Materials, equipment, fixtures, etc., herein named or indicated on drawings establish the type, size, appearance and quality required of products other manufacturers must meet to be acceptable.
- C. Requests for substitutions must include necessary data to conclusively demonstrate equality in type, size, appearance, quality, etc. Any deviation in the opinion of Architect may be cause for rejection.

2.11 COMMISSIONING

- A. Contractor shall install all items of equipment as identified in this specification in strict accordance with manufacturer's requirements (whether identified in this specification or not), shop drawings and contract documents. Contractor shall coordinate with Mechanical, and Temperature Control System Contractors to insure a complete installation. Start-up of all equipment shall be by manufacturer authorized representative. Start-up services shall be provided for as long a period of time as is necessary to insure proper operation of the equipment items. The start-up technician shall conduct all operating tests as required to insure the equipment is operating in

accordance with design parameters. Complete testing of all safety and emergency control devices shall be made. The start-up technician shall submit a written report to the engineer (prior to final punch list inspection) containing all test data recorded as required above and a letter certifying that the equipment is operating properly.

B. Other specific items of commissioning shall be as follows:

1. All electrical outlets and devices shall be tested for proper operation. Receptacles shall be checked for proper hot, neutral and ground connections with suitable plug-in tester. Light switches and dimmers shall be switched to check that the correct lights are controlled and that dimmers operate properly.
2. Test and balance all switchboard, panelboard and power feeders over 50 amps in accordance with 16010-2.5.
3. Measure voltage and ampacity at each panelboard and switchboard under full load conditions (as best as can be achieved) for each phase. Adjust transformer taps as required to maintain design voltage.
4. Test fire alarm system in accordance NFPA-72 and Section 16650 requirements. Test proprietary fire alarm reporting.
5. Electrical gear equipment supplier shall perform a selective coordination study based on feeder diagram, panel schedules and equipment loads to determine settings and adjustments on all electronic, GFI and adjustable breakers. Time/current characteristic curves shall be generated and settings adjusted accordingly.
6. The emergency generator shall be tested in accordance with NFPA - 110 requirements at full load for a minimum of 4 hours. Perform adjustments as required to meet design conditions. All equipment and transfer switches on emergency power shall be operationally tested. Request all time delay settings from engineer and program accordingly.
7. Voice and data systems shall be tested in accordance with Section 16770 requirements.
8. Master Label for the Lightning Protection System shall be provided and installed, as per the requirements of Section 16670.
9. Provide written reports for all tests described above prior to final punch list inspection.

END OF SECTION

SECTION 16050

ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

Applicable items of this Section shall apply to all sections of ELECTRICAL.

PART 2 - PRODUCTS AND INSTALLATION

2.1 METHODS OF WIRING

- A. No wire shall be smaller than No. 12 except those for fixture drops and for control circuits of equipment. All wire shall have 600-volt insulation equivalent to type THHN/THWN unless otherwise noted on the drawings.
- B. All wiring shall be run in conduits sized as shown on the drawings and as herein after specified. Conductors shall be continuous from outlet to outlet and no splices shall be made except in outlet or junction boxes. MC cable shall not be allowed.
- C. Homeruns to panelboards may be collected in one or more conduits provided all circuiting is done in accordance with Code requirements and the maximum unbalanced current does not exceed the capacity of the neutral conductors.
- D. Powdered soapstone or approved pulling compound shall be used as a pulling lubricant for all non-lead covered conductors. Use Thomas and Betts Wireslick, Ideal 77 or equal.
- E. All empty conduits installed shall contain a #14 fish wire.
- F. Conduit sizes shall conform to the requirements of the National Electric Code and/or sizes shown on the drawings. Minimize size conduit shall be ½".
- G. No conduit shall be routed within concrete floor slabs, except as required to serve floor boxes where shown on the drawings. Where required for power/data service to floor boxes, conduit in slab shall be ¾" PVC. Conduit shall be installed in accordance with requirements of Structural Engineer and shall exit floor slab at nearest wall or to accessible ceiling space below. No more than 10 feet of conduit shall be allowed in floor slab per location. Vertical penetrations of concrete slabs shall be sleeved and sealed. Where conduits turn out of slab, conduits shall be transitioned to rigid steel conduits. PVC conduits are not allowed to pass thru slab. In area below a distribution panel, contractor shall provide enhancement of reinforcing as required by structural engineer. Size and location of all sleeves are subject to the approval of the structural engineer. Conduits routed below the first floor slab shall be Schedule 40 PVC, supported using 3/8" stainless steel threaded rods. Supports shall be spaced in accordance with

- NEC-346-12. Any exposed conduits on exterior of building, shall be heavy wall hot dipped galvanized rigid conduit.
- H. Underground conduits for branch circuit conductors shall be Schedule 40 PVC direct buried minimum 24" below grade. Sweep elbows shall be galvanized rigid steel, or Schedule 40 PVC encased in concrete. All underground conduits shall be installed with metallic marker tape buried 12" below grade, directly above conduit, and continuous for entire length of conduit.
 - I. Conduits in metal stud walls, exposed within mechanical and electrical rooms, and above ceilings shall be EMT. Conduits in hollow cmu walls shall be EMT with concrete tight set screw fittings. Conduits in solid, infilled cmu walls shall be Schedule 40 PVC.
 - J. Aluminum conduit may be used in lieu of steel conduit in sizes over 2" provided same does not run underground or in or passing through concrete.
 - K. All raceways shall be concealed unless otherwise indicated.
 - L. All conduit and tubing shall be Armco, Plastic Wire & Cable, Steelduct, Republic, Allied, or approved equal.
 - M. Branch circuit conduits feeding outlets in masonry walls shall be concealed in masonry. Where outlet boxes are indicated in bare masonry walls, the box shall be mounted so that two edges of the box or plaster cover will fall in a mortar joint. Where switchboxes will not accommodate the number of conductors required and 4" square or larger boxes are installed, the device covers shall be manufactured by Steel City Manufacturing Co., or Appleton, 1" minimum in depth, with straight rectangular openings for drywall construction. Where grouting is required to fill up improperly cut openings in the masonry, the work will be rejected. Electrical Contractor shall cooperate with the bricklayer to insure a neat and workmanlike job.
 - N. Solderless Fixed spring connectors (T & B 10-100, Ideal wrap-cap, or equal) shall be used for all branch circuit wiring and fixture connections on all conductors #10 AWG and smaller. Split bolt or 2 bolt connectors (T & B 6 HPW, O-Z Gedney PMX, or equal) shall be used for connections and splices on all conductors #8 AWG or larger.
 - O. Connections to all motors not equipped with a portable cord shall be made with a short piece of flexible metal conduit between rigid conduit system and motor terminal box. Ground bond of separate copper conductor shall be made between motor frame and rigid conduit system. In all outdoor locations, liquid tight flexible metal conduit shall be used.
 - P. All recessed fixtures, unless they contain a box approved for THW wire shall be wired with THHN, in four feet (4') of flexible metal conduit from a box at least one foot (1') from the fixture. Not more than two individual or two rows of continuous fixtures shall be connected to any one of these outlet boxes. This box shall be located above the ceiling and shall be accessible by removing fixture. Installation of blank covers on ceilings to provide access to such boxes will not be acceptable.

- Q. Splices in all low voltage wiring shall be made at terminal blocks furnished with the equipment. At junction boxes or where other splices are required, these splices shall be soldered.
- R. Other routings than those indicated may not be used without the approval of the Architect, but Contractor shall make allowance for possible obstructions to routes indicated. Conduits shall be grouped together and run on common hangers parallel to building lines in areas of open ceilings.
- S. Surface mounted raceways shall be Wiremold Series 2000, 2-piece, steel, with all fittings and mounting hardware necessary for complete installation.

2.2 WIRING IN RACEWAYS

- A. Conduit sizes shall conform to requirements of the National Electrical Code and/or sizes shown on drawings.
- B. It is not mandatory that all conduits be routed as shown on the drawings. Other routings facilitating speed and ease of installation may be used, provided the general intent of these specifications is followed and the specific intent of the particular circuit or circuits and the National Electrical Code are not violated; such changes and must be approved by the Architect before work is done. Contractor shall make full allowances for possible obstructions to these routes, as no extra charges will be allowed for added lengths that may be necessary.
- C. Conduits shall be installed in a neat appearing manner and shall be rigidly secured in place. The use of wooden plugs in masonry or concrete as a base to fasten raceways will not be permitted. Approved anchors only shall be used for this purpose. Exposed conduits shall be installed with runs arranged parallel or perpendicular to walls and ceilings, with rigid angle turns consisting of symmetrical bends, condulets and junction boxes. Bends and offsets shall be held to a minimum. Conduits shall be kept at least six (6") inches from parallel runs of hot piping flues, or other hot objects.
- D. Conduits shall be cut with a hacksaw; ends must be square, threads cut and cleaned before reaming. Conduits must be securely fastened to all outlet and junction boxes with two locknuts and one bushing of approved make, care being exercised to see that full number of threads project through to permit bushings to butt up tight against the end of the conduit, after which the locknuts shall be screwed tight. Conduit shall be joined by approved conduit couplings and shall have ends butted in all cases where couplings are used. Use three piece threaded electrical unions where standard couplings cannot be used. The use of running threads will not be permitted. Where condulets cannot be joined by standard thread couplings, approved type conduit unions shall be used. Connectors and couplings for electric metallic tubing shall be of the set screw type. Couplings for rigid heavy-wall conduit shall be of the threaded type.
- E. Conduit fittings shall be Crouse-Hinds or Appleton grounding type, or approved equal.
- F. Insulated bushings shall be provided for all conductors #4 and larger.

- G. No wire shall be pulled in until the conduit system is complete and plastering dried. This does not include the white finish coat of plaster.
- H. During Construction, all outlet boxes and conduit stub-ins shall be suitably protected against the entrance of foreign material.

2.3 BOXES AND FITTINGS

- A. Boxes and fittings shall conform to requirements of Article 314 of the N.E.C.
- B. Junction and pull boxes required by field conditions shall be installed whether indicated on drawings or not
- C. The location of outlets not specifically dimensioned on the drawings should be considered as approximate only. The Contractor shall study the general plans with relation to the spaces surrounding each outlet in order that his work fit the work of others so that when fixtures or other fittings are installed, they will be symmetrically located according to design requirements.
- D. Use only galvanized outlet and junction boxes, conduit fittings, covers, and supports for interior wiring and cast fittings and boxes with gasketed covers for exterior wiring. The Contractor shall provide all necessary structural supports for boxes and cabinets. Kindorf or Unistrut channels shall be used where applicable.
- E. Boxes for concealed outlets shall be 4" square by 1-1/2" deep, or larger, with raised device covers as required, except that 2-3/4" deep switch boxes may be used where only one conduit enters a box.
- F. Boxes for concealed ceiling outlets shall be 4" octagonal by 1-1/2" deep, or larger. Boxes in plaster ceilings shall have plaster covers. Fixture outlet boxes shall be equipped with fixture studs secured to the boxes.
- G. Outlet boxes for exposed work shall be 4" square by 1-1/2" deep, or larger. Boxes shall have Appleton 1/2" deep surface metal covers to accommodate the devices indicated, or approved equal.
- H. In walls or ceilings of concrete, tile or other non-combustible material, boxes and fittings shall be so installed that the front edge of the box or fitting will not set back of the finished surface more than 1/4". In walls or ceilings constructed of wood or other combustible material, outlet boxes and fittings shall be set flush with the finished surface.
- I. If a fixture, canopy or pan is used as an outlet box cover, any combustible wall or ceiling finish between the edge of the canopy and the outlet box shall be covered with non-combustible material.
- J. Fixture studs shall be installed in all fixture outlets. In each case, the maximum permissible number of conductors shall be reduced by one.

- K. Appropriate galvanized blank covers, subject to approval of the Architect, shall be installed over outlet or junction boxes which do not house a device. Multiple devices shall be installed in one-piece multi-gang box with one-piece multi-gang cover plates. On surface mounted switch and receptacle outlets, provide raised covers to permit mounting devices without additional device plates.
- L. For junction and pull boxes, 14 gauge or thicker sheetmetal. Attach covers by means of 1/4" X 20 round head machine screws. In damp locations, provide rubber or neoprene gaskets.
- M. Attention is called to National Electrical Code, Article 314, Paragraph 314-16, Sub-paragraph (a) and (b) relative to allowable number of conductors in outlet boxes. Contractor shall make provisions to prevent overcrowding outlet and junction boxes regardless of number of conductors shown on the drawings at the outlets. There shall be no deviations from Code requirements on this subject.

2.4 CONDUCTORS

- A. All conductors shall be copper and no wire shall be less than #12 AWG except as otherwise noted herein and or indicated on drawings.
- B. All conductors, except as herein noted and/or as indicated on drawings, shall have 600 volt insulation type THHN/THWN. Wiring through channels of continuous surface or suspended fluorescent fixtures shall be Type RHH, or THHN.
- C. Recessed fluorescent fixtures shall be fed with type THHN, or RHH conductors and recessed incandescent fixtures shall be fed with Type THHN conductors.
- D. Conductors #8 and larger shall be stranded. Feeders shall be of the size and type indicated on drawings.
- E. Type MC cable shall not be used.

2.5 GROUNDING

- A. Grounding shall conform to the requirements of Article 250 of the N.E.C.
- B. Contractor shall provide grounding system indicated on drawings.
- C. The steel conduit systems and the neutral conductors of the wiring systems shall be grounded at the service equipment. The copper service ground conductors shall be extended in conduit from the services to as near as practicable to the point of entrance of the water service. Where the conduit routing is via finished areas, it shall be run concealed. Ground connection shall be visible, and connection of conduit and conductors to the water pipe shall be made with an approved ground connector, conduit hub, and water pipe clamp.
- D. A grounding conductor shall be provided in all conduit. The grounding conductor shall be green insulated, with a minimum size of #12 AWG, or as indicated on the drawings or

per NEC-250. Grounding conductors routed entirely in soil as part of the ground loop shall be bare copper. The grounding conductor connecting the electrical service to the ground system shall be green insulated copper.

- E. The above requirements shall be supplemented by ground to ¾" diameter, 10'-0" long driven copper bonded ground rods as shown on the drawings.
- F. Bond jumpers shall be used around concentric or eccentric knockouts on service equipment.
- G. Grounding pole of each polarized receptacle shall be bonded to its outlet box with copper wire and machine or self-tapping screw.

2.6 EQUIPMENT SUPPORTS

All electrical switches, panels, appurtenances, etc., shall be rigidly supported on Unistrut or equal steel framing which shall be securely fastened to walls, floors, ceilings, etc., as required. Details of framing must be submitted to Architect for approval before installation.

2.7 WIRING DEVICES

- A. Devices shall be Specification Grade as manufactured by Leviton, Hubbell, P & S, or approved equal. Provide red colored receptacle where connected to emergency circuit. All emergency circuits shall be labeled on receptacle face plate.
- B. All devices listed below may not necessarily be used.
- C. Comparative catalog numbers of devices shall conform to the following: (All devices listed may not be used).
 - 1. Duplex receptacle, 20A, 125V, NEMA 5-20
Hubbell CR5362
Leviton 5362
P & S 5362
 - 2. Duplex receptacle, GFI, 20A, 125V, NEMA 5-20
Hubbell GF5362
Leviton 6899
P & S 2091
 - 3. Simplex Receptacle, 30A, 125V, NEMA 5-30
Hubbell HBL 9308
Leviton 5371
P & S 3802
 - 4. Toggle switch, 20A, 120-277V, SPST
Hubbell CS1221
Leviton 1221-2

P & S 20AC1

5. Toggle switch, 20A, 120-277V, DPST
Hubbell CS1222
Leviton 1222-2
P & S 20AC2
6. Toggle switch, 20A, 120-277V, 3-way
Hubbell CS1223
Leviton 1223-2
P & S 20AC3
7. Toggle switch, 20A, 120-277V, 4-way
Hubbell CS1224
Leviton 1224-2
P & S 20AC4
8. Toggle switch, 20A, 120-277V, pilot light
Hubbell HBL 1221 PL
Leviton 1221-7LI
P & S 20AC1-RPL
9. Dimmer switch, incandescent
120V, 2000W, rotary
Leviton 62000
10. Dimmer switch, fluorescent
120V, 600W, rotary for use with
Lutron - C-600
11. Dimmer switch, fluorescent
120V, 2000W, rotary for use with
electronic ballast
Lutron C-2000/HP-2 dimming module
12. Isolated ground receptacles - 20A, 125V,
3 pole grounded hospital grade, Leviton 16362-IG.
13. Duplex Weatherproof - Leviton #6898 with WP cover.
14. Special Receptacles -
Leviton # 5372 (250V, 2 pole, 3 wire, 30A)
Leviton #5821 (250V, 2 pole, 3 wire, 20A)

D. All receptacles shall be mounted with the grounding connection at the top. All receptacles shall be provided with child safety insulated inserts.

E. Occupancy Sensors shall be wall-mounted in standard 2-gang wall box. Unit shall be listed for 120-277 VAC operation with electronic ballasts, with a minimum load no more than 100 watts, and a maximum load no less than 600 watts. Sensor shall utilize dual

technology sensing, using the following types of detection: Passive Infrared, or Ultrasonic (40 k Hz). Unit shall have an adjustable time delay with minimum range of 30 seconds to 20 minutes. All units shall be set at 5 minutes. Beam patterns must be minimum 170 degrees horizontal, and plus/minus 15 degrees vertical, with an overall coverage area no less than 900 square feet.

F. Floor Boxes and Fittings:

1. Floor boxes shall be single or multi-service power/data, and flush-mounted. Type used is dependent upon structural slab conditions at each location. Where indicated in an existing floor slab, provide poke through device with fire rating equal to or greater than that of the slab. Where indicated in a new floor slab, floor box shall coordinate with slab thickness at each location (ranging from 2-inch to 4-inch).
 2. All covers shall coordinate with finished floor (carpet or tile) and services provided (power/data), and provided with receptacles and jacks as required. Covers shall be brass, or at architect's request only, aluminum with color selected by architect from manufacturer's standard finishes.
 3. Floor boxes shall be Steel City or Hubbell Scrub Shield series (poke-through) as indicated on drawings.
- G. Plug mold - Provide Wiremold AL series surface mounted raceway. Provide inline receptacles in Wiremold raceway on 18" centers. Length of track shall be as indicated on drawings. Evenly distribute circuits indicated on drawings between receptacles.

2.8 DEVICE PLATES

- A. Wall plates shall be of the one-piece type, .100" smooth nylon of color as determined by Architect. Plates shall be of the same manufacturer as devices furnished.
- B. Use Multi-gang plates where switches are grouped.
- C. Plates shall be installed with all four edges in continuous contact with finished wall surfaces without the use of mats or similar devices. Plaster fillings will NOT be permitted. Plates shall be installed with an alignment tolerance of 1/16" from the vertical or horizontal. Plates for devices fed with exposed conduit shall be as hereinbefore specified.
- D. Device plates shall not be installed until painting is completed. Device plates having paint on their surfaces, or having their finish marred by use of paint remover, shall be replaced at no additional cost to the Owner.
- E. Where device is located outdoors or specified as weatherproof, use cast aluminum box with cast aluminum cover listed for wet location when cover is closed (NEC 410-57(b) exception).

2.7 MOUNTING HEIGHTS

- A. If not otherwise indicated in Architectural or Electrical drawings, mounting heights to centerline of outlets shall be as follows:
- B. Receptacles - 18" above finished floor except above counter where indicated, or as directed by Owner.
- C. Light Switches - 48" above finished floor.
- D. Panelboard - Not more than 6'-0" from topmost operating handle to floor.
- E. Bracket Fixtures - 8'-0" above floor, or where mounted above exterior door, mirror, medicine cabinet, at a height just sufficient to clear the swing of the door or medicine cabinet.
- F. The above mounting heights may be adjusted as required to permit bottom or top of plate to align with mortar joints in unfinished masonry walls, provided joints are not raked. Where joints are raked, adjust height as required to insure that center of outlet box will be in center of a masonry unit.

2.10 PANELBOARDS

- A. Panelboards shall be constructed with copper or silver plated copper bus bars. Panelboard shall be fully rated (no series rating allowed) with a minimum rating for each panelboard as indicated on panel schedules on the drawings.
- B. See drawings for panelboard schedules. Provide 200% neutral bus where indicated. All panels shall have ground bus. Provide contactors where indicated on schedule.
- C. Panelboards shall be mounted in suitable electro-galvanized or sherardized, code-gauge, dead front, steel boxes with trim arranged for flush or surface mounting as indicated on drawings. Sufficient space shall be provided for not less than 4" gutters on the sides, top and bottom of panels. The doors shall be fitted with not less than two welded and riveted hinges, fitted with non-removal pins and provided with latches and locks with three (3) keys. Door and trim shall be properly matched and fitted closely by means of welded rebates on the sides of the trim and shall be finished to match surrounding walls or as otherwise directed by the Architect. Directory frame with typewritten directory of circuits under transparent cover shall be provided inside of door.
- D. Panelboards shall be so located that its rating will not be reduced by heat from external sources.
- E. Circuit breakers shall be bolted to the bus bar, and be quick-make, quick-break, using over-center toggle mechanism. Breakers shall indicate tripped position by assuming the center toggle position. Breakers shall have deion arc extinguisher principle. All two and three-pole breakers shall have single handle and the common trip. No bail handle ties will be acceptable.

- F. Panelboards shall be as shown in panelboard schedule and shall be manufactured by Cutler-Hammer or Square D, GE, Siemens or equal.

2.11 SAFETY SWITCHES

- A. Safety switches shall be of the visible blade, heavy duty knife switch type. They shall be of the fused or unfused type as required. Fused switches shall have positive pressure fuse clips. Switches shall be fully interlocked with provision to neutralize the interlock by a screwdriver while under load without interrupting the circuit. Switches shall be complete with insulated base and pressure or solderless lugs. All switches shall be horsepower rated, capable of breaking stalled-rotor motor current at these ratings. Outdoor locations shall have NEMA Type 3R enclosures, indoor locations shall have NEMA 1 enclosures.
- B. Switches shall have provision for padlocking in the "ON" or "OFF" positions. Safety switches, as indicated on plans, shall be Cutler Hammer or Square D, GE, Siemens or equal.

2.12 FUSES

Fuses utilized shall provide type 2 "no damage" as defined by IEC 947. All fuses shall have a minimum interrupting rating of 200,000 A. Fuses protecting transformers shall be Class J or RK5 time delay. Fuses protecting motor loads shall be Class J or RK1 current limiting. Provide one set of spare fuses for each load protected. Fuses shall be manufactured by Ferraz-Shawmut, Cooper Bussman, or approved equal.

2.13 TRANSFORMERS

Transformers shall be low loss type with minimum efficiency per NEMA TP-1. Transformers shall be three phase with 480 volt primaries and 208V/120 volts secondaries. Transformers shall be indoor, floor mounted, dry type with 2 - 2-1/2" FCAN and FCBN taps. Transformers shall be designed for 150 degrees C. temperature rise, UL approved, and shall meet ASA-NEMA sound level standards for the KVA size indicated on the drawings. Transformers shall be provided with a normal K factor, unless noted otherwise on the drawings. Provide 4 inch housekeeping concrete pad under each transformer. Transformers shall be as manufactured by Cutler-Hammer, Square D, GE, Siemens, or equal.

2.14 SWITCHBOARDS

- A. Switchboard shall be 480/277 or 120/208 volt, 3 phase, 4 wire, dead-front, metal enclosed, free-standing, front accessible structure with protective devices as specified on the drawings. Switchboard shall be suitable for use as service entrance equipment. Switchboard shall have copper bussing of sufficient cross sectional area to continuously conduct rated full load current without exceeding the maximum temperature rise limits set by UL #891, and shall have AIC ratings as shown on the plans. Ventilation openings shall be provided where required. Temperature rise not to exceed 55 degrees C. All switchboard section busses shall be fully rated, with no tapering, and shall have a 100%

rated neutral bus. Ground fault protection shall be provided on main of 480-volt switchboard as shown on the drawings, utilizing return path sensors. A ground bus shall be provided to extend the entire length of the switchboard. Provide separate barrier section for fire pump feeders. Main breaker shall be 100% rated electronic trip type.

- E. Each switchboard shall be provided with a check meter which will indicate phase currents, avg. phase current, ampere demand, phase voltages, avg. phase voltage, line voltages, avg. line voltage, Kilowatts, KVA, KVAR, KW demand, KW hours, KVAR hours, power factor, frequency (Siemens 9350 power meter or approved equal).
- F. Provide one spare of each type and size of breaker utilized (including electronic trip type) for maintenance inventory.
- G. All switchboard breakers shall be electronic trip type, full function with zone selective interlocking. Manufacturer shall perform coordination study and adjust breaker settings accordingly. See Section 16010 - Commissioning.
- H. Switchboards shall be manufactured by Siemens, Cutler-Hammer, Square D, GE, or approved equal.
- I. A factory representative shall torque all breakers and bus bars to factory tolerances prior to startup of electrical systems.

2.15 TERMINATIONS

All termination lugs shall be rated 75 degrees C or higher, and shall be compatible with number and size of wires to be terminated.

END OF SECTION

SECTION 16400

ELECTRICAL SERVICE

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Applicable items of all other ELECTRICAL SECTIONS shall apply to this Section.
- B. This Contractor shall arrange with Entergy Corporation to provide the new electrical service and shall pay all fees and assessments.
- C. All arrangements and installations of services shall comply with requirements of Entergy Corporation and the N.E.C.

PART 2 - EXECUTION

2.1 TEMPORARY POWER AND LIGHTING

- A. The Contractor shall make all necessary arrangements for furnishing a temporary power supply with service as required by the General Contractor and various Sub-contractors employed in connection with the work to be performed on the job site. The Contractor shall cooperate with other Sub-contractors to insure that adequate power and lighting service is available at all times during the progress of the work.
- B. The Contractor shall include in his price all fees, assessments and permit costs for the new electrical service.

2.3 NEW SERVICE TO BUILDING

- A. This Contractor shall make arrangements with Entergy for the provision of the required service and shall pay all fees and assessments.
- B. All arrangements of service installation shall comply with requirements of the contract documents and approval of Entergy. Contractor shall coordinate with Entergy for the provision of all raceways, manholes, and points of termination as shown on the contract documents prior to installation. Any conflict shall be brought to the attention of the Architect and Consulting Engineer immediately.
- C. Metering of the new service shall be provided by Entergy, integral to new Entergy transformer.
- D. Contractor shall contact Entergy for inspection of all underground work and grounding prior to backfill.

END OF SECTION

SECTION 16470

POWER DISTRIBUTION UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. The following technical specification describes the requirements of the power distribution unit for supplying computer grade power to the data processing equipment and other essential loads. The system shall be known as a Power Distribution Unit (PDU).

1.2 STANDARDS

- A. The PDU shall be designed and manufactured to the following standards:
 - 1. Underwriters Laboratories Standard, UL 60950
 - 2. Canadian Standards Association CSA 60950, C22.2 No.29 & No.31
 - 3. FCC Part 15 EMI Emission Limits for Class A Computing Devices (47 CFR 0-19)
 - 4. National Electric Code (NEC)
 - 5. ISO9001
 - 6. American National Standards Institute (ANSI)
 - 7. National Electrical Manufacturers Association (NEMA)
 - 8. National Fire Protection Association (NFPA)
 - 9. Federal Information Processing Standards (FIPS)

1.3 SYSTEM DESCRIPTION

- A. The PDU shall be designed for operation in the following conditions:
 - 1. Operating temperature: 0°C to +40°C
 - 2. Storage: -40°C to +60°C
 - 3. Relative humidity: 10% to 95% non-condensing
 - 4. Audible noise: meet or exceed ANSI C89 standard for transformers
- B. The PDU shall have a continuous output capacity of 300 kVA.
- C. The input voltage shall be 480 VAC, three phase 60Hz, 3-wire plus ground.
- D. The output voltage shall be 120/208 VAC wye, three phase, four-wire plus ground.

1.4 DOCUMENTATION

- A. The manufacturer shall furnish an Operation and Maintenance manual detailing

installation and start-up instructions. Wiring diagrams and instruction leaflets for major components shall be furnished. Detailed shop drawings for the equipment furnished shall be prepared and submitted for review.

1.5 WARRANTY

- A. The PDU manufacturer warrants that the Product manufactured will conform to Seller's applicable specifications and be free from failure due to defects in workmanship and material for one (1) year from the date of installation of the Product or eighteen (18) months from the date of shipment, whichever occurs first. Repairs or replaced equipment are covered under the period of the original warranty, or ninety (90) days, whichever is longer. Warranty is contingent upon having a factory-authorized representative perform the start-up.
- B. The PDU manufacturer shall offer, to the Owner, a three year service plan with one PM per year.

1.6 QUALITY ASSURANCE

- A. The PDU shall be factory tested before shipment. Testing shall include, but shall not be limited to: "Hi-Pot" Test at two times rated voltage plus 1000 volts, per UL requirements and Metering Calibration Tests. The manufacturer shall be ISO 9001 certified. The PDU shall be UL listed and labeled as defined in NFPA 70, Article 100.

PART 2 - PRODUCTS

2.1 ENCLOSURE CONSTRUCTION

- A. The cabinet enclosure shall be mobile and contain a minimum of three (3) 360° swivel plus two (2) rigid casters and four (4) leveling feet for final installation. The cabinet shall be a freestanding NEMA type 1 enclosure. The frame shall be made of galvanized steel with a welded base and bolted gussets.
- B. The cabinet shall have double-hinged doors and use natural convection for cooling purposes. The top of the PDU shall prevent entry of foreign material from above per UL60950 guidelines. This specification strictly forbids PDUs that require cooling from the sides of the enclosure.
- C. The cabinet shall have provision for top and bottom cable entry to facilitate all load and incoming cables. Both top and bottom of the enclosure shall be equipped with removable gland plates for managing load and main incoming power cable connections.
- D. The inside of the cabinet shall have individual hinged trims over the

panelboard(s), subfeed breakers and main breaker sections that are easily removable to facilitate installation. All removable exterior panels shall be grounded to the frame by way of stranded copper wire.

- E. The main enclosure shall not exceed 42"W x 35.5"D) x 77"H .
- F. The main enclosure shall be configured with two (2) "Front-Mounted" sidecars, each containing 84 additional branch circuit breaker pole positions.
- G. The Front-Mounted sidecar shall not exceed 20" in width and shall match the depth of the PDU. The PDU shall have the capability of mounting any or all front-mounted sidecars on the left, right or both sides of the PDU.
- H. The PDU shall be painted black, UBT4-90001, having a fine texture finish.
- I. No back or side clearance or access shall be required for the system. The back and side enclosure covers shall be capable of being located directly adjacent to a wall. All serviceable subassemblies shall be modular and capable of being replaced from the front of the UPS (front access only required). Side or rear access for installation, service, repair or maintenance of the UPS system shall not be required. The system shall require no more than forty-two (42) inches of front service access room and shall not require side or rear access for service or installation.

2.2 INPUT CABLE CONNECTIONS

- A. All main input power connections (three-phase power, neutral and ground) shall be made from the front of the PDU.

2.3 INPUT MAIN CIRCUIT BREAKER

- A. The PDU shall include an input main circuit breaker to provide overcurrent protection and a means of disconnecting power to the unit.
- B. The system's input main circuit breaker shall be a 3-pole thermal magnetic molded case circuit breaker sized for 125% of the PDU full load current rating and rated for 600 VAC. The system's input main circuit breaker shall have a minimum interrupting rating of 35,000 symmetrical amps @ 480 VAC.
- C. The system's input main circuit breaker shall contain a 24 VDC shunt trip mechanism, which shall be interfaced to the local Emergency Power Off (EPO) pushbutton, Remote Emergency Power Off (REPO) pushbuttons and High Temperature Transformer contact. The PDU shall include a means to indicate and alarm a TRIPPED condition of the main circuit breaker.

2.4 MANUAL RESTART

- A. The PDU shall contain a manual restart feature to protect the connected load and allow for a controlled startup after a power failure. A means shall be provided to deactivate this feature in the field.

2.5 MAIN ISOLATION TRANSFORMER

- A. The PDU shall be fed from a 3-phase, copper wound, double-shielded, convection air-cooled transformer, for both voltage step-down and isolation purposes. The core shall be manufactured from quality non-aging, cold rolled, fully processed silicon steel laminations.
- B. The transformer shall have the following electrical characteristics:
 - 1. Insulation Class: Class H (220°C) with a maximum 150°C rise above 40°C ambient temperature
 - 2. Optional NEMA TP-1 available, Efficiency levels (97.5% @ 30kVA, 98% @ 50-75kVA, 98.2 @ 100kVA, 98.3% @ 125-150kVA, 98.5% @ 200-225kVA, 98.6% @ 300kVA)
 - 3. Percent impedance: 3% to 5.5%
 - 4. Percent reactance: 3% to 4.5%
 - 5. Percent regulation: 3.5%
 - 6. Crest Factor: 3.5:1
 - 7. Harmonic Distortion: 1% maximum
 - 8. The neutral of the transformer shall be rated 200% to accommodate the effects of non-linear loads for K13 and K20 applications.
 - 9. Voltage Taps: The transformer shall have six (6), 2 1/2% full load compensation taps (two [2] above and four [4] below nominal). These taps shall be accessible from the front of the panel located behind the interior trim(s).
 - 10. The transformer shall contain six (6) thermal overload protection devices to monitor core temperature in each winding. The first set (3) of thermal devices shall be calibrated to open at 180°C for alarm purposes. The second set (3) of thermal device shall be calibrated to open at 200°C.
 - 11. Transformers shall comply with UL 1561 requirements for non-sinusoidal load current handling capability to the degree defined by the designated K-factor.
 - a. K13
 - b. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to the designated K-factor.
 - c. Indicate value of K-factor on transformer nameplate
 - 12. Each winding shall have an independent, double, full-width copper electrostatic shield arranged to minimize inter-winding capacitance.
 - a. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
 - b. Include special terminal for grounding the shield
 - c. Shield Effectiveness

1. Capacitance between Primary and Secondary windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz
2. Common-Mode Noise Attenuation using matched impedance no load method:
 - a) Minus 120 dBA minimum at .5 to 1.5 kHz
 - b) Minus 65 dBA minimum at 1.5 to 100 kHz
 - c) 100 dB at 60 Hz to 1 kHz
 - d) 90 dB at 1 kHz to 10 kHz
 - e) 80 dB at 10 kHz to 100 kHz
3. Normal-Mode Noise Attenuation:
 - a) 52 dBA minimum at 1.5 to 10 kHz
 - b) 30 dBA minimum at 10kHz-100kHz
 - c) 10 dB @ 10 kHz
 - d) 20 dB @ 100 kHz
 - e) 40 dB @ 1000 kHz
4. Magnetic Field Strength: Less than .1 gauss measured 1.5 feet from cabinet.

2.6 DISTRIBUTION PANELBOARDS

- A. The PDU shall contain six (6), 42-pole, 225 amp, 208V, three (3) phase distribution panelboards with a short circuit rating of 65,000 AIC. Each 42-pole distribution panelboard shall be protected by a 225 amp, 208V, 3-pole main circuit breaker protective device.
- B. Each distribution panelboard shall employ copper busbars and shall be capable of accepting 1-pole, 2-pole, and 3-pole circuit breakers rated up to 100 amps.
- C. Each distribution panelboard shall only accept bolt-on branch circuit breakers.
- D. Each distribution panelboard shall feature a 42-position neutral bus assembly and a 42-position ground bus kit to provide sufficient output ground and neutral termination space.
- E. Each neutral bus kit associated with each 42-pole distribution panelboard shall be fed by two (2) 1/0 THHN/THWN copper conductors. This will provide 450 amps of conductor to each neutral bus kit to accommodate the anticipated high nonlinear loads.

2.7 BRANCH CIRCUIT BREAKERS

- A. Each output computer power cable shall be protected by a branch circuit breaker.
- B. Each branch circuit breaker protective device shall have three (3) toggle positions: ON, OFF, and TRIPPED.

- C. Branch circuit breakers shall be bolt-on with a 22,000 AIC rating and sized in compliance with the National Electric Code.

2.8 OUTPUT COMPUTER CABLES

- A. The PDU shall have provision for up to 168 output computer power cables per 168 pole positions. The output computer power cables shall enter the PDU at the top and bottom of the cabinet enclosure.

2.9 ENERGY MANAGEMENT SYSTEM (EMS)

- A. The energy management system shall be provided with a level 3 configuration. The energy management system shall provide microprocessor based monitoring and control for the PDU. Information shall be displayed on a local 8 X 40 backlight LCD panel located on the front of the PDU accessible without opening the door. The LCD panel shall have 4 indicators for On, Off, Overload and Alarm. A Horn shall be integral to the system. The LCD panel shall have 5 key switches for menu navigation for monitoring, control and setup functions. The system shall be capable to monitor two (2) three phase voltage/current ports and up to 336 additional branch circuit feeds. Note that typical maximum branch circuit feed wire diameter supported is .350". The energy management system shall have event log capability for Alarm, Notice Status and Command events. Data shall be displayed on an LCD panel and have capability to be transmitted serially to communications devices such as WebServers, Modems and RS232 ports via Web/SNMP or Modbus TCP/IP protocols including Powerware's centralized monitoring system utilizing "X-slot" technology.
- B. Analog and digital signals shall be processed by the controller generating metering, alarm, statistical and status information. The system shall drive 1 [5] [9] programmable output relays and two serial ports and also provide two discrete inputs for programmable building alarms. All currents and voltages shall be monitored using true RMS measurements. The energy management system shall come fully calibrated from the factory. This specification strictly forbids field calibration requirements.
- C. Information shall be displayed on a local 8 X 40 backlight LCD panel located on the front of the PDU accessible without opening the door. The LCD panel shall have 4 indicators for On, Off, Overload and Alarm. A Horn shall be integral to the system. The LCD panel shall have 5 push buttons for menu navigation for monitoring, configuration and control functions.
- D. Four LEDs located on the LCD panel shall indicate the following:

GREEN: Illuminates when the output is energized

YELLOW: Illuminates if output current of any phase exceeds its 100% current level

YELLOW: Illuminates when the output is de-energized. When EPO reset is required, the LED will flash at a one second rate.

RED: Will flash any time an active Alarm is present on the active alarms screen.

- E. The PDU shall be capable of a shutdown on the following alarms:
1. Phase Rotation
 2. Phase Loss
 3. Ground Overcurrent
 4. Building Alarms
 5. Transformer Over Temperature
 6. Neutral Overcurrent
 7. Frequency Out of Tolerance
 8. Input Voltage Low
 9. Input Voltage High
 10. Overload
 11. EPO
- F. The Level 3 shall provide a premium system with advanced system features plus branch circuit monitoring and alarm support for panel boards or sub feed breakers including side car capability. All branch circuit and main PDU level parameters and alarms shall be displayed and communicated remotely via optional Power Xpert Gateway X-Slot card. The level 3 branch circuit energy monitoring system shall be capable of monitoring up to 336 single pole circuits. Note that typical maximum branch circuit feed wire diameter supported is .350". There shall be a real-time clock that shall time stamp each significant event such as an alarm or notice. The system shall have the following Supported cards
1. Power Xpert Gateway X-Slot Card providing SNMP, Modbus TCP, Email and Environmental Monitoring Probe functionality
- G. The energy management level 3 system shall monitor and display the following branch circuit and subfeed breaker parameters:
1. RMS Amps
 2. % Amps
 3. Watts
 4. VA
 5. PF
 6. KWH
 7. MAX Amps
 8. MAX VA
 9. MIN PF
 10. KWH/m
 11. KWH/y

- H. The energy management level 3 system shall support the following branch circuit alarms:
1. Branch Circuit, Panel or Subfeed Breaker Overload Notice (80%)
 2. Branch Circuit, Panel or Subfeed Breaker Overload Alarm (90%)
- I. When a level 3 system significant event occurs it shall be time-stamped and recorded in a 128 long circular queue called the Event Log. There shall be two level of significant events are categorized as an Alarm and Notice (warning). When the event is either an alarm or notice, it shall be also shown on the active events screen and available through serial communication devices.
- J. A level 3 system Alarm is a condition that requires immediate attention. When an alarm is active, it shall be displayed on the mimic screen header and on the active events screen. The alarms light shall light when any alarm is active or latched active. The horn shall sound at a ½ beep rate when an alarm activates. The alarm thresholds shall be programmable.
- K. A level 3 system Notice is a minor alarm condition that does not require immediate attention and is encountered during normal operation. When a notice is active, it shall be displayed on the mimic screen header and on the active events screen. The alarm light should not light. The horn shall sound at a 1 second beep rate when a notice activates. The notice thresholds shall be programmable.
- L. The Energy Management System Level 3 shall monitor and display the following panel parameters:
1. Overall % Load per Panel
 2. Average Voltage
 3. Max Current
 4. Individual Output Voltages per Phase
 5. Individual Output Current per Phase
 6. Current Rating % per Phase
 7. Output kW
 8. Output kVa
 9. Output PF
 10. KWH/m
 11. Overall KWH
 12. Vmax
 13. Imax
- M. Panel Breakers under the level 3 system shall be easily configurable using the LCD panel. The following parameters shall be configurable:
1. Panel Configuration
 - a. Panel Name
 - b. Number of Breakers

- c. Number of Phases
 - d. Panel Breaker Rating
2. Individual Branch Circuit Configuration (up to 42)
- a. Breaker Rating
 - b. Breaker Warning level
 - c. Breaker Overload level
 - d. Number of Phases
3. The following parameters shall be factory calibrated to have an accuracy of $\pm 1\%$:
- a. Input Voltage (VL-L)
 - b. Input Current (A, B & C phase)
 - c. Output Voltage (VL-L and VL-N)
 - d. Output Current (A, B & C phase)
 - e. Output Neutral Current
 - f. Output Current Crest Factor
 - g. System Ground Current

Note: The above parameters shall also be calibrated and verified in the field by a service technician.

4. The following parameters shall be based on the above parameters and are accurate to within $\pm 5\%$ of the actual value:
- a. Input Voltage THD for all three phases
 - b. Input Current THD for all three phases
 - c. Output Voltage Total Harmonic Distortion (THD) for all three phases
 - d. Output Current Total Harmonic Distortion (THD) for all three phases
 - e. Input Power Factor (Lead/Lag Indicator)
 - f. Output Power Factor (Lead/Lag Indicator)
 - g. Input Frequency
 - h. Output Frequency
 - i. Output kVA
 - j. Output kW
 - k. Output KWH
 - l. Monthly KW HR
 - m. Yearly KW HR
 - n. Total KW HR
 - o. Output Current % (A, B & C phase)
 - p. Panel RMS Amps
 - q. Panel % Amps
 - r. Panel Watts
 - s. Panel VA
 - t. Panel PF
 - u. Panel KWH
 - v. Panel MAX Amps
 - w. Panel MAX VA

- x. Panel MIN PF
- y. Panel KWH/m
- z. Panel KWH/y
- aa. Overall % Load per Panel
- bb. Panel Average Voltage
- cc. Panel Max Current
- dd. Panel Individual Output Voltages per Phase
- ee. Panel Individual Output Current per Phase
- ff. Panel Current Rating % per Phase
- gg. Panel Output kW
- hh. Panel Output kVa
- ii. Panel Output PF
- jj. Panel KWH/m
- kk. Panel Overall KWH
- ll. Panel Vmax
- mm. Panel Imax

Note: The accuracy of the above parameters can be adversely affected if the first group of parameters is not properly calibrated.

2.10 INPUT SURGE PROTECTION

- A. The PDU shall be equipped with a secondary - class surge protector to divert high energy transients quickly and safely to ground. It shall be mounted in parallel ahead of all electrical components to provide maximum protection of the unit insulation and wiring and shall be capable of repeated operations. It shall be have a maximum discharge voltage of 1700 VAC at 1500 amperes.

2.11 OUTPUT SURGE SUPPRESSION MODULE

- A. The surge suppression system shall incorporate a hybrid designed, individually fused, MOV surge suppressor for the service entrance and other distribution levels. The system shall not utilize silicon avalanche diodes, air gaps or other components that may crowbar the system voltage leading to system upset.
- B. TVSS units and all components shall be designed, manufactured and tested in accordance with the latest applicable UL Listed standards: UL 1449 2nd Edition, UL 1283 and CSA certified per CSA 22.2
- C. The surge current shall be equally distributed to each individually fused MOV component to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. The MOVs shall have a response time of less than 0.5 nanoseconds.
- D. Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be 40 dB at 100 kHz using the MIL-STD-220A insertion loss test method. The unit shall be complimentary listed to UL 1283. Products not able to demonstrate noise attenuation of 40 dB @ 100 kHz

shall be rejected.

- E. Each phase shall be equipped with green indicator lights. The TVSS shall also have an audible alarm and Form C Contacts.
- F. Minimum Repetitive Surge Current Capability shall be as per ANSI/IEEE C62.41 and ANSI/IEEE C62.45 -1992 suppression filter system must be repetitive surge tested in every mode. Utilizing a 1.2 x 50µsec 20kV open circuit voltage, 8 x 20µsec 10kA short circuit current Category C3 Combination waveform at one minute interval without suffering either performance degradation or more than 10% deviation of clamping voltage at a specified surge current.
- G. The TVSS shall have a minimum total surge current capacity, based on a standard 8x20 microsecond waveform as follows: 200 kA/Phase.

2.12 ISOLATED GROUND

- A. The PDU system shall have an isolated ground bus.

2.13 DUAL INPUT POWER SOURCE

- A. The PDU shall include two input main circuit breakers to provide over-current protection and a means of disconnecting power to the unit. Both input main breakers shall have the same characteristic and features as the standard input main breaker as previously described.
- B. The (2) input main breakers shall be mechanically interlocked by means of Kirk Key interlock. Instruction (CE70236H01) for transition from one source to the other shall be provided. One 120V permissive signal (NO) from customer shall be required to start the transition if the synch-check relay is not equipped.
- C. The shunt trip mechanism for both input breakers shall be activated consecutively whenever the unit shut down is required. For example, transformer over temperature (200°C) occurs.

PART 3 EXECUTION

3.1 INSTALLATION, INSPECTION, AND FACTORY AUTHORIZED STARTUP

- A. Factory start-up, preventative maintenance and full service for the above specified system shall be available and included upon request. The manufacturer shall nationally employ their own internal service organization of factory-trained personnel dedicated to the start-up, maintenance and repair of the manufacturer's power equipment.
- B. The manufacturer shall offer, as an option, 7x24 on-site service support with

guaranteed response times of 8, 4, or 2 hours.

3.2. INSTALLATION AND START UP SHALL INCLUDE THE FOLLOWING

A. Visual Inspection

1. Visually inspect all equipment for signs of damage and/or foreign materials.
2. Observe type of ventilation, room cleanliness, and the proper application of safety signs.

B. Mechanical Inspection

1. Check all internal power connections for proper tightness (torque).
2. Check all control wiring terminations and plugs for tightness and/or proper connection.
3. Check all PCBA's for proper configuration wiring or jumper settings.
4. Ensure all subassemblies, barriers, and safety guards are installed and secure.

C. Electrical Pre-check

1. Verify modules have been installed in accordance to their installation documentation.
2. Check system for phase to ground shorts internally and externally of the cabinet.
3. Check system for phase to phase shorts internally and externally of the cabinet.

D. Initial Unit Energization

1. Check input power terminations for proper supply voltage and phase rotation.
2. Check all power supply voltages and lamp tests, adjust as necessary.
3. Check all internal and output voltages are within acceptable tolerances.

E. System Monitoring and Control Settings

1. Level 3 Check all measured and displayed values are within acceptable tolerances.
2. Check all alarm and operating transition threshold settings.
3. Check all remote monitor operations and displayed parameters.
4. Verify local and remote EPO operation.

F. Waveforms

1. Check all utility input waveforms (voltage and current)
2. Check primary output waveforms (voltage and current)
3. Check logic power supply ripple waveform.

G. System Verification after Critical Loads Have Been Applied

1. Recheck all measured and displayed values (volts, amps, frequency, and power).
2. Recheck all input and output, voltage and current waveforms.
3. Verify output voltage regulation is within acceptable tolerances.

3.3 TRAINING

- A. Concurrent with factory authorized system startup the manufacturer's field service engineer shall train the owner's operating personnel in the proper operation of the system. Training shall last a minimum of one hours and shall include:
1. Safety precautions
 2. Features and construction of project equipment
 3. Voltage adjustment procedures
 4. Routine inspection and test procedures, if applicable
 5. Routine cleaning
 6. Reading and interpretation of statuses and alarms

END OF SECTION

SECTION 16500

LIGHTING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. All Drawings and General Provisions of the Contract, including General Conditions, Supplementary Conditions, and other Division 1 Specification Sections apply to this Section.
- B. Applicable items in all other Electrical Sections shall be included in this Section.

1.2 DESCRIPTION OF WORK

- A. Contractor shall furnish and install all lighting fixtures as shown in fixture schedule and at locations indicated on drawings. This includes all fixtures with lamps, necessary supports, etc., for a complete and safe installation, along with wiring and connections thereto. Where fixture model number and description differ, fixture description shall be followed.
- B. All recessed fixtures installed in plaster ceilings shall be furnished with metal plaster frames.
- C. Electrical Contractor shall advise General Contractor as to the exact location of all recessed fixtures so that ceiling construction and/or joist spacing may be coordinated as necessary to permit symmetrical positioning of fixture in each room.
- D. In acoustical tile ceilings, recessed fluorescent fixtures shall be installed so as to alleviate the necessity for cutting the tile.
- E. Trims of all recessed fixtures shall be installed in a neat and workmanlike manner so as to fit tightly and evenly against the surface of the ceiling. Adapters shall be installed to compensate for slope ceilings.
- F. For acoustical tile ceilings, surface fixtures shall be centered on a tile or a tile joint, unless noted otherwise.

PART 2 - PRODUCTS

2.1 BALLASTS

- A. Ballasts for operation of all fluorescent lamps shall be HPF Electronic with Class A Sound Rating.
- B. Fluorescent ballasts for operation of F32 T8 rapid start lamps shall be electronic high-efficiency type with the following characteristics:
 - 1. Operate multiple lamps as parallel circuit, operating remaining lamps at full light output upon failure of other lamps connected to the same ballast.
 - 2. Operate at rated circuit voltage, at an input frequency of 60 Hz, and tolerate +/- 10% sustained voltage variation without damage to the ballast, and maintain light output at +/- 10% voltage variation.
 - 3. Comply with EMI and RFI limits set by the FCC (CRF 47 Part 18) for non-consumer applications and not interfere with normal electrical equipment.
 - 4. Power Factor shall be not less than 0.95.
 - 5. Total Harmonic Distortion shall be less than 10%.
 - 6. Lamp Crest Factor shall be 1.7 or less.
 - 7. Withstand transients shall be as specified by ANSI C.62.41 for location category A.
 - 8. Shall comply with applicable ANSI standards.
 - 9. Shall be provided with a three (3) year warranty.
- C. Individual ballasts specifically designed and UL Listed are to operate one, two, three, or four lamps as scheduled on the drawings.
- D. Ballast Factor shall be greater than 0.85, and sound rating shall be "A".

2.2 LAMPS

- A. Lamps may operate in instant start mode, and shall operate at a frequency higher than 20 kHz.
- B. All incandescent lamps shall be furnished inside frosted except where specifically noted otherwise.
- C. T8 fluorescent lamps shall be four (4') feet long, bi-pin, rapid start, 3500 K, 85 CRI, except where specifically noted otherwise.
- D. All H.I.D. lamps shall be phosphor coated, wattage as specified in the drawings.
- E. Where they are indicated, exit fixtures shall have LED lamps and shall have letters at least five (5") inches high on a metal stencil with a red translucent background. Exit fixtures shall be wall mounted (unless ceiling mounted is required for the particular location) above doors as shown on drawings, and shall be mounted such that viewing angles are maximized.

2.3 MANUFACTURERS

- A. Certain items in this Specification are listed by manufacturer and/or manufacturer's model number to establish general style, type, character, and quality of product

desired. Similar items manufactured by other than those listed will be considered, providing submittals are made according to substitution requirements of the General Specifications. Where fixture description provided is in conflict with the model number provided, contractor shall provide a light fixture meeting the description, not the model number.

- B. See Lighting Fixture Schedule on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fixtures to be installed in or on painted ceilings and/or walls shall not be installed until painting is completed. Fixtures installed with paint applied over factory finishes will be rejected.
- B. For any type ceiling which itself does not provide sufficient support for fixtures, support fixtures from structure above. Lay-in troffers in grid type ceilings shall be installed with at least 2 supports on diagonal corners.

END OF SECTION

SECTION 16550

DIMMING SYSTEM

PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION

- A. The intent of this specification is to define parameters for furnishing and installing a complete working system to the Owner. The dimming equipment provider shall provide coordination with all associated trades to insure a proper and correct installation. The system is designed to meet specific operational requirements. Performance deviations will not be accepted.
- B. The system shall be designed for the control of architectural and theatrical lighting and shall consist of factory pre-wired dimming and processing rack enclosures containing dimmers, power supplies, breakers, terminals and/or control electronics.
- C. System shall work in conjunction with specified low-voltage control stations.

1.2 SUBMITTALS

- A. Six sets of full system submittals shall be furnished for approval within 60 days of award of Contract. Prior to fabrication of equipment, two sets shall be returned appropriately marked as the approval document.
- B. Manufacturer shall provide any additional information, including equipment demonstration, as required by the engineer or specifier to verify compliance with specifications.

1.3 QUALITY ASSURANCE

- A. Manufacturer shall be one who has been continuously engaged in the manufacturer of lighting control equipment for a minimum of ten years. All dimmer and cabinet fabrication must take place in a U.S. manufacturing plant.
- B. The manufacturer shall have a factory authorized stocking service center with at least one full time service technician on stall located within 150 miles of the job site. In addition, the manufacturer shall have a toll free 24-hour hotline with a maximum response time of 20 minutes, 24 hours a day and 365 days a year.
- C. All equipment, where applicable standards have been established, shall be built to the standards of Underwriters Laboratories, Inc., the National Electric Code and the United States Institute for Theater Technology. Permanently installed power distribution equipment such as dimmer racks and distribution shall be UL and C-UL Listed, and/or CE

marked (where applicable) and bear the appropriate labels. Portable equipment such as consoles and fixtures shall be UL and C-UL Listed, ETL Listed and/or CE marked (where applicable) and bear the appropriate labels.

PART 2 - PRODUCTS

2.1 RACK ENCLOSURES

- A. The rack enclosure shall be the Unison DRd Series Control Enclosure as manufactured by Electronic Theatre Controls, Inc., or approved equal.
- B. Mechanical
 - 1. The Rack Enclosure shall be a surface mounted, deadfront switchboard, constructed of 18-gauge formed steel panels with a hinged, lockable full-height door containing an integral electrostatic air filter.
 - a. Filter shall be removable for easy cleaning.
 - b. The enclosure shall support one control processor and one station power module plus accessories
 - c. The enclosure door shall have an opening to allow limited access to the control module face panel.
 - 2. All rack components shall be properly treated and finished.
 - a. Exterior surfaces shall be finished in fine textured, scratch-resistant, epoxy paint.
 - 3. The fully digital rack enclosure shall be available with six or twelve dimmer module spaces, one processor and a single station power supply, Rack dimensions and weights (without modules) shall not exceed:
 - a. DRd621.9" H x 17" W x 9.6" D 38 lb.
 - b. DRd1231.0" H x 17" W x 9.6" D 51 lb.
 - 4. A single low-noise fan shall be located at the top of each rack. The fan shall draw all intake air through the integral electrostatic air filter, over the surfaces of the module housing and out the top of the rack.
 - a. The fan shall maintain the temperature of all components at proper operating levels with dimmers under full load, provided the ambient temperature of the dimmer room does not exceed 40°C/104°F.
 - b. In the event of an over-temperature condition, only the affected dimmer module(s) shall shut down. A red indicator LED will flash and an error message shall appear on the Control Processor.
 - 5. Rack Enclosures shall be designed to allow easy insertion and removal of dimmer and control modules without the use of tools. (230 volt racks with CE certification shall require a screwdriver.)
 - a. Supports shall be provided for precise alignment of modules into power and signal connector blocks.
 - b. With modules removed, racks shall provide clear front access to all load, neutral and control wire terminations.
 - 6. Rack Enclosures shall support use of any combination of rack option cards designed to provide additional rack features. Rack option cards shall include:

- a. FLO - The Fluorescent Option Board shall provide termination for 4 wire low voltage electronic fluorescent dimming ballasts. FLO shall provide 24, 0-10Vdc outputs.
- b. DALI - The DALI Option Board shall provide termination for DALI fluorescent dimming ballasts. FLO shall provide 24, DALI outputs for up to 63 ballasts each in a broadcast mode.
7. Optional floor mounting pedestal shall be available for the 12-module rack.
8. Racks enclosures shall be designed for use with AX series auxiliary racks for Main Circuit Breaker, Main Lug, and cross bussing applications.
9. The following Accessories shall be provided:
 - a. RideThru Option (RTO)
 - 1) The Rack Enclosure shall support a short-term back-up power source for the control electronics.
 - 2) The short-term back-up power source shall automatically engage upon the loss of normal power, seamlessly transitioning the supply power for the control electronics power to itself.
 - 3) The short-term back-up power supply shall detect the return of normal power, and seamlessly return the control electronics to normal power.
 - 4) The short-term back-up power source shall support the control electronics for at least 10 seconds.
 - b. BatteryPack Option (BPO)
 - 1) The Rack Enclosure shall support a long-term back-up power source for the control electronics.
 - 2) The long-term back-up power source shall automatically engage upon the loss of normal power, seamlessly transitioning the supply power for the control electronics power to itself.
 - 3) The long-term back-up power supply shall detect the return of normal power, and seamlessly return the control electronics to normal power.
 - 4) A test switch/indicator shall be available without opening the rack door or removal of any modules/components.
 - 5) The long-term back-up power source shall supply power to the control electronics for at least 90 minutes.

C. Electrical

1. Rack enclosures shall be available in 100, 120, 230, 240 and 277 volt, three-phase, main lug configurations. 120 volt rack enclosures shall be field configurable for single phase operation without the need for additional components
2. Rack enclosures shall be completely pre-wired by the manufacturer. The contractor shall provide input feed, load, and control wiring.
3. Standard Short Circuit Current Ratings (SCCR) shall be 22,000 at 100-277 Volt Higher SCCR ratings, up to 100,000 SCCR, shall be possible when used with an AX series Auxiliary Rack Enclosure.
4. All control wire connections shall be terminated via factory provided connectors.
5. Rack enclosures shall support dimming for incandescent, fluorescent, neon, cold cathode, electronic low voltage and magnetic low voltage transformer load types.
6. The rack enclosure shall support 16-bit DMX input
7. The rack enclosure shall support 65,000 steps of dimming.
8. The rack enclosure dimming engine shall support multiple dimmer curves including modified square law, linear, switched, fluorescent, pre-heat and electronic low voltage.

9. The rack enclosure shall support voltage regulation including, minimum and maximum scale voltages with offsets
10. Rack enclosure shall support a UL924 listed contact input for emergency lighting control bypass. Emergency lighting input shall support load shedding
11. Rack enclosures shall be designed to support the following wire terminations:
 - a. AC
 - b. Echelon link power (Belden 8471 or equivalent)
 - c. 24Vdc (2- 16AWG Wire)
 - d. DMX512A Port A (In or Out) (Belden 9729 or equivalent)
 - e. DMX512A Port B (Out) (Belden 9729 or equivalent)
 - f. RS232 Serial In/Out (Belden 9729 or equivalent)
 - g. Unshielded Twisted Pair (UTP) Category 5/5e Ethernet
 - h. Contact Closure In (14AWG to 26AWG Wire)
 - i. Contact Closure Out (14AWG to 26AWG Wire)
 - j. Contact Closure Out shall provide 1A @ 30vDC
12. Station Power Modules
 - a. Station power modules shall provide LinkPower for up to 32 stations and 1.5A@24VDC of Auxiliary (AUX) power.
 - b. Station power repeater modules shall provide LinkPower for 30 stations and 1.5A@24VDC of Auxiliary (AUX) power.
 - c. Station power module shall support over-current/short protection for LinkPower and Auxiliary (AUX) power. LinkPower shall support fault detection on each leg of the balanced data bus.
13. All control wire connections shall be terminated via factory provided connectors.
14. Main feed lugs shall accept a maximum of 350 MCM wire.
15. Load terminals shall accept a maximum of #6 AWG wire.

D. Thermal

1. Ambient room temperature: 0-40°C / 32-104°F
2. Ambient humidity: 10-90% non-condensing

2.2 CONTROL PROCESSOR MODULES

- A. The Architectural Control Processor shall be the Unison Paradigm P-ACP Series Control Processor as manufactured by Electronic Theatre Controls, Inc., or equal.
- B. The Architectural Control Processor (ACP) assembly shall be designed for use in DRd Series Dimming Enclosures and ERn Series Control Enclosures.
- C. The processor shall utilize microprocessor based, solid state technology to provide multi-scene lighting and building control.
 1. ACP shall support functions such as station programming, macro sequencing, electronic lockout, room combine and astronomical time clock events. ACP station processor shall allow configuration of the control system via the menus. See software section for additional system details.
 2. When used in a dimming enclosure, the ACP shall allow access to dimming control menus including the status screen, dimming configuration screen, backup menu, test menu and configuration menu.

- D. One ACP shall be rated to drive 1024 channels of control, 1024 zones, 64 rooms, 512 presets, 62 button or button/fader stations and 6 Touchscreen Stations
- E. ACP module electronics shall be convection cooled.
- F. The ACP shall provide front-panel RJ45 jack, Secure Digital (SD) card slot, and Universal Serial Bus (USB) Port for configuration and data exchange.
- G. Architectural Lighting System configuration and program information shall be stored in flash memory, which does not require battery backup.
- H. The ACP shall be contained in a plug-in assembly and require no discrete wiring connections; all wiring shall be terminated into Dimming or Control Enclosure. The ACP shall support the following communications:
 - 1. Echelon LinkPower
 - 2. 10/100BaseTX, auto MDI/MDIX, 802.3af compliant Ethernet networking with TCP/IP, ESTA BSR E1.17 Advanced Control Networks (ACN) and ESTA BSR E1.31 (sACN) Protocols
 - 3. EIA-232 serial protocol
 - 4. ESTA DMX512A, configurable as input or output ports
 - 5. Dry contact closure inputs
 - 6. Dry contact closure outputs, rated at 1A@30VDC

2.3 TOUCHSCREEN CONTROL STATIONS

- A. The Touchscreen Control Stations shall be the Unison Paradigm Touchscreen P-LCD Series Control Stations as manufactured by Electronic Theatre Controls, Inc., or approved equal.
- B. General
 - 1. Touchscreen stations shall support default and fully graphical control pages.
 - 2. The Touchscreen station shall operate using graphic buttons, faders and other images on at least 30 separate programmable control pages.
 - 3. Touchscreen stations shall also allow programming of page pass-code, lock out and visibility levels.
- C. Mechanical
 - 1. Touchscreen stations shall consist of a seven inch, backlit liquid crystal display (LCD) with a minimum resolution of 800 by 400 pixels and 12-bit color depth with a touch interface.
 - 2. Touchscreen bezels shall be constructed of aluminum and shall have no visible means of attachment.
 - a. The bezel shall install and remove without the use of tools.

- b. The bezel shall provide two working positions for the Touchscreen: service and operating.
 3. The Touchscreen shall have a protective overlay over the display.
 - a. The overlay shall reduce wear
 - b. The overlay shall reduce glare
 4. The manufacturer shall provide backboxes for all LCD stations.
 - a. Flush back box dimensions shall be 7.94" wide x 5.33" high x 3.25" deep
 - b. Surface back box dimensions shall be 8.3" wide x 5.6" high x 2.55" deep

D. Electrical

1. Touchscreens shall be powered entirely by the System network.
2. Touchscreens shall connect to the System using an Ethernet network with Power over Ethernet (PoE) or the Unison control station Echelon® Link power network.
 - a. Ethernet Network
 - 1) Ethernet network shall be 10/100BaseTX, auto MDI/MDIX, 802.3af compliant.
 - 2) Network shall utilize Unshielded Twisted Pair (UTP) Category 5 wiring.
 - b. Echelon® Link power network.
 - 1) Link power shall utilize low-voltage Class II unshielded twisted pair, type Belden 8471 or equivalent, and one #14 ESD drain wire (when not installed in grounded metal conduit).
 - 2) Touchscreen stations shall also require (2) #16 AWG stranded wires for 24Vdc operating power. 24Vdc wiring shall be topology free.
 - 3) Network wiring may be bus, loop, home run, star or any combination of these.
 - 4) Network insulation displacement connectors shall be provided with all stations.

E. Functional

1. System
 - a. The Touchscreen shall support configuration firmware upload from a Paradigm Processor as proxy
 - b. The Touchscreen shall support configuration or firmware upload from local removable media
2. Setup Mode
 - a. There shall be a setup display that is separate from any user-defined configuration
 - b. It shall be possible to view and modify connectivity settings
 - c. It shall be possible to view status information
 - d. It shall be possible to view and modify LCD screen settings
 - e. It shall be possible to perform Touchscreen calibration
 - f. It shall be possible to view and modify audio settings
 - g. The appearance of the setup display shall be standard and not editable
 - h. The setup display may be invoked from within the user-defined configuration and/or physical button on the Touchscreen
 - i. There shall be a default protected method to invoke the setup display
3. Configurations
 - a. It shall be possible to have multiple configurations stored within an LCD Station
 - b. Only one configuration may be active on the LCD Station

- c. It shall be possible for Touchscreen Stations connected via the Echelon® Link power network to select a configuration automatically based on the configuration of the physical connection.
 - d. Where multiple configurations are stored there shall be a boot menu to allow selection of a configuration
 - e. Each configuration shall be identified as a different Station within the System
4. Operation
- a. The Unison Paradigm Control System shall be designed to allow control of lighting and associated systems via Touchscreen controls. System shall allow the control of presets, sequences, macros and time clock events.
 - 1) System presets shall be programmable via Button, Button/Fader, Touchscreen, or LightDesigner software.

Presets shall have a discrete fade time, programmable from zero to 84,600 seconds with a resolution of one hundred milliseconds.

Presets shall be selectable via Touchscreen stations.

- 2) System macros and sequences shall be programmable via LightDesigner system software.

Macro and sequence steps shall provide user selectable steps, and allow the application of conditional logic.

Macro and sequences shall be activated by button, time clock event or LightDesigner software.

- 3) System time clock events shall be programmable via the Touchscreen, LightDesigner system software, the processor user interface, or the internal web server.

Time clock events shall be assigned to system day types. Standard day types include: anyway, weekday, weekend, Sunday, Monday, Tuesday, Wednesday, Thursday, Friday and Saturday. System shall support programming of additional custom or special day types.

Time clock events shall be activated based on sunrise, sunset, time of day or periodic event. System shall automatically compensate for regions using a fully configurable daylight saving time.

- b. Touchscreen stations shall be designed to operate standard default or custom system functions. Components shall operate default functions unless re-assigned via LightDesigner, the Windows-based configuration program.
 - 1) Optional button functions include: preset selection, manual mode activation, record mode activation, station lockout, raise, lower, macro activation, and cue light, or room join/separate.
 - 2) Optional fader functions include master control, individual channel control, fade rate control or preset master control.
- c. Touchscreen stations shall allow programming of station and component electronic lockout levels via LightDesigner.
- d. It shall be possible to adjust LCD contrast and brightness.
- e. It shall be possible to program the station to dim during periods of inactivity.

2.4 STATIONS

- A. The Lighting Control Stations shall be the Unison Heritage UH Series Control Stations as manufactured by Electronic Theatre Controls, Inc., or equal.
- B. Mechanical
 - 1. Unison Heritage Button and Button/Fader Stations shall operate using up to sixteen programmable faders and twelve programmable buttons.
 - 2. All button/fader stations shall be available with white, cream, ivory, gray or black faceplates, fader knobs, and buttons. Manufacturer's standard colors shall conform to the RAL CLASSIC Standard.
 - 3. Stations shall have indicators lights at each button or fader.
 - a. Indicators shall be comprised of red, green and blue LED's
 - b. Indicator color and state (steady On, Blink, Off) shall be configured in software, and shall operate relative to the button or fader it is associated with.
 - 4. All faceplates shall be designed for flush or surface mounting.
 - 5. Station faceplates shall be constructed of ABS plastic and shall use no visible means of attachment.
 - 6. Station faceplates shall be indelibly marked for each button or fader function.
 - 7. The manufacturer shall supply back boxes for flush mounted half gang stations and for all surface mounted stations.
- C. Functional
 - 1. The Unison Paradigm Control System shall be designed to allow control of lighting and associated systems via Button, Button/Fader, and Interface or Astronomical time clock controls. System shall allow the programming of presets, sequences, macros and time clock events.
 - 2. Station Button, Button/Fader, and Interface) control components shall be designed to operate standard default or custom system functions. Components shall operate default functions unless re-assigned via LightDesigner, the Windows-based configuration program.
 - 3. Stations (Button and Button/Fader) shall allow programming of station and component electronic lockout levels via LightDesigner.
- D. Electrical
 - 1. Unison control station wiring shall be an Echelon® Link power network.
 - a. Link power shall utilize low-voltage Class II unshielded twisted pair, type Belden 8471 or equivalent, and one #14 ESD drain wire (when not installed in grounded metal conduit).
 - b. Touchscreen and Interface stations shall also require (2) #16 AWG stranded wires for 24Vdc operating power. 24Vdc wiring shall be topology free.
 - c. Network wiring may be bus, loop, home run, star or any combination of these.
 - d. Network insulation displacement connectors shall be provided with all stations.

PART 3 - EXECUTION

3.1 ENERGIZATION

- A. A qualified Service Representative employed full time by the manufacturer shall visit the job site after the installation is complete and prior to the energization of the system to inspect, test and adjust the system. Instruction shall be provided for the Owners' representatives in the operation and maintenance of the system. These services shall not exceed one (1) day and shall be provided with a minimum of fourteen (14) days written notice by the contractor.

3.2 MANUFACTURER SERVICES

- A. Service shall be provided directly by the manufacturer and service visits shall be made within twenty four (24) hours.

3.3 WARRANTY

- A. Manufacturer shall warrant products under normal use and service to be free from defects in materials and workmanship for a period of two years from date of delivery
- B. Warranty shall cover repair or replacement of such parts determined defective upon inspection.
- C. Warranty does not cover any product or part of a product subject to accident, negligence, alteration, abuse or misuse. Warranty does not cover any accessories or parts not supplied by the manufacturer.
- D. Warranty shall not cover any labor expended or materials used to repair any equipment without manufacturer's prior written authorization.

END OF SECTION

SECTION 16650

FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 SCOPE:

- A. This specification describes a Fire Detection and Alarm system. The control panel, shall be intelligent device addressable, analog detecting, low voltage and modular, with digital communication techniques, in full compliance with all applicable codes and standards. The features and capacities described in this specification are required as a minimum for this project and shall be furnished and installed by the Contractor.
- B. The system shall be in full compliance with National and Local Codes.
- C. The system shall include all required hardware, raceways, interconnecting wiring and software to accomplish the requirements of this specification and the contract drawings, whether or not specifically itemized herein.
- D. All equipment furnished shall be new and the latest state of the art products of a single manufacturer, engaged in the manufacturing and sale of analog fire detection devices for over ten years.
- E. The system as specified shall be supplied, installed, tested and approved by the Local Authority Having Jurisdiction, and turned over to the owner in an operational condition.
- F. The system specified shall be that of Siemens Fire Safety or approved equal, which meets the project requirements. Alternate Manufacturers may submit prior to bid date for approval by the Architect. The system submittal shall meet all the requirements spelled out in this specification, with any deviations noted. Failure to note these deviations shall be cause for rejection.

1.2 RELATED WORK

The following Sections of the Specifications shall apply to this work:

Division 1	Bidding Requirements and Conditions Of The Contract.
Division 16	Section 16050 Electrical Material & Methods.
Division 15	Section 15500 Fire Suppression Systems.
Division 15	Section 15950 Building Temp. Control & Energy Mgmt.
Division 8	Section 08700 Door Hardware.

1.3 STANDARDS & CODES

- A. The publications listed below form a part of this publication to the extent referenced. The publications are referenced in the text by the basic designation only. The latest version of each listed publication shall be used as a guide unless the Authority Having Jurisdiction has adopted an earlier version.
- B. National Fire Protection Association (NFPA) Most current or approved Standard
 1. NFPA 13 Standard For The Installation of Sprinkler Systems.
 2. NFPA 13A Recommended Practice For The Inspection, Testing And Maintenance of Sprinkler Systems.
 3. NFPA 70 National Electrical Code.
 4. NFPA 72 National Fire Alarm Code.
 5. NFPA 90A Standard For The Installation of Air Conditioning And Ventilating Systems.
 6. NFPA 101 Life Safety Code.
- C. Underwriters' Laboratories, Inc. (UL) Appropriate "UL" equipment standards.
 1. "UL" 864 Control Panels.
 2. "UL" 268 Smoke Detectors.
 3. "UL" 268A Smoke Detectors (HVAC).
 4. "UL" 464 Audible Signal Appliances.
 5. "UL" 1971, Standard for Visual Signaling Appliances.
- D. Building Codes
 1. Standard Building Code and the Standard Fire Code.
 2. Uniform Building Code and the Uniform Fire Code.
 3. International Building Code and the International Fire Code.
 4. NFPA 5000 Building Code.
 5. State and Local Building Codes as adopted and/or amended by The Authority Having Jurisdiction.
 6. ADA, and/or State and local equivalency standards as adopted by The Authority Having Jurisdiction.

1.4 QUALIFICATIONS OF INSTALLERS

- A. Before commencing work, submit data showing that the manufacturer has successfully installed fire alarm systems of the same scope, type and design as specified.
- B. The contractor shall submit copies of all required Licenses and Bonds as required in the State having jurisdiction. Contractor shall be licensed by the State of Louisiana Fire Marshall as a Fire Alarm Contactor.
- C. Provide the services of a factory trained and certified representative or technician, experienced in the installation and operation of the type of system provided. The representative shall be licensed in the State if required by law. The technician shall supervise installation, software documentation, adjustment, preliminary testing, final testing and certification of the system. The technician shall provide the required instruction to the owner's personnel in the system operation and maintenance.

1.5 SUBMITTALS

A. The contractor shall include the following information in the equipment submittals:

1. Power calculations. Battery capacity calculations. Battery size shall be a minimum of 125% of the calculated requirement. Supervisory power requirements for all equipment. Alarm power requirements for all equipment.
2. Power supply rating justification showing power requirements for each of the system power supplies. Power supplies shall be sized to furnish the total connected load in a worst-case condition plus 25% spare capacity.
3. Voltage drop calculations for Notification circuit wiring runs demonstrating worst-case condition.
4. NAC circuit design shall incorporate a 15% spare capacity for future expansion.
5. Submit manufacturer's requirements for testing Device Loop Card circuits and device addresses prior to connecting to control panel.
6. Complete manufacturers catalog data including supervisory power usage, alarm power usage, physical dimensions, and finish and mounting requirements.
7. Complete drawings covering the following shall be submitted by the contractor for the proposed system:
 - a) Floor plans in a CAD compatible format showing all equipment and raceways, marked for size, conductor count with type and size, showing the percentage of allowable National Electric Code used.
 - b) Provide a fire alarm system function matrix as referenced by NFPA 72. Matrix shall illustrate alarm input/out events in association with initiation devices. Matrix summary shall include system supervisory and trouble output functions. Include any and all departures, exceptions, variances or substitutions from these specifications and/or drawings at time of bid.
8. Incomplete submittals shall be returned without review.
9. Contractor shall provide all documents required by the State Fire Marshal to review. Documents shall include all calculations and data necessary. These documents shall be sent to the Architect for his forwarding to the State Fire Marshal. This Contractor shall pay all fees associated with the Fire Marshal submittal. No work shall be done until the submittal is approved and returned from the Fire Marshal.

1.6 SYSTEM REQUIREMENTS

A. The system shall be a complete, electrically supervised fire detection and notification system, microprocessor based operating system having the following; capabilities, features and capacities:

1. Single addressable loop
2. 252 addressable initiation device capability as a minimum.
3. Each address shall be capable of supporting one input and one out put, for a total of 504 programmable points on a single loop.
4. Addressable devices shall be polarity insensitive.

5. Addressable devices shall operate on "standard wire" no special twist or shield shall be required
6. 4 notification circuits capable of Style Y (Class B), or 2 notification circuits capable of Style Z (Class A).
7. Optional relays or LED drivers for graphic annunciation.
8. Optional Remote annunciator/control panel.
9. Optional DACT capable of sending point information to a Central Station depending on protocol required by the Central Station.
10. 80-character backlit LCD display with 40 character Customer defined message.
11. Be programmable from system keypad or Laptop computer.

1.7 SYSTEM OPERATION

- A. Activation of any manual pull station, smoke detector, heat detector or sprinkler water flow switch shall activate the building notification appliances throughout the building including a pre-recorded voice evacuation message broadcast throughout the entire building, and shall signal the Central Station to an alarm condition, if the DACT is installed.
- B. Activation of a supervisory device shall sound an audible and light LED at the control panel to signal a supervisory condition.
- C. Activation of a supervisory causing device shall signal the Central Station to a supervisory condition, if the DACT is installed.
- D. Activation of a trouble shall sound an audible and light an LED at the control panel to signal a trouble condition.
- E. Activation of a trouble shall signal the Central Station to a trouble condition, if the DACT is installed.

PART 2 - PRODUCTS

2.1 CONTROL PANEL

- A. The control panel shall have digital communications, addressable devices, control points and relays. The system shall have the following;
 1. Application specific fire detection
 2. Auto configuration, which, reads all addressed devices on the loop and automatically creates a basic general alarm configuration
 3. Manual changes by the Owner or Siemens distributor without special tools.
 4. Windows type software to make configurations easier.
 5. Eighty- (80) character backlit LCD display with full system control and up to forty (40) character available for custom message on display.
 6. Fully field programmable from the local display or by a PC configuration tool.

7. 2000-event history log.
 8. Alarm verification
 9. Cross zoning
 10. Positive Alarm Sequence
 11. Walk test by a single individual in either a silent or audible mode.
 12. Maintenance and Technician level with Password protection.
 13. Up to 252 addressable initiation devices with the ability for 504 programmable points.
 14. Addressable initiating devices shall be polarity insensitive
 15. Addressable initiating devices shall operate on standard wire, no special twist or shield shall be required
 16. 4 notification circuits capable of Style Y (Class B), or 2 notification circuits capable of Style Z (Class A).
 17. Built-in RS-232 port for computer connection
- B. The system shall have the ability for programmable form C relays, with contact ratings of 1 amp @ 28 VDC. Each relay module can support up to three (3) relay boards with each board containing 8 relays for a total of up to 24 relays. The relay module is Model FS-RU2. For additional relays a relay extender module shall provide up to three (3) relay boards of eight (8) relays each. A maximum of eight (8) relay modules for a total of 192 relays per system can be supported simultaneously within the system.
- C. The system shall have the ability to support off site reporting modules within the enclosure and with one of the following modules;
1. A system DACT shall be supplied with the following;
 - a) Support two (2) lines and up to four (4) accounts
 - b) Can transmit serial information by point to the Central or Remote Station.
 - c) Be capable of transmitting information in the following protocols as a minimum; SIA DCS 8, SIA DCS 20, Ademco Contact ID, 3/1 1400 Hz, 3/1 2300 Hz, 4/2 1400 Hz and 4/2 2300Hz.
 - d) The DACT module shall be Model FS-DACT.
 2. A Municipal Tie/Lease Line module shall provide local energy output for municipal call box connection or a reverse polarity output for lease line connection. The module shall be model FS-MT. The system described shall be Siemens Model FS-250.
- D. The local control shall have voice evacuation capabilities integrated into the software, hardware and operating system. The audio capabilities shall be furnished as follows:
1. The audio control modules supplied shall communicate with the fire alarm master via high speed network communications lines.
 - a. Provide a microphone, microphone supervision and all required pre-amplifier circuitry.
 - b. A backup tone card shall be furnished for the audio control module.

2. The integrated voice system shall utilize local or distributed amplification as required for optimum system performance and configuration.
 - a. The voice system amplifiers shall be capable of operating 25 vrms and/or 70 vrms speakers as required to optimize system performance. The amplifiers shall be modular in 100 watt or 30 watt modules as required for system configuration, providing power as required to supply a minimum of 2.0 watts of power for each connected system speaker. Amplifiers shall automatically transfer to standby battery when commercial power fails or is disconnected.
3. The integrated voice system shall be capable of operation of three voice channels simultaneously; Evacuation, Alert and Auxiliary. Systems using a dedicated paging channel shall not be considered equal.
 - a. Amplifiers shall be configured for single channel, two channel or 3 channel use to satisfy system operational requirements.
 - b. All amplifiers shall be supervised and provide automatic switching to backup amplifier output in the event of amplifier failure.
4. The master microphone module and master telephone shall be permanently mounted behind the locked access door, visible through the viewing window and provide firefighters with the means of issuing voice message instructions to specific audio zones, groups of zones or all zones. The microphone, telephone, and the press-to-talk switches shall be supervised. This module shall contain a local speaker with volume control to monitor selected audio channels.
5. The voice system shall be operable as a voice node on the external voice network composed of up to sixty three self standing network panels, allowing paging to or from other external network nodes as selected in system programming.
 - a. The voice network shall be capable of configuration using conventional hard wired techniques or fiber optics transmission systems.
6. Voice digitizer modules shall be furnished as required to satisfy the system operating requirements with the following capacities and capabilities:
 - a. Phrase libraries for alarm and alert channels, each storing in excess of 100 phrases which, when linked via software, will comprise evacuation alert and announcement messages of any length required. Additional phrases as required shall be recorded or downloaded using a microphone or tape recorder for use in system messages.
 - b. Phrase selection shall be accomplished as a software function of the control panel programming. Systems using separate programming for the voice digitizer shall not be acceptable due to the possibility for programming changes within one or the other creating conflicting messages as an output.

- c. Software control of message generation using phrases from the selected library, duration selectable pauses, tones, and on site recorded phrases as desired. A total of two phrase libraries shall be available on multi-channel systems.
 - d. Minimum message capacity shall be 500 messages; 250 evacuation and 250 alert messages. Messages shall be repeatable as selected in software.
 - e. Messages shall be selected for distribution to any combination of speaker zones within the system and initiated as a result of any input logic function, time control or software function key.
 - f. The digitizer shall support spoken coded operation, allowing the code to be broadcast without the delay and errors inherent in counting pulses on conventional notification appliances.
 - g. The voice digitizer shall support a spoken one person walk test, announcing the test and announcing the system address of each device as it is tested, it's function (alarm, supervisory, trouble), and completing with a confirmation that the test of that device has been completed.
 - h. Messages shall be delivered in a prioritized order with a minimum of ten priority levels available.
 - i. Systems requiring external inputs such as relays or solid state switches, jumper or dip switch selection, or custom module inter-wiring shall not be considered acceptable.
7. Furnish supervisory circuitry for amplifiers, speaker circuits and visual circuits in quantities as required by system design. All audible and visual notification circuits shall be power limited.
- a. Furnish for the display of fire sprinkler system status, annunciator modules comprised of eight software programmed LED's, in quantities as required to indicate real time alarm supervisory and trouble status of each system waterflow switch and valve supervisory switch. A valve closure shall cause all waterflow indicators effected by that closure to flash yellow, indicating the lack of water supply for that sprinkler system branch.

2.2 POWER SUPPLY

The power supply shall be capable of 6 amps. A maximum of 3.0 amps available for the NAC circuits. This shall be expanded to 6 amps by adding an additional transformer. The power supply/battery charger shall support up to 38AH battery sets.

2.3 ENCLOSURE

The system enclosure shall be sized to carry all the modules required to meet the specification requirements.

2.4 PRINTER INTERFACE

An interface for a printer shall be provided to allow system events shall be printed.

2.5 REMOTE ANNUNCIATOR

A Remote Annunciator shall provide all the system reporting found on the system annunciator and has the ability to provide, remote acknowledge, silencing, and reset capability secured with a key-switch. The system shall be capable of handling up to sixteen (16) remote annunciators. The remote annunciator shall be Model FS-RD2.

2.6 FIELD PROGRAMMING UNIT

- A. The programming tool shall program the intelligent devices address. The unit shall test the loop wiring for grounds, opens and shorts. Systems not having this ability shall test all the above items and provide a written report documenting the testing procedure as required in the submittal section.
- B. The system programmer shall print labels for all addressable devices and contain the complete SLC circuit and device numbers. The programmer shall be Model DPU.
- C. Systems that do not meet these requirements will not be accepted.

2.7 ADDRESSABLE INITIATION DEVICES

- A. Smoke detectors shall be an intelligent photoelectric detector with thermal element that provides digital communications to the FACP. Detectors shall be listed for use as open area protective coverage, in duct installation and duct sampling assembly installation and shall be insensitive to air velocity changes. Detectors shall be programmable as application specific, selected in software for a minimum of eleven environmental fire profiles unique to the installed location. These fire profiles shall eliminate the possibility of false indications caused by dust, moisture, RFI/EMI, chemical fumes and air movement while factoring in conditions of ambient temperature rise, obscuration rate changes and hot/cold smoke phenomenon into the alarm decision to give the earliest possible real alarm condition report. The detector shall be designed to eliminate calibration errors associated with field cleaning of the chamber. The detector shall support the use of a relay, or LED remote indicator. The detector shall not exceed 2.5 inches of extension below the finish ceiling. Detector wiring shall not require any special cable. The intelligent smoke detector shall be Model HFP-11. Provide (10) ten additional detectors where directed by Engineer. Include approximately 25 feet of wiring, conduit and fittings for each detector.

- B. The addressable thermal detector shall be a rate of rise detector rated at 135(F. The detector shall be mounted in an DB-11, DB-HR, or ADBH-11 base Provide Model HFPT-11.
- C. The addressable detector shall be a photo only detector that uses the light scattering principle with a supervised light source and receiver. The detector shall be mounted in an DB-11, DB-HR, or ADBH-11 base. Provide Model HFPO-11.
- D. Detector bases shall be low profile twist lock type with screw clamp terminals and self-wiping contacts. Bases shall be installed on an industry standard, 4" square or octagonal electrical outlet box. Bases shall be supplied with the following features as required for performance to this specification. Select the following bases as required for design operation;
 - 1. Standard detector base Model DB-11.
 - 2. Detector relay base with software programmed addressable relay integral to the base. Detector relay base Model DB-HR.
 - 3. Detector audible base with software programmed operation of the base audible. Detector audible base Model ADBH-11.
- E. Duct Detector, Intelligent shall use one of the photoelectric detectors listed above for the sampling.
 - 1. The duct detector shall be capable of multi colored LED remote indicator light.
 - 2. The detector shall be supplied with the appropriate sampling tubes to fit the duct shall be monitored.
 - 3. Where indicated on drawings provide duct detector with remote relay that shall be operated form the control panel.
 - 4. Provide Model AD-HR/AD-11P.
- F. The manual pull station shall be addressable and semi flush mounted. Where surface mounted is required supply the manufacturers surface mount box. Supply either of the following;
 - 1. A single action pull station Model HMS-S.
 - 2. A double action pull station Model HMS-D.
- G. Furnish and install, for the monitoring of contact type initiation devices and for the control of electrical devices where required, intelligent analog signaling circuit interface module. Modules shall be supplied to meet the project requirements as follows:
 - 1. A single circuit intelligent signaling circuit interface module for monitoring alarm, trouble, supervisory or status contact type devices. Provide Model HTR I-R
 - 2. The single circuit interface shall also be available as a freestanding shrink-wrapped unit with pigtail wire leads for direct mounting with contact devices. Provide Model HTRI-M
 - 3. A single circuit intelligent signaling circuit interface module for monitoring alarm, trouble, supervisory security or status contact type devices with form C software programmable control contacts for the management of specified electrical loads as

- required by this specification. Provide Model HTRI-R
4. Dual circuit intelligent signaling circuit interface module for monitoring alarm, trouble, supervisory security or status contact type devices. Provide Model HTRI-D

2.8 NOTIFICATION APPLIANCES

- A. The Horn or horn/strobe appliance as indicated on the drawings shall be a synchronized temporal horn with a synchronized strobe light with multiple candela taps to meet the intended application. The appliance shall be red or white as indicated on the drawings. The strobe light taps shall be adjustable for 15/75, 30/75, 75, and 110 candela. The appliance shall be red for wall mounted and white for ceiling mounted. Ceiling mounted appliances shall be rated for that application. Provide model U-MHU-1G/U-MHU-MCS series, for synchronized operation. Provide Model U-MMT-1G/U-MMT-MCS series for non-synchronized operation.
- B. The electronic chime or chime/strobe as indicated on the drawings shall be a speaker with a tone card and have adjustable tone and volume capabilities. The chime or chime/strobe shall be adjustable for either single stroke or continuous operation. The chime/strobe shall be available with adjustable strobe intensities of 15/75, 30/75, 75, and 110 candela. The appliance shall be red for wall mounted and white for ceiling mounted. Ceiling mounted appliances shall be rated for that application. The model number shall be U-EC series.
- C. The strobe only appliance as indicated on the drawings shall be a synchronized/non-synchronized strobe light with multiple candela taps to meet the intended application. The strobe light taps shall be adjustable for 15/75, 30/75, 75, and 110 candela. The appliance shall be red for wall mounting and white for ceiling mounted. Ceiling mounted appliances shall be rated for that application. The model number shall be the U-MCS (Adapter Series)
- D. An alarm extender panel shall be provided where needed. The power supply shall be a minimum of 6 amps. The power supply shall contain four supervised notification circuits maximum of 3 amps each circuit. The power supply shall contain built-in synchronizing modules for strobes and audibles. There shall be a 3 amp filtered auxiliary power limited output. There shall be a minimum of 8 options PAD-3.
- E. Evacuation Signals, Voice Reproducing
 - (1) Furnish and install where shown on the drawings, voice reproducing audible signals (integral with strobe where noted), with the following characteristics and capacities:
 - a) Field selectable power taps at 3db increments between .25 and 2 watts and driven at 25vrms or 70.7vrms.
 - b) Sound output rating of 90db at full power tap.

- c) Pressure type screw terminals with capacity to use up to 12AWG wire for speaker connection.

F. Provide (10) ten additional 110Cd speaker/strobes where directed by Engineer. Include approximately 25 feet of wiring, conduit and fittings for each speaker/strobe.

2.9 DOOR HARDWARE

Provide magnetic door holders as shown on drawings. Coordinate equipment with door hardware installer.

2.10 ADDITIONAL DEVICES

1. Waterflow Indicators

- a. Waterflow switches shall be an integral, mechanical, non-coded, non-accumulative type. Coordinate sprinkler system requirements with Division 15.
- b. Waterflow switches shall have an alarm transmission delay time adjustable from 0 to 60 seconds. Initial settings shall be 30-45 seconds.
- c. Waterflow switches shall be provided and connected under this section but installed under Division 15.

2. Sprinkler and Standpipe Valve Supervisory Switches

- a. Each sprinkler system water supply control valve riser, zone control valve and standpipe system riser control valve shall be equipped with a supervisory switch. Coordinate sprinkler system requirements with Division 15. As a minimum, each floor, the Atrium and the theater shall be zoned separately.
- b. Main gate valves shall be equipped with a supervisory switch.
- c. Supervisory switches shall be provided and connected under this section but installed under Division 15.

3. Addressable Modules

- a. Addressable monitor modules shall be provided to connect supervised zones to fire alarm control panel SLC loops. There shall be one monitor module for each supervisory switch or alarm switch. Fire pump shall be monitored in accordance with NFPA 72.
- b. Addressable control modules shall be provided to supervise and control operation of addressable control points. There shall be one control module for each control

point. For fan shutdown, damper closure and other auxiliary control functions, the control module may be set to operate as a dry contact relay.

2.11 INTERFACE WITH OTHER BUILDING SAFETY SYSTEMS

- A. HVAC and fans shall shutdown when either the duct detector for that unit is alarmed or when any device of the fire alarm system is activated. The FACP and remote annunciator shall be programmed with buttons for manual operation of each air-handling unit and smoke control fan.
- B. Sprinkler monitoring shall include waterflow switches, supervisory switches and fire pump supervision. Coordinate with Section 15500 requirements to interconnect all monitored points with the fire alarm system.
- C. Fire alarm system activation shall cause the following additional operations:
 - 1. Release door magnetic holders to adjacent zones on floor of activation.
 - 2. Return elevators to primary or alternate floor of egress.
 - 3. Elevator lobby smoke detectors, equipment room smoke detectors and hoistway smoke detectors shall return elevators to primary or alternate floor of egress.
 - 4. Smoke detectors or heat detectors installed to shut down elevator power shall do so in accordance with ANSI A17.1 requirements.
 - 5. Duct smoke detector activation or fire alarm system activation shall shut down RTU-1, 2 and 3 and close RTU-1 and RTU-2 supply and return smoke dampers.
 - 6. Provide all necessary detectors, controls, valves, relays, etc. for elevator sprinkler pre-action control as required by ANSI A17.1 code and NFPA-72. Heat detectors shall shunt-trip elevator power prior to activation of sprinkler system solenoid valves.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Perform work in accordance with the requirements of NFPA 70, NFPA 72.
- B. Fasten equipment to structural members of building or metal supports attached to structure, or to concrete surfaces.
- C. All cable runs shall be run parallel or at right angles to building walls, supported from structure at intervals not exceeding 3 feet and where installed in environmental air plenums, be rated for such use and tied/supported by components listed for environmental air plenums installation.

3.2 BOXES, ENCLOSURES AND WIRING DEVICES

- A. Boxes shall be installed plumb and firmly in position.
- B. Extension rings with blank covers shall be installed on junction boxes where required.
- C. Junction boxes served by concealed conduit shall be flush mounted.
- D. Upon initial installation, all wiring outlets, junction, pull and outlet boxes shall have dust covers installed. Dust covers shall not be removed until wiring installation when permanent dust covers or devices are installed.
- E. "Fire alarm system" decal or silk-screened label shall be applied to all junction box covers.

3.3 CONDUCTORS

- A. Each conductor shall be identified, as shown on the submittal drawings, with wire markers at terminal points. Attach permanent wire markers within 2 inches of the wire termination. Marker legends shall be visible.
- B. All wiring shall be supplied and installed in compliance with the requirements of the National Electric Code, NFPA 70, Article 760, and that of the manufacturer.
- C. Wiring for Notification Appliance circuits shall be a minimum 14 AWG
- D. All splices shall be made using solderless connectors. All connectors shall be installed in conformance with the manufacturer recommendations.
- E. Crimp-on type spade lugs shall be used for terminations of stranded conductors to binder screw or stud type terminals. Spade lugs shall have upset legs and insulation sleeves sized for the conductors.
- F. Permanently label or mark each conductor at both ends with permanent alphanumeric wire markers.
- G. A consistent color code for fire alarm system conductors throughout the installation.
- H. The installation contractor shall submit for approval prior to installation of wire, a proposed color code for system conductors to allow rapid identification of circuit types.
- I. Wiring within sub panels shall be arranged and routed to allow accessibility to equipment for adjustment and maintenance.

3.4 DEVICES

- A. Relays and other devices shall be mounted in auxiliary panels and shall be securely fastened to avoid false indications and failures due to shock or vibration.

- B. Wiring within panels shall be arranged and routed to allow accessibility to equipment for adjustment and maintenance.
- C. All devices and appliances shall be mounted to or in an approved electrical box.

3.5. CERTIFICATE OF COMPLIANCE

A Certificate of Compliance shall be completed and submitted to the Architect, in accordance with NFPA 72, most current edition, as required by the State Of Louisiana Fire Marshall.

3.6. FIELD QUALITY CONTROL

A. Testing, general

1. All Alarm Initiating Devices shall be observed and logged for correct zone and sensitivity. These devices and their bases shall be tagged with adhesive tags located in an area not visible when installed, showing the initials of the installing technician and date.
2. Wiring runs shall be tested for continuity, short circuits and grounds before system is energized. Resistance, current and voltage readings shall be made as work progresses.
3. The acceptance inspector shall be notified before the start of the required tests. All items found at variance with the drawings or this specification during testing or inspection by the acceptance inspector shall be corrected.
4. Test reports shall be delivered to the acceptance inspector as completed.
5. All test equipment, the installing contractor shall make instruments, tools and labor required to conduct the system tests available. The following equipment shall be a minimum for conducting the tests:
 - a) Ladders and scaffolds as required to access all installed equipment.
 - b) Multi-meter for reading voltage, current and resistance.
 - c) Two way radios, and flashlights.
 - d) A manufacturer recommended device for measuring airflow through air duct smoke detector sampling assemblies.
 - e) Decibel meter.
 - f) In addition to the testing specified shall be performed by the installing contractor, the installation shall be subject to test by the acceptance inspector.

3.7 ACCEPTANCE TESTING

- A. A written acceptance test procedure (ATP) for testing the fire alarm system components and installation shall be submitted by the Contractor to the Architect and shall be in accordance with NFPA 72 and this specification. The contractor shall be responsible for the performance of the ATP, demonstrating the function of the system and verifying the correct operation of all system components, circuits, and programming.

- B. A program matrix shall be prepared by the installing contractor referencing each alarm input to every output function affected as a result of an alarm condition on that input.
- C. The installing contractor prior to the ATP shall prepare a complete listing of all device labels for alphanumeric annunciator displays.
- D. The acceptance inspector shall use the system record drawings in combination with the documents specified in this specification during the testing procedure to verify operation as programmed. In conducting the ATP, the acceptance inspector shall request demonstration of any or all input and output functions. The items tested shall include but not be limited to the following:
 - 1. System wiring shall be tested to demonstrate correct system response and correct subsequent system operation in the event of:
 - a) Open, shorted and grounded signal line circuits.
 - b) Open, shorted and grounded notification circuits.
 - c) Primary power or battery disconnected.
 - 2. System notification appliances shall be demonstrated as follows:
 - a) All alarm notification appliances actuate as programmed
 - b) Audibility and visibility at required levels.
 - 3. System indications shall be demonstrated as follows:
 - a) Correct message display for each alarm input at the control display.
 - b) Correct annunciator light for each alarm input at each annunciator and graphic display as shown on the drawings.
 - c) Correct history logging for all system activity.
 - 4. System off-site reporting functions shall be demonstrated as follows:
 - a) Correct point transmitted for each alarm input
 - b) Trouble signals received for disconnect
 - 5. Secondary power capabilities shall be demonstrated as follows:
 - a) System primary power shall be disconnected for a period of time as specified herein. At the end of that period, an alarm condition shall be created and the system shall perform as specified for a period as specified.
 - b) System primary power shall be restored for forty-eight hours and system-charging current shall be normal trickle charge for a fully charged battery bank.
 - c) System battery voltages and charging currents shall be checked at the fire alarm control panel

3.8 DOCUMENTATION

- A. System documentation shall be furnished to the owner and shall include but not be limited to the following:
 - 1. System record drawings and wiring details including one set of reproducible masters and drawings on a CD ROM in a DXF format suitable for use in a CAD drafting program.
 - 2. System operation, installation and maintenance manuals.
 - 3. System matrix showing interaction of all input signals with output commands.
 - 4. Documentation of system voltage, current and resistance readings taken during the installation, testing and ATP phases of the system installation.

5. System program showing system functions, controls and labeling of equipment and devices.

3.9 SERVICES

- A. The contractor shall warrant the entire system against mechanical and electrical defects for a period described in the contract general conditions.
- B. The fire alarm system subcontractor shall offer, for the owner's consideration at the time of system submittal, a priced inspection, maintenance, testing and repair contract in full compliance with the requirements of NFPA 72. The owner shall have the option of renewing at the price quoted for single or multiple years up to five years.
- C. The contractor performing the contract services shall be qualified and listed to maintain ongoing certification of the completed system to the UL for specific installed system listing.
- D. The installation contractor shall furnish training as follows for a minimum of four employees of the system user:
 1. Training in the receipt, handling and acknowledgment of alarms.
 2. Training in the system operation including manual control of output functions from the system control panel.
 3. Training in the testing of the system including logging of detector sensitivity, field test of devices and response to common troubles.
 4. The total training requirement shall be a minimum of 2 hours, but shall be sufficient to cover all items specified.

END OF SECTION

SECTION 16670

LIGHTNING PROTECTION SYSTEM

PART 1 - GENERAL

1.1 OBJECTIVE

To provide safety for the building and occupants by preventing damage to building structure caused by lightning.

1.2 STANDARDS

- A. The following specifications and standards of the latest issue form a part of this specification:
 - 1. Lightning Protection Institute, Installation Standard, LPI 175.
 - 2. Underwriters Laboratories, Inc., Installation Requirements, UL96A.
 - 3. National Electrical Code (NEC).
 - 4. National Fire Protection Association, Lightning Protection Code, NFPA 780.

1.3 SYSTEM DESIGN

- A. The work covered by this section of the specifications consists of furnishing all labor, materials, and items of service required for the furnishing and installation and completion of a functional and unobtrusive lightning protection system for the entire new building as approved by the Engineer, and in strict accordance with this section of the specifications and the applicable contract drawings.
- B. If any departure from the contract drawings or submittal drawings covered below are deemed necessary by the Contractor, details of such departures and reasons therefore shall be submitted as soon as practical to the Engineer for approval.
- C. The Contractor shall provide all hardware and devices to make the lightning protection system complete and functional. The entire system shall be provided to make the installation compliant with NFPA 780.

1.4 SUBMITTALS

Complete design drawings showing the type, size, and locations of all grounding, down conductors, through roof/through wall assemblies, roof conductors, and air terminals shall be submitted to the Engineer for approval.

1.5 QUALITY ASSURANCE

The lightning protection system shall conform to the requirements and standards for lightning protection systems of the LPI, UL, NFPA, and NEC. Upon completion, application shall be made to the Underwriters Laboratories, Inc., for inspection and certification. In addition, the Lightning Protection Institute certified system certificate shall be delivered to the Engineer ensuring that the concealed components have also been monitored during job progress.

1.6 WARRANTY

Provide a full 1-year warranty after Owner acceptance of system including parts and labor for all equipment furnished and installed.

PART 2 - PRODUCTS

2.1 STANDARD

- A. The system to be furnished under this specification shall be the standard product of manufacturers regularly engaged in the production of lightning protection equipment and shall be the manufacturer's latest approved design. The equipment shall be UL listed and properly UL labeled.
- B. All equipment shall be new, and of a design and construction to suit the application where it is used in accordance with accepted industry standards and LPI, UL, NFPA, and NEC code requirements.
- C. Approved Manufacturers:
 - 1. Advanced Lightning Technology
 - 2. Thompson Lightning Protection
 - 3. Harger Lightning Protection
 - 4. East Coast Lightning Equipment

2.2 LIGHTNING PROTECTION EQUIPMENT

- A. All materials shall be copper and bronze and of the size, weight, and construction to suit the application and used in accordance with LPI, UL, and NFPA code requirements. Class I sized components shall be utilized on roof levels 75 feet and below in height. Bolt type connections and splicers shall be utilized on Class I structures. Pressure squeeze clamps are not acceptable. All mounting hardware shall be stainless steel to prevent corrosion.

- B. Contractor shall reference floor plans, elevations, roof plans and MEP drawings to provide complete coverage of all equipment and building conditions for lightning protection systems.

2.3 ALUMINUM COMPONENTS

Aluminum materials may not be used except on roofs that utilize aluminum roofing components. On aluminum metal roofs or where aluminum parapet caps exist, the entire roof lightning protection equipment shall utilize aluminum components to insure compatibility. However, the down leads and grounding are to utilize copper with the bimetal transition occurring at the through roof assembly with an approved bimetal through roof assembly.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The installation shall be accomplished by an experienced installation company that is UL listed, a member of the Lightning Protection Institute and an employer of Certified Master Installers of lightning protection systems. A certified Master Installer shall directly supervise the work.
- B. All equipment shall be installed in a neat, workmanlike manner. The system shall consist of a complete conductor network at the roof and include air terminals, connectors, splicers, bonds, copper down leads, and proper ground terminals.
- C. Copper down lead conductors shall be utilized even when aluminum is required on the roof. Down lead conductors in conduit shall not be brought directly through the roof. Through roof assemblies with solid brass or stainless steel rods shall be utilized for this purpose. Structural steel may be utilized in the installation as outlined by UL, NFPA, and LPI.

3.2 COORDINATION

- A. The lightning protection installer will work with other trades to insure a correct, neat and unobtrusive installation. The roofing contractor will be responsible for sealing and flashing all lightning protection roof penetrations as per the roof manufacturer's recommendations. However, the lightning protection contractor will be required to coordinate locations of through roofs and submit details of through roof penetrations as required. Should the roofing manufacturer require any special walk pads, membrane patches or pavers under the components of the lightning materials (patches, pads, pavers, adhesive) supplied by the roofing manufacturer at no additional cost to the Owner. The roofing contractor shall be required to instruct the lightning protection installer of the proper installation procedures of the roof pads, patches and/or pavers if required.

- B. It shall be the responsibility of the lightning protection installer to assure a sound bond to the main water service and to assure interconnection with main electrical service ground system.

3.3 COMPLETION

Upon completion of the installation, the lightning protection installer shall secure and deliver to the Engineer the Underwriters Laboratories, Inc. Master Label certification and the Lightning Protection Institute Certified System certification. The system will not be accepted without the UL Master Label plate and the LPI certification certificate.

END OF SECTION

SECTION 16700

EMERGENCY GENERATOR

PART 1 - GENERAL

1.1 SCOPE

- A. Provide two complete factory assembled generator sets equipment with digital (microprocessor-based) electronic generator set controls, digital governor, and digital voltage regulator. Generator sets shall be as manufactured by Baldor or prior approved equal.
- B. Provide factory test, startup by a supplier authorized by the manufacturer, and on-site testing of the system.
- C. The generator set manufacturer shall warrant all equipment provided under this section so that there is one source for warranty and product service. Technicians specifically trained and certified by the manufacturer to support the product and employed by the generator set supplier shall service the generator sets.

1.2 CODES AND STANDARDS

- A. The generator set and its installation and on-site testing shall conform to the requirements of the following codes and standards:
 - 1. IEEE446 - Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
 - 2. IEEE587 for voltage surge resistance.
 - 3. Mil Std 461D -1993. Military Standard, Electromagnetic Interference Characteristics.
 - 4. Mil Std 462D - 1993. Military Standard, Measurement of Electromagnetic Interference Characteristics.
 - 5. NEMA ICS10-1993 - AC Generator sets.
 - 6. NFPA70 - National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.
 - 7. NFPA99 - Essential Electrical Systems for Health Care Facilities
 - 8. NFPA110 - Emergency and Standby Power Systems. The generator set shall meet all requirements for Level 1 systems. Level 1 prototype tests required by this standard shall have been performed on a complete and functional unit, component level type tests will not substitute for this requirement.
 - 9. UL508. The entire control system of the generator set shall be UL508 listed and labeled.
- B. The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

1.3 ACCEPTABLE MANUFACTURERS

Only approved bidders shall supply equipment provided under this contract. Equipment specifications for this project are based on microprocessor-based generator sets manufactured by Baldor Generators. Equipment by other suppliers that meets the requirement of this specification are acceptable, if approved not less than 2 weeks before scheduled bid date. Proposals must include a line by line compliance statement based on this specification.

PART 2 - PRODUCTS

2.1 GENERATOR SET

A. Ratings

1. Each generator set shall operate at 1800 rpm and at a voltage of 277/480 Volts AC, Three phase, Four-wire, 60 hertz.
2. Each generator set shall be rated at 1,600 kW, 2,000 kVA at 0.8 PF, based on site conditions of : Altitude 0 ft., ambient temperatures up to 122 degrees F.
3. Each generator set rating shall be based on emergency/standby service.

B. Performance

1. Voltage regulation shall be plus or minus 0.5 percent for any constant load between no load and rated load for non-parallel applications. Random voltage variation with any steady load from no load to full load shall not exceed plus or minus 0.5 percent.
2. Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.25%.
3. The diesel engine-generator set shall be capable of single step load pick up of 100% nameplate kW and power factor, less applicable derating factors, with the engine-generator set at operating temperature.
4. Motor starting capability shall be a minimum of 4,600 SkVA at 30% transient voltage dip Max. Engine Generator shall have 100 % recovery @ 60 HZ. Alternator shall be sized and rated 105 degree rise @ 1600 kW. Sub-transient reactance shall be no more than 14% at rated voltage of 480 VAC. Staror pitch shall be 2/3 Voltage regulation no load to full load with PMG regulation +/- 0.5%.
5. The alternator shall produce a clean AC voltage waveform, with not more than 5% total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3% in any single harmonic. Telephone influence factor shall be less than 40.

C. Construction

Each engine-generator set shall be mounted on a heavy-duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails.

D. Connections

1. The generator set load connections shall be composed of silver or tin plated copper bus bars, drilled to accept mechanical or compression terminations of the number and type as shown on the drawings. Sufficient lug space shall be provided for use with cables of the number and size as shown on the drawings.
2. Power connections to auxiliary devices shall be made at the devices, with required protection located at a wall-mounted common distribution panel.
3. Generator set control interfaces to other system components shall be made on a common, permanently labeled terminal block assembly.

2.2 ENGINE AND ENGINE EQUIPMENT

- A. Each engine shall be diesel fueled, 4 cycle, radiator and fan cooled. Minimum displacement shall be 3989 cubic inches, with 16 cylinders. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories. Engine accessories and features shall include the items herein after listed.
- B. An electronic governor system shall provide automatic isochronous frequency regulation.
- C. Remote mounted horizontal radiator and cooling system rated for full load operation in 104 degrees F ambient as measured at the generator air inlet, based on 0.5 in H₂O external static head. Radiator shall be sized based on a core temperature which is 20 F higher than the rated operation temperature. The cooling system shall be filled with a 50/50-ethylene glycol/water mixture by the equipment manufacturer. Rotating parts shall be guarded against accidental contact.
- D. Electric starter capable of three complete cranking cycles without overheating.
- E. Positive displacement, mechanical, full pressure, lubrication oil pump.
- F. Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.
- G. Replaceable dry element air cleaner.
- H. Flexible supply and return fuel lines.
- I. Engine mounted battery charging alternator, 40-ampere minimum, and solid-state voltage regulator.
- J. Coolant heater

1. Engine mounted, thermostatically controlled, coolant heater. Heater voltage shall be as shown on the project drawings. The coolant heater shall be UL499 listed and labeled.
 2. The coolant heater shall be installed on the engine with silicone hose connections. The coolant heater installation shall be specifically designed to provide proper venting of the system.
 3. The coolant heater shall be provided with a thermostat, installed at the engine thermostat housing. An AC power connection box shall be provided for a single AC power connection to the coolant heater system.
 4. The coolant heater(s) shall be sized as recommended by the engine manufacturer to warm the engine to a minimum of 80°F in a 40°F ambient.
- D. Provide vibration isolators, spring/pad type, quantity as recommended by the generator set manufacturer.
- E. Starting and Control Batteries shall be calcium/lead antimony type, 24 volt DC, sized as recommended by the engine manufacturer, complete with battery cables and connectors.
- F. Provide exhaust silencer(s) as recommended by the generator set manufacturer and approved by the engine manufacturer. The mufflers shall be critical grade. Exhaust system shall be installed according to the engine manufacturer's recommendations and applicable codes and standards.
- G. A UL listed 10 amp voltage regulated battery charger shall be provided for the engine-generator set. The charger shall be wall mounted. The charger shall require an input of 120AC voltage and provide an output of 24VDC output. Chargers shall be equipped with float and equalize charge settings. The charger shall include an Analog DC voltmeter and ammeter, 12 hour equalize charge timer, and AC and DC fuses.

2.3 AC GENERATOR

- A. Each AC generator shall be; synchronous, four pole, 2/3 pitch, revolving field, drip-proof construction, single prelubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system. Actual temperature rise measured by resistance method at full load shall not exceed 125 degrees Centigrade over 40 degrees Centigrade ambient.
- B. Each generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage not more than 5 percent above or below rated voltage.
- C. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and

controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of rated current for not more than 10 seconds.

2.4 GENERATOR SET CONTROL.

- A. Each generator set shall be provided with a microprocessor-based control system that is designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set as described in this specification. The control shall be mounted on the generator set. The generator set mounted control shall include the features and functions as here in after specified.
- B. The mode select switches shall initiate the following control modes. When in the RUN or Manual position the generator set shall start, and accelerate to rated speed and voltage as directed by the operator. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
- C. Generator Set AC Output Metering.
 1. Voltmeter, Ammeter, Frequency. Voltmeter and ammeter shall display all three phases
 2. Digital metering set, 0.5% accuracy, to indicate generator RMS voltage and current, frequency, output current, output KW, KW-hours, and power factor. Generator output voltage shall be available in line-to-line and line-to-neutral voltages.
- D. Generator Set Alarm and Status Display.
 1. Each generator set shall be provided with alarm and status indicating lamps to indicate non-automatic generator status, and existing warning and shutdown conditions. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions. The generator set control shall indicate the existence of the following alarm and shutdown conditions on an alphanumeric digital display panel:
 - low oil pressure (alarm)
 - low oil pressure (shutdown)
 - oil pressure sender failure (alarm)
 - low coolant temperature (alarm)
 - high coolant temperature (alarm)
 - high coolant temperature (shutdown)
 - low coolant level (alarm or shutdown--selectable)
 - overcrank (shutdown)
 - overspeed (shutdown)
 - low battery voltage (alarm)
 - high battery voltage (alarm)
 - weak battery (alarm)
 - low fuel-daytank (alarm)
 - engine kW over load (alarm)

- battery charger failure
 - fuel leak
 - maintenance interval timer
2. Provisions shall be made for indication of four customer-specified alarm or shutdown conditions. Labeling of the customer-specified alarm or shutdown conditions shall be of the same type and quality as the above specified conditions. The non-automatic indicating lamp shall be red, and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.
- E. Engine Status Monitoring. The following information shall be available from a digital status panel on each generator set control :
1. engine oil pressure (psi or kPA)
 2. engine coolant temperature (degrees F or C)
 3. engine speed (rpm)
 4. number of hours of operation (hours)
 5. battery voltage (DC volts)
- F. Engine Control Functions.
1. The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and # of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15-second rest period between cranking periods.
 2. The control system shall include time delay start (adjustable 0-30 seconds), time delay stop (adjustable 0-60 minutes), and engine maintenance (0-5000 hours) functions.
 3. The control system shall include sender failure monitoring logic for speed sensing and oil pressure.
- G. Alternator Control Functions:
1. Each generator set shall include an automatic voltage regulation system. It shall be immune from misoperation due to load-induced voltage waveform distortion. The voltage regulation system shall be equipped with three-phase RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of [58-59] HZ. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off.
 2. Controls shall be provided to individually monitor all three phases of the output current for short circuit conditions. The control/protection system shall monitor the current level and voltage. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (short circuit shutdown).
 3. A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 25VDC or more than 32 VDC. During engine cranking (starter engaged), the low voltage limit shall be disabled, and if DC voltage drops to less than 14.4 volts for more than two seconds a "weak battery" alarm shall be initiated.

- H. Provide and install a 17-light LED type remote alarm annunciator with horn, located as shown on the drawings or in a location that can be conveniently monitored by facility personnel. The remote annunciator shall provide all the audible and visual alarms called for by NFPA Standard 110 for level 1 systems; and in addition shall provide indications for high battery voltage, low battery voltage, loss of normal power to the charger. Alarm silence and lamp test switch(es) shall be provided. Alarm horn shall be switchable for all annunciation points. Alarm horn (when switched on) shall sound for first fault, and all subsequent faults, regardless of whether first fault has been cleared, in compliance with NFPA110 3-5.6.2. The annunciator shall be connected to the engine generator set controller via a RS485 port. The interconnection wires shall be limited to four.
- I. Each generator set shall be provided with a mounted main line circuit breaker, sized to carry the rated output current of the generator set on a continuous basis.

2.5 FUEL SYSTEM

- A. The fuel system for each diesel generator set shall include a 12 hour (usable), double wall base mounted fuel tank. It shall have a stub-up area convenient for electrical conduit entry. It shall have the structural integrity to support the engine-generator set and carry the UL 142 mark. Minimum features shall include all welded construction, a fuel filler cap, electronic and manual fuel gauge, electric fuel level sensor, fuel line check valve, vent and fittings for fuel supply, return, fill and emergency vent. This tank shall be supplied by the engine-generator set manufacturer and be installed before shipment. Sub-base shall have a return or pump-back capability. Supply the sub-base tank with emergency venting per NFPA 37.
- B. A 5000 gallon useable capacity UL 2085 fuel tank shall be provided for each generator. Tank shall have a steel exterior with the interstitial space fill with 3" of lightweight concrete material which offers a 2 hour fire rating. Tank shall have bottom C-Channel supports to raise the tank 2" off the concrete pad. Tank shall be a minimum of 48"H to reduce footprint. Entire tank shall be sandblasted prior to priming and final finish. Tank shall have alarms indicating low fuel level, high fuel level, critical high fuel level, and fuel in basin. System controls shall be able to detect low and high fuel level in generator sub-base tank and allow for proper fill. Tank shall be equipped with provisions for a remote alarm fill station with a minimum 5 gallon capacity. A four alarm panel with horn and silence switch shall be mounted inside the lockable, wall mountable fill station.

2.6 AUTOMATIC TRANSFER SWITCH

- A. Provide automatic transfer switches that will initiate a signal on primary power failure and automatically detect a secondary power source, transferring the load to this secondary source. On restoration of primary power, the switches shall automatically retransfer the load back to primary power and signal the secondary source to shut down. The switches shall be a self contained device with all features described herein. The transfer switches must be UL listed for use in emergency systems.

- B. Each automatic transfer switch shall be furnished by the manufacturer of the engine-generator set so as to maintain system compatibility and local service responsibility for the complete emergency power system. It shall be listed by Underwriter's Laboratory, Standard 1008 with fuse or circuit breaker protection. Representative production samples of the transfer switch supplied shall have demonstrated through tests the ability to withstand at least 10,000 mechanical operation cycles. One operation cycle is the electrically operated transfer from normal to emergency and back to normal. Wiring must comply with NEC table 312.6. The manufacturer shall furnish schematic and wiring diagrams for the particular automatic transfer switch and a typical wiring diagram for the entire system.
- C. Each automatic transfer switch shall be a 4 pole design rated for 2000 amps continuous operation in ambient temperatures of -20 degrees Fahrenheit (-30 degrees Celsius) to +140 degrees Fahrenheit (+60 degrees Celsius). Main power switch contacts shall be rated for 600 V AC minimum. The transfer switch supplied shall have a minimum withstand and closing rating when fuse protected of 200,000 amperes. Where the line side over current protection is provided by circuit breakers, the short circuit withstand and closing ratings shall be 42,000 amperes RMS. These RMS symmetrical fault current ratings shall be the rating listed in the UL listing or component recognition procedures for the transfer switch. All withstand tests shall be performed with the over current protective devices located external to the transfer switch.
- D. Each transfer switch shall be double throw construction, positively electrically and mechanically interlocked to prevent simultaneous closing and mechanically held in both normal and emergency positions. Independent break before make action shall be used to positively prevent dangerous source to source connections. When switching the neutral, this action prevents the objectionable ground currents and nuisance ground fault tripping that can result from overlapping designs. The transfer switch shall be approved for manual operation. The electrical operating means shall be by electric solenoid. Every portion of the contactor is to be positively mechanically connected. No clutch or friction drive mechanism is allowed, and parts are to be kept to a minimum. This transfer switch shall not contain integral over current devices in the main power circuit, including molded case circuit breakers or fuses.
- E. Each transfer switch electrical actuator shall have an independent disconnect means to disable the electrical operation during manual switching. Maximum electrical transfer time in either direction shall be 160 milliseconds, exclusive of time delays. Main switch contacts shall be high pressure silver alloy with arc chutes and separate arcing contacts to resist burning and pitting for long life operation.
- F. Each Transfer switch shall have the Controls as here in after described.
 - 1. All control equipment shall be mounted on the inside of the cabinet door in a metal lockable enclosure with transparent safety shield to protect all solid state circuit boards. This will allow for ease of service access when main cabinet lockable door is open, but to prevent access by unauthorized personnel. Control boards shall have installed cover plates to avoid shock hazard while making control adjustments. The solid state voltage sensors and time delay modules shall be plug-in circuit boards with silver or gold contacts for ease of service.

2. A solid state under voltage sensor shall monitor all phases of the normal source and provide adjustable ranges for field adjustments for specific application needs. Pick-up and drop-out settings shall be adjustable from a minimum of 70% to a maximum of 95% of nominal voltage. A utility sensing interface shall be used, stepping down system voltage of 277/480 VAC, 3 phase to 24VAC, helping to protect the printed circuit board from voltage spikes and increasing personnel safety when troubleshooting.
3. Signal the engine-generator set to start in the event of a power interruption. A set of contacts shall close to start the engine and open for engine shutdown. A solid state time delay start, adjustable, .1 to 10 seconds, shall delay this signal to avoid nuisance start-ups on momentary voltage dips or power outages.
4. Transfer the load to the engine-generator set after it reached proper voltage, adjustable from 70-90% of system voltage, and frequency, adjustable from 80-90% of system frequency. A solid state time delay, adjustable from 5 seconds to 3 minutes, shall delay this transfer to allow the engine-generator to warm-up before application of load. There shall be a switch to bypass this warm-up timer when immediate transfer is required.
5. Retransfer the load to the line after normal power restoration. A return to utility timer, adjustable from 1-30 minutes, shall delay this transfer to avoid short term normal power restoration.
6. The operating power for transfer and retransfer shall be obtained from the source to which the load is being transferred. Controls shall provide an automatic retransfer of the load from emergency to normal if the emergency source fails with the normal source available.
7. Signal the engine-generator to stop after the load retransfers to normal. A solid state engine cool down timer, adjustable from 1-30 minutes, shall permit the engine to run unloaded to cool down before shutdown. Should the utility power fail during this time, the switch will immediately transfer back to the generator.
8. Provide an engine minimum run timer, adjustable from 5-30 minutes, to ensure an adequate engine run period.
9. The transfer switch shall have a time delay neutral feature to provide a time delay, adjustable from .1-10 seconds, during the transfer in either direction, during which time the load is isolated from both power sources. This allows residual voltage components of motors or other inductive loads (such as transformers) to decay before completing the switching cycle. A switch will be provided to bypass all transition features when immediate transfer is required.
10. The transfer switch shall have an in phase monitor which allows the switch to transfer between live sources if their voltage waveforms become synchronous within 20 electrical degrees within 10 seconds of transfer initiation signal. A switch shall be provided to bypass this feature if not required.

11. If the in-phase monitor will not allow such a transfer, the control shall default to time delay neutral operation. Switches with in phase monitors which do not default to time delay neutral operation are not acceptable.
12. Front mounted controls shall include a selector switch to provide for a NORMAL TEST mode with full use of time delays, FAST TEST mode which bypasses all time delays to allow for testing the entire system in less than one minute, or AUTOMATIC mode to set the system for normal operation.
13. Provide bright lamps to indicate the transfer switch position in either UTILITY (white) or EMERGENCY (red). A third lamp is needed to indicate STANDBY OPERATING (amber). These lights must be energized from utility or the engine-generator set.
14. Provide manual operating handle to allow for manual transfer. This handle must be mounted inside the lockable enclosure so accessible only by authorized personnel.
15. Provide maintenance disconnect switch to prevent load transfer and automatic engine start while performing maintenance. This switch will also be used for manual transfer switch operation.
16. Provide LED status lights to give a visual readout of the operating sequence. This shall include utility on, engine warm-up, standby ready, transfer to standby, in phase monitor, time delay neutral, return to utility, engine cool down and engine minimum run. A "signal before transfer" lamp shall be supplied to operate from optional circuitry.
17. The transfer switch mechanism and controls shall be mounted in a NEMA 3R enclosure.
19. The following options are to be provided by the transfer switch manufacturer.
 - a. Signal before transfer contacts, wired to an identified terminal strip, used to supply a signal to selected loads prior to the operation of the transfer switch adjustable from 1 to 30 seconds.
 - b. A remote automatic control circuit to allow a normal test of the standby power system from a remote location.
 - c. A manual bypass for return to normal push button. This option will prevent the re-transfer of the load back to utility until the operator actuates this push button.
 - d. A preferred source selector switch to allow the selection of which power source to be considered normal and which to be emergency.
 - e. A second set of DPDT (form C), 10 ampere, 250 volt auxiliary contacts, operated by the transfer switch mechanism shall be installed.

2.7 OPERATION AND CONFIGURATION

- A. Operation: Upon loss of normal source or unacceptable parameters, transfer switch control system shall start both generator sets. The first to produce acceptable voltage and frequency is selected by ATS 1. If the first engine generator set operates properly after a pre-set period, the other set is shut down; it will be started up and put on the line if the first one fails at any time during operation. When normal power is restored, the load is retransferred to normal by the main ATS 2.
- B. Configuration: The 3 source automatic transfer system consists of a generator ATS 1 used in conjunction with a separately provided main ATS 2. The generator ATS 1 sources are engine generator 1 and engine generator 2. The generator ATS 1 load feeds the emergency side of the main ATS 2. The main ATS 2 source are the utility (normal) and the load feed from ATS 1 (emergency). The main ATS load feeds the facility loads.

PART 3 EXECUTION

3.1 FACTORY TESTING.

- A. Before shipment of the transfer switch shall be tested under operating conditions for performance and proper functioning of control and interfacing circuits. Tests shall include; Verify all timing sequences operate properly and are set to factory settings; Verify the transfer mechanism operates properly; and Verify all manual operations and indicators are functioning properly.
- B. The generator set manufacturer shall perform a complete operational test on each generator set prior to shipping from the factory. A certified test report shall be provided. Equipment supplied shall be fully tested at the factory for function and performance.

3.2 INSTALLATION

- A. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction.
- B. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.
- C. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer's instructions.
- D. Equipment shall be initially started and operated by representatives of the manufacturer.
- E. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.

3.3 ON-SITE ACCEPTANCE TEST

- A. The complete installation shall be tested for compliance with the specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by Contractor. The Engineer shall be notified in advance and shall have the option to witness the tests.
- B. Installation acceptance tests to be conducted on-site shall include a "cold start" test, a two hour full load test, and a one step rated load pickup test in accordance with NFPA 110. Provide a resistive load bank and make temporary connections for full load test.
- C. Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service, and observing proper operation of the system for at least 2 hours. Coordinate timing and obtain approval for start of test with site personnel.

3.4 TRAINING

The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 4 hours in duration and the class size shall be limited to 5 persons. Training date shall be coordinated with the facility owner.

3.5 SERVICE AND SUPPORT

- A. The manufacturer of the generator set shall maintain service parts inventory at a central location which is accessible to the service location 24 hours per day, 365 days per year.
- B. The generator sets shall be serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.
- C. The manufacturer shall maintain model and serial number records of each generator set provided for at least 20 years.

3.6 WARRANTY

- A. Each generator set and associated equipment shall be warranted for a period of not less than 3 years from the date of commissioning against defects in materials and workmanship.
- B. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, etc.

END OF SECTION

SECTION 16760 SURGE PROTECTIVE DEVICES (SPDs)

PART 1 - GENERAL

1.1 SCOPE

- A. The Contractor shall furnish and install the Surge Protective Device (SPD) equipment having the electrical characteristics, ratings, and modifications as specified herein and as shown on the contract drawings. To maximize performance and reliability and to obtain the lowest possible let-through voltages, the ac surge protection shall be integrated into electrical distribution equipment such as switchgear, switchboards, panelboards, busway (integrated within bus plug), or motor control centers.

1.2 REFERENCES

- A. SPD units and all components shall be designed, manufactured, and tested in accordance with the latest applicable UL standard (ANSI/UL 1449 3rd Edition).

1.3 SUBMITTALS

- A. The following information shall be submitted to the Engineer:
 - 1. Provide verification that the SPD complies with the required ANSI/UL 1449 3rd Edition listing by Underwriters Laboratories (UL) or other Nationally Recognized Testing Laboratory (NRTL). Compliance may be in the form of a file number that can be verified on UL's website or on any other NRTL's website, as long as the website contains the following information at a minimum: model number, SPD Type, system voltage, phases, modes of protection, Voltage Protection Rating (VPR), and Nominal Discharge Current (I_n).
 - 2. For sidemount mounting applications (SPD mounted external to electrical assembly), electrical/mechanical drawings showing unit dimensions, weights, installation instruction details, and wiring configuration.
- B. Where applicable the following additional information shall be submitted to the engineer:
 - 1. Descriptive bulletins
 - 2. Product sheets
- C. The following information shall be submitted for record purposes:
 - 1. Final as-built drawings and information for items provided and shall incorporate all changes made during the manufacturing process

1.4 QUALIFICATIONS

- A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
- B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.
- C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- D. The SPD shall be compliant with the Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of manufacturer's instructions shall be included with the equipment at time of shipment.

1.6 OPERATION AND MAINTENANCE MANUALS

- A. Operation and maintenance manuals shall be provided with each SPD shipped.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The surge protective devices shall be as manufactured by Eaton Cutler-Hammer or approved equal.

2.2 VOLTAGE SURGE SUPPRESSION - GENERAL

A. Electrical Requirements

1. Unit Operating Voltage - Refer to drawings for operating voltage and unit configuration.
2. Maximum Continuous Operating Voltage (MCOV) - The MCOV shall not be less than 125% of the nominal system operating voltage.
3. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.
4. Protection Modes - The SPD must protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

Configuration	Protection Modes			
	L-N	L-G	L-L	N-G
Wye	•	•	•	•
Delta	N/A	•	•	N/A
Single Split Phase	•	•	•	•
High Leg Delta	•	•	•	•

5. Nominal Discharge Current (I_n) - All SPDs applied to the distribution system shall have a 20kA I_n rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an I_n less than 20kA shall be rejected.
6. ANSI/UL 1449 3rd Edition Voltage Protection Rating (VPR) - The maximum ANSI/UL 1449 3rd Edition VPR for the device shall not exceed the following:

Modes	208Y/120	480Y/277	600Y/347
L-N; L-G; N-G	700	1200	1500
L-L	1200	2000	3000

B. SPD Design

1. Maintenance Free Design - The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.
2. Balanced Suppression Platform - The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable SPD modules shall not be accepted.
3. Electrical Noise Filter - Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method. Products unable to meet this specification shall not be accepted.
4. Internal Connections - No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.
5. Monitoring Diagnostics - Each SPD shall provide the following integral monitoring options:
 - a. Protection Status Indicators - Each unit shall have a green / red solid-state indicator light that reports the status of the protection on each phase.
 - i. For wye configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes. Wye configured units shall also contain an additional green / red solid-state indicator light that reports the status of the protection elements and

- circuitry in the N-G mode. SPDs that indicate only the status of the L-N and L-G modes shall not be accepted.
- ii. For delta configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes.
 - iii. The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.
- b. Remote Status Monitor - The SPD must include Form C dry contacts (one NO and one NC) for remote annunciation of its status. Both the NO and NC contacts shall change state under any fault condition.
 - c. Audible Alarm and Silence Button - The SPD shall contain an audible alarm that will be activated under any fault condition. There shall also be an audible alarm silence button used to silence the audible alarm after it has been activated.
 - d. Surge Counter - The SPD shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of $50 \pm 20A$ occurs. A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. In order to prevent accidental resetting, the surge counter reset button shall be depressed for a minimum of 2 seconds in order to clear the surge count total.
 - i. The ongoing surge count shall be stored in non-volatile memory. If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in non-volatile memory and displayed after power is restored. The surge counter's memory shall not require a backup battery in order to achieve this functionality.
6. Overcurrent Protection
- a. The unit shall contain thermally protected MOVs. These thermally protected MOVs shall have a thermal protection element packaged together with the MOV in order to achieve overcurrent protection of the MOV. The thermal protection element shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.
7. Fully Integrated Component Design - All of the SPD's components and diagnostics shall be contained within one discrete assembly. SPDs or individual SPD modules that must be ganged together in order to achieve higher surge current ratings or other functionality shall not be accepted.
8. Safety Requirements

- a. The SPD shall minimize potential arc flash hazards by containing no user serviceable / replaceable parts and shall be maintenance free. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.
- b. SPDs designed to interface with the electrical assembly via conductors shall require no user contact with the inside of the unit. Such units shall have any required conductors be factory installed.
- c. Sidemount SPDs shall be factory sealed in order to prevent access to the inside of the unit. Sidemount SPDs shall have factory installed phase, neutral, ground and remote status contact conductors factory installed and shall have a pigtail of conductors protruding outside of the enclosure for field installation.

2.3 SYSTEM APPLICATION

- A. The SPD applications covered under this section include distribution and branch panel locations, busway, motor control centers (MCC), switchgear, and switchboard assemblies. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.
- B. Surge Current Capacity - The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
Category	Application	Per Phase	Per Mode
C	Service Entrance Locations (Switchboards, Switchgear, MCC, Main Entrance)	250 kA	125 kA
B	High Exposure Roof Top Locations (Distribution Panelboards)	160 kA	80 kA
A	Branch Locations (Panelboards, MCCs, Busway)	120 kA	60 kA

- C. SPD Type - all SPDs installed on the line side of the service entrance disconnect shall be Type 1 SPDs. All SPDs installed on the load side of the service entrance disconnect shall be Type 1 or Type 2 SPDs.

2.4 LIGHTING AND DISTRIBUTION PANELBOARD REQUIREMENTS

- A. The SPD application covered under this section includes lighting and distribution panelboards. The SPD units shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category B environments.
1. The SPD shall not limit the use of through-feed lugs, sub-feed lugs, and sub-feed breaker options.
 2. SPDs shall be installed immediately following the load side of the main breaker. SPDs installed in main lug only panelboards shall be installed immediately following the incoming main lugs.
 3. The panelboard shall be capable of re-energizing upon removal of the SPD.
 4. The SPD shall be interfaced to the panelboard via a direct bus bar connection. Alternately, an SPD connected to a 30A circuit breaker for disconnecting purposes may be installed using short lengths of conductors as long as the conductors originate integrally to the SPD. The SPD shall be located directly adjacent to the 30A circuit breaker.
 5. The SPD shall be included and mounted within the panelboard by the manufacturer of the panelboard.
 6. The SPD shall be of the same manufacturer as the panelboard.
 7. The complete panelboard including the SPD shall be UL67 listed.
- B. Sidemount Mounting Applications Installation (SPD mounted external to electrical assembly)
1. Lead length between the breaker and suppressor shall be kept as short as possible to ensure optimum performance. Any excess conductor length shall be trimmed in order to minimize let-through voltage. The installer shall comply with the manufacturer's recommended installation and wiring practices.
- C. Switchgear, Switchboard, MCC and Busway Requirements
1. The SPD application covered under this section is for switchgear, switchboard, MCC, and busway locations. Service entrance located SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C environments.
 2. The SPD shall be of the same manufacturer as the switchgear, switchboard, MCC, and busway
 3. The SPD shall be factory installed inside the switchgear, switchboard, MCC, and/or bus plug at the assembly point by the original equipment manufacturer
 4. Locate the SPD on the load side of the main disconnect device, as close as possible to the phase conductors and the ground/neutral bar.
 5. The SPD shall be connected through a disconnect (30A circuit breaker). The disconnect shall be located in immediate proximity to the SPD. Connection shall be made via bus, conductors, or other connections originating in the SPD and shall be kept as short as possible.

6. The SPD shall be integral to switchgear, switchboard, MCC, and/or bus plug as a factory standardized design.
7. All monitoring and diagnostic features shall be visible from the front of the equipment.

2.5 ENCLOSURES

- A. All enclosed equipment shall have NEMA 1 general purpose enclosures, unless otherwise noted. Provide enclosures suitable for locations as indicated on the drawings and as described below:
 1. NEMA 1 – Constructed of a polymer (units integrated within electrical assemblies) or steel (sidemount units only), intended for indoor use to provide a degree of protection to personal access to hazardous parts and provide a degree of protection against the ingress of solid foreign objects (falling dirt).
 2. NEMA 4 - Constructed of steel intended for either indoor or outdoor use to provide a degree of protection against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (dirt and windblown dust); to provide a degree of protection with respect to the harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose directed water); and that will be undamaged by the external formation of ice on the enclosure. (sidemount units only)
 3. NEMA 4X - Constructed of stainless steel providing the same level of protection as the NEMA 4 enclosure with the addition of corrosion protection. (sidemount units only)

PART 3 - EXECUTION

3.1 FACTORY TESTING

- A. Standard factory tests shall be performed on the equipment under this section. All tests shall be in accordance with the latest version of NEMA and UL standards.

3.2 INSTALLATION

- A. The Contractor shall install all equipment per the manufacturer's recommendations and the contract drawings.

3.3 WARRANTY

- A. The manufacturer shall provide a full ten (10) year warranty from the date of shipment against any SPD part failure when installed in compliance with manufacturer's written instructions and any applicable national or local code.

END OF SECTION

SECTION 16780
STATIC UNINTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL

1.1 SUMMARY

- A. This specification describes a three-phase continuous duty, on-line, double conversion, solid-state uninterruptible power system, hereafter referred to as the UPS. The UPS shall operate in conjunction with the existing building electrical system to provide power conditioning, back-up and distribution for critical electrical loads. The UPS system shall consist of, as required by the project, the UPS module, battery cabinets, maintenance bypass, and other features as described in this specification.
- B. UPS System A and UPS System B shall be as indicated on drawings, and as here in after specified.
- C. System shall be as manufactured by Eaton Electrical Inc. (Powerware brand UPS), or approved equal.

1.2 UPS SYSTEM DESCRIPTION

- A. Each UPS system shall consist of the following main components:
 - 1. One 450Kva(405Kw)integrated system bypass module (ISBM) and two 275Kva(250Kw) internal uninterruptible power modules (UPM's) with capacity provisions to add a third future UPM. The ISBM includes a Static Bypass and associated Control and Monitor Panel, and each UPM includes a Rectifier, Inverter, and Battery Charger.
 - 2. Each UPS system shall have three shared battery strings in matching Battery Cabinets for 27 minutes battery backup at 250kW loads with capacity provisions to add a fourth cabinet for 17 minutes battery back up at 405kW loads
 - 3. Non-matching floor standing maintenance bypass/distribution cabinets. Cabinets shall include MBP, MIS & BIB bypass breakers along with two sub-feed distribution breakers
- B. UPM Modes of Operation: Each UPM shall operate as an on-line, fully automatic system in the following modes:
 - 1. Normal: Utilizing commercial AC power, the critical load shall be continuously supplied by the Inverter. The Inverter shall power the load while regulating both voltage and frequency. The Rectifier shall derive power from the commercial AC source and shall supply DC power to the Inverter. Simultaneously, the Battery Charger shall charge the battery.
 - 2. Battery: Upon failure of the commercial AC power, the critical load shall continue to be supplied by the Inverter, which shall obtain power from the batteries without any

operator intervention. There shall be no interruption to the critical load upon failure or restoration of the commercial AC source.

3. Recharge: Upon restoration of the AC source, the Charger shall recharge the batteries and simultaneously the Rectifier shall provide power to the Inverter. This shall be an automatic function and shall cause no interruption to the critical load.
4. Bypass: If the UPM must be taken out of the Normal mode for overload, load fault, or internal failures, the static bypass switch shall automatically transfer the critical load to the commercial AC power. Return from Bypass mode to Normal mode of operation shall be automatic. No-break transfer to and from Bypass mode shall be capable of being initiated manually from the front panel.

1.3 REFERENCES

- A. UL 1778 (Underwriters Laboratories) - Standard for Uninterruptible Power Supply Equipment. Product safety requirements for the United States.
- B. CSA C22.2 No 107.1(Canadian Standards Association) - Commercial and Industrial Power Supplies. Product safety requirements for Canada.
- C. NEMA PE-1 - (National Electrical Manufacturers Association) - Uninterruptible Power Systems standard.
- D. IEC 62040-1-1 (International Electrotechnical Commission) - Uninterruptible power systems (UPS) - Part 1-1: General and safety requirements for UPS used in operator access areas.
- E. IEC 62040-1-2 (International Electrotechnical Commission) - Uninterruptible power systems (UPS) - Part 1-2: General and safety requirements for UPS used in restricted access locations.
- F. IEC 62040-3 (International Electrotechnical Commission) - Uninterruptible power systems (UPS) - Part 3: Method of specifying the performance and test requirements.
- G. IEEE 587 (ANSI C62.41) Category A & B (International Electrical and Electronics Engineers) - Recommended practices on surge voltages in low voltage power circuits.
- H. CISPR 22: FCC Rules and Regulations 47, Part 15, Class A (Federal Communications Commission) - Radio Frequency Devices (prior to Feb 16, 2006).
- I. MIL-HDBK-217E (Military Handbook) - Reliability prediction of electronics equipment

1.4 SUBMITTALS

- A. The UPS shall be supplied with sufficient documentation, including the following manuals:
1. Installation and Operation Manual: One copy of the installation and operation manual shall be furnished. It shall possess sufficient detail and clarity to enable the owner's technicians or representatives to install and operate the UPS equipment and accessories. The manual shall include the following major items:
 - a. UPS description
 - b. UPS site planning and unpacking
 - c. UPS installation
 - d. Optional accessory installation
 - e. UPS theory of operation
 - f. Operating procedures
 - g. System events
 - h. UPS maintenance
 - i. Performance and technical specifications
 - j. Wiring requirements and recommendations
 - k. Physical features and requirements
 - l. Cabinet dimensions

1.5 QUALIFICATIONS

- A. The UPS manufacturer shall have experience in the design, manufacture and testing of solid-state UPS systems.
- B. The UPS manufacturer shall have ISO 9001 certification for engineering/R&D, manufacturing facilities and service organization.
- C. The UPS manufacturer shall maintain a staffed 7x24x365 call center for technical and emergency support.
- D. The UPS manufacturer shall directly employ a nationwide field service department staffed by factory-trained field service engineers dedicated to startup, maintenance, and repair of UPS equipment. The organization shall consist of local offices managed from a central location. Field engineers shall be deployed in key population areas to provide on-site emergency response within 24 hours. A map of the United States showing the location of all field service offices must be submitted with the proposal. Third-party maintenance will not be accepted.

- E. Spare Parts Support: Parts supplies shall be located in the field to provide 80% of all emergency needs. The factory shall serve as the central stocking facility where a dedicated supply of all parts shall be available within 24 hours.
- F. Product Enhancement Program: The UPS manufacturer shall make available feature upgrade service offerings to all users as they are developed. These upgrades shall be available as optional field-installable kits.
- G. Maintenance Contracts: A complete range of preventative and corrective maintenance contracts shall be provided and offered with the proposal. Under these contracts, the manufacturer shall maintain the user's equipment to the latest factory revisions.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. The UPS shall withstand any combination of the following external environmental conditions without operational degradation.
 - 1. Operating Temperature: 0 degrees C to + 40 degrees C (32 degrees F to 104 degrees F) without de-rating (excluding batteries).
 - 2. Storage Temperature: - 25 degrees C to + 60 degrees C (-13 degrees F to 140 degrees F). Prolonged storage above + 40 degrees C (104 degrees F) will cause rapid battery self-discharge.
 - 3. Relative Humidity (operating and storage): 95% maximum non-condensing.
 - 4. Elevation:
 - a. Operational: 1500 meters maximum without de-rating.
 - b. Transportation: Capable of air transport.

1.7 SAFETY

- A. The UPS shall be certified by a US recognized NRTL (National Recognized Test Laboratory) in accordance with UL 1778.
- B. The UPS shall be certified by a Canadian Recognized Test Laboratory in accordance with CSA C22.2 No.107.3-05.

PART 2 - PRODUCTS

2.1 UPS STANDARD FEATURES - The UPS shall consist of the following standard components and features:

- A. One or more UPM's, each consisting of:
 - 1. Rectifier/Charger: Each rectifier/charger shall convert incoming AC power to regulated DC output for supplying the inverter and for charging the battery. The

rectifier/charger shall be a high-frequency PWM design, using Insulated Gate Bipolar Transistors (IGBTs). The modular design of the UPS shall permit safe and fast removal and replacement of the rectifier/charger module. Mean time to repair (MTTR) for the module shall be no more than 30 minutes in order to return UPS to normal mode. The rectifier/charger module shall also provide the following:

- a. The rectifier shall be capable of drawing power from the utility with a power factor of 0.99 under nominal conditions.
 - b. The rectifier shall feature protection circuitry that prevents the IGBTs from sourcing current in excess of their published ratings.
 - c. An option shall be provided to allow the rectifier to be capable of operating from a delta transformer output or high impedance grounded transformer
2. Inverter: Each inverter shall feature an IGBT pulse-width-modulation (PWM) design with high speed switching. The inverter shall also have the following features:
- a. The inverter shall be capable of providing the specified quality output power while operating from any DC source voltage (rectifier or battery) within the specified DC operating range.
 - b. The modular design of the UPS shall permit safe and fast removal and replacement of the inverter module. Mean time to repair (MTTR) for the module shall be no more than 30 minutes in order to return UPS to normal mode.
 - c. The inverter shall feature protection circuitry that prevents the IGBTs from sourcing current in excess of their published ratings.
- B. ISBM section with Static Bypass: The bypass shall serve as an alternative source of power for the critical load when an abnormal condition prevents operation in normal mode. The bypass shall consist of a fully rated, continuous duty, naturally commutated static switch for high-speed transfers. The bypass shall feature the following transfer and operational characteristics.
1. Transfers to bypass shall be automatically initiated for the following conditions:
 - a. Output overload period expired.
 - b. Critical bus voltage out of limits.
 - c. Internal over temperature period expired.
 - d. Total battery discharge.
 - e. UPS failure.
 2. Uninterrupted automatic re-transfer shall take place whenever the inverter is capable of assuming the critical load.
 3. Uninterrupted automatic re-transfers shall be inhibited for the following conditions:
 - a. When transfer to bypass is activated manually or remotely.

- b. In the event of multiple transfers/re-transfer operations the control circuitry shall limit "cycling" to three (3) operations in any ten-minute period. The fourth transfer shall lock the critical load on the bypass source.
 - c. UPS failure.
 - 4. Uninterrupted manual transfers shall be initiated from the control panel. Uninterrupted manual transfers to bypass and from bypass shall be possible with the inverter logic. During manual transfers to bypass mode, the inverter must verify proper bypass operations before transferring the critical load to the bypass.
 - a. All transfers to bypass shall be inhibited for the following conditions:
 - b. Bypass voltage out of limits (+/- 10% of nominal)
 - c. Bypass frequency out of limits (+/- 3 Hz, adjustable, factory set)
 - d. Bypass out of synchronization
 - e. Bypass phase rotation / installation error
 - 5. Static transfer time: No break, complete in less than 4ms.
 - 6. The bypass shall be manually energized using the control panel or remotely through a building alarm input.
- C. Monitoring and control components: The following components shall provide monitor and control capability:
 - 1. Control panel with status indicators.
 - 2. Alarm and metering display.
 - 3. Building alarm monitoring.
 - 4. Communication ports.
- D. Battery management system: The UPS shall contain a battery management system which has the following features:
 - 1. The battery management system shall provide battery time remaining while operating in normal mode and battery mode. Battery time available information shall be displayed real-time, even under changing load conditions. Upon commissioning, battery runtime information shall be available.
 - 2. The battery management system shall automatically test the battery string(s) to ensure that the battery is capable of providing greater than 80% of its rated capacity. Testing the batteries shall not jeopardize the operation of the critical load. Upon detection of the battery string(s) not capable of providing 80%, the UPS system will alarm that the battery needs attention/replacement. The battery test shall be able to detect the following:
 - a. Open battery string
 - b. Shorted battery string
 - c. Battery capacity (runtime) less than 80% of "new" battery capacity

1. The UPS shall communicate battery test and monitoring data to the UPS manufacturer's remote monitoring site. Battery life remaining, capacity, and number of on-battery events shall be provided in a monthly report.
 2. A temperature sensor shall be included to monitor the ambient temperature internal to the battery cabinet. If the ambient temperature increases, the UPS system charger shall automatically reduce the charging voltage to a level recommended by the battery manufacturer. If the ambient temperature is decreased the UPS shall automatically increase the battery charge voltage to that recommended by the battery manufacturer.
- E. Wiring Terminals: The UPS module shall contain mechanical compression terminals (adequately sized to accommodate 90°C wiring) for securing user wiring to the following locations:
1. Rectifier/charger input connections (3-wire plus ground)
 2. Bypass input connections (3-wire plus ground for 3-wire plus ground output configuration (480Vac), or 4-wire plus ground for 4-wire plus ground output configuration)
 3. DC link connections for battery cabinets (positive and negative).
 4. AC output connections (3 or 4 wires plus ground).
- F. UPS System Configuration Features
1. UPS Configurations for Capacity and Redundancy: UPS shall be constructed such that multiple internal UPM's can be combined for redundancy or capacity. Internal UPM's shall be capable of being paralleled to increase system power levels or to provide redundant power. Up to 3 internal UPM's shall be capable of parallel operation, either for capacity or redundancy. The UPS shall have intelligence to automatically recognize the need for capacity and/or redundancy. The UPS shall utilize autonomous internal UPM's that do not rely on any control interconnections for synchronized operation. The internal UPM's shall operate in a peer-to-peer manner to provide automatic load sharing, synchronization, and selective tripping capabilities. "Master-slave" configurations are not acceptable.
 2. The UPS shall utilize a communications network to provide system information and status, such as operating mode and meter data. This network shall provide individual internal UPM information as well as total UPS information, and shall be available from the UPS front panel display. The loss of this system information network shall not cause the UPS to transfer to bypass or drop the critical load.
 - a. UPS's with more than one internal UPM shall be inherently redundant when the load is less than 50% of the UPS rated capacity. Under load conditions less than 50% of rated UPS capacity, at least one internal UPM shall be redundant.

- b. Concurrent maintenance: Any redundant internal UPM can be concurrently isolated and serviced (by factory-trained service engineers) while the other internal UPM continues to provide protected power to the load.

2.03 UPS SYSTEM OPTIONS AND ACCESSORIES

The UPS system shall consist of the following options and accessories :

- A. Field upgrades: Manufacturer shall offer the ability to upgrade the capacity or redundancy of the UPS system in the field. Manufacturer shall offer integrated UPM's that can be added in the field, to increase the capacity or redundancy of the UPS. UPS design shall allow at least one integrated UPM to be added in the field.
- B. SNMP Network Adapter and UPS Power Monitoring Software: SNMP adapters shall provide a communications interface between the UPS module and SNMP-compatible network management systems. This capability shall allow the unit to be monitored remotely over an Ethernet network using a standard web browser.
 - 1. UPS Power Monitoring Software: This system shall continuously monitor critical power elements associated with the UPS, using the communications port on each module and a customer furnished PC. The system shall automatically alarm if any problems arise and notify local or remote personnel of the alarm condition via email, page, or text message.
- C. Battery Cabinet: The battery cabinet shall feature valve regulated, high-rate discharge, lead-acid batteries which provide energy to the support the critical load during a momentary loss of input power to the rectifier. The batteries shall be flame retardant in accordance with UL 94V2 requirements. The battery cabinet shall have the following features:
 - 1. The battery cabinet shall be the same depth and height as the UPS module.
 - 2. The battery cabinet shall feature a mechanical enclosure of like appearance to the UPS module and shall feature casters. Each battery cabinet shall require front access only for installation, service and maintenance. The battery cabinet shall provide top and bottom cable entry.
 - 3. Power wiring internal to each battery cabinet shall be factory provided. Each battery cabinet shall feature up to 10 battery trays which can be individually disconnected from the battery cabinet power wiring with quick disconnect devices. Each battery tray shall be firmly secured to the battery cabinet frame with fasteners. Each battery tray shall be removable from the front of the battery cabinet.
 - 4. Each battery cabinet shall feature a DC rated circuit breaker. The circuit breaker within the battery cabinet shall only provide protection to the battery string within that battery cabinet. For battery configurations involving multiple battery cabinets, a battery string in one battery cabinet may be isolated from the DC link via its

circuit breaker without removing other battery strings from the DC link and the UPS module.

5. The circuit breaker in each battery cabinet shall feature an A/B auxiliary switch. The UPS module shall be capable of monitoring and alarming an open battery cabinet circuit breaker condition.
6. The circuit breaker in each battery cabinet shall feature a 48VDC under voltage release device. The UV device shall operate to trip the battery breaker(s) for an emergency power off command or battery disable command.
7. The batteries shall be configured with a ¼" spade type connector for attaching sense leads to each jar to facilitate the future addition of a battery monitoring system.
8. Expected battery life: 200 complete full load discharge cycles when operated and maintained within specifications.

2.05 UNINTERRUPTIBLE POWER SUPPLY RATINGS AND OPERATING CHARACTERISTICS

A. UPS Continuous Ratings. The UPS shall be rated:

UPS Rating (max)	Operational Rating
450kVA/405kW	275kVA/250kW N+1
Future 450kVA/405kW	Future 450kVA/405kW N+1

UPS Rating (max) is the maximum output possible from the UPS (for a load power factor range of 0.9 lagging to 0.9 leading).

B. Rectifier/charger input:

1. Nominal three phase input voltage: 480 VAC:
2. 3-wire plus ground input
3. Operating input voltage range: + 10%, - 30% of average nominal input voltage without battery discharge.
4. For 60Hz systems, operating input frequency range shall be 55 to 65Hz.
5. Input power factor 0.99 lagging.
6. Normal input current limit: The UPS shall have the following programmable input current limit settings while operating in normal mode:

- a. Rectifier/charger input current limit shall be adjustable from 100 to 115% of full-load input current.
- b. Battery input current limit shall be adjustable from 10% to 15% of the UPS full load input current regardless of the actual load on the UPS.
- c. On generator input current limit: The UPS shall have the following programmable input current limit settings while operating in normal mode on generator:
 1. Rectifier/charger input current limit shall be adjustable from 100% to 115% of full-load input current.
 2. Battery recharge input current limit shall be adjustable from 10% to 15% of the UPS full load input current regardless of the actual load on the UPS.
- d. Input current total harmonic distortion (THD) shall be less than 3.0%.
- e. Power walk-in: Ramp-up to full utility load adjustable from 3 seconds to 60 seconds.

C. Bypass input:

1. Synchronizing bypass voltage range shall be +/- 10% of average nominal input voltage.
2. Synchronizing bypass frequency range is centered on the nominal frequency.
3. Bypass and rectifier inputs can be supplied from out of phase sources if required.
4. Input surge withstand capability: The UPS shall be in compliance with IEEE 587 (ANSI C62.41), category A & B (6kV).

D. Rectifier/charger output:

1. Nominal DC voltage shall be 480VDC.
2. Steady state voltage regulation shall be +/- 0.5%.
3. Voltage ripple shall be less than 0.5% (peak-to-peak).
4. Capacity: The rectifier/charger shall support a fully loaded inverter and recharge the battery to 90% of its full capacity within 10 times the discharge when input current limit is set at maximum.

5. Low line operation: The rectifier/charger shall be capable of sharing the DC load with the battery when the input voltage falls below the specified operation input voltage range, the on battery indicator shall enunciate operation in this mode.
6. DC sensing: Redundant DC voltage sensing methods shall be incorporated for providing battery over-voltage protection.
7. Battery charger characteristics: The UPS battery charging system shall have the following characteristics:
 - a. The charger shall be capable of being configured for several charge modes including:
 1. A charging mode that increases battery life by allowing the battery to rest, reducing positive plate corrosion
 2. A charging mode floating the battery at a set level, which can be adjusted via software, used for flooded cell applications
 - b. Nominal Float Voltage: 2.25 V per cell.
 - c. Equalizing Voltage: 2.38 V maximum per cell (adjustable).
 - d. Automatic (time based) or manual (user initiated) equalization available
 - e. UPM will automatically adjust battery shutdown based upon loading and battery capacity.
 1. The UPM shall automatically adjust the final discharge voltage between 1.67 and 1.75 Volts per cell based on the existing load and the rate and length of discharge.
 2. The absolute minimum operational voltage is 1.67 V per cell (adjustable).
 - a. The UPM will automatically disconnect the battery system in case of full battery discharge followed by prolonged utility AC voltage failure. The time window before battery disconnection occurs shall be programmable for both time and voltage.

E. UPS output in normal mode

1. 480V, 3-phase, 3-wire or 4 wire plus ground. Output wiring configuration is based upon input wiring configuration for systems without internal transformers.
2. Steady-state voltage regulation (in inverter) shall be within +/- 1% average from nominal output voltage.
3. Transient voltage response shall be < +/- 5% from nominal voltage for 100% load step, full load re-transfers and full load drop on battery.
4. Transient voltage recovery shall be 25ms to within +/- 1% of steady state.

5. Linear load harmonic distortion capability: Output voltage THD of less than 2% for 100% linear load.
6. Non-linear load harmonic distortion capability: Output voltage THD of less than 5% for 100% non-linear load when tested using the non-linear load described in IEC 62040-3 connected line to neutral.
7. Manual output voltage adjustment shall be +/- 3% from nominal.
8. Line synchronization range shall be +/- 3Hz, adjustable to +/- 5Hz.
9. Frequency regulation shall be +/- 0.01Hz free running.
10. Frequency slew rate shall be 1 Hz/second maximum (adjustable).
11. Phase angle control:
 - a. Balanced linear load shall be +/- 1 degree from nominal 120 degrees
 - b. Unbalanced linear loads shall less than +/- 5 degrees from average phase voltage for 100% load unbalance.
12. Phase voltage control:
 - a. Balanced linear loads shall be +/- 1% from average phase voltage
 - b. Unbalanced linear loads shall be less than +/- 5% for 100% load unbalanced
13. Overload current capability (with nominal line and fully charged battery): The unit shall maintain voltage regulation for up to 110% of resistive/inductive load for 10 minutes, up to 125% for 30 seconds, and up to 150% for 10 seconds.
14. Fault clearing current capability: 150% phase-to-phase for 10 cycles; 300% phase-to-neutral for up to 10 cycles
15. Static transfer time: No break, completed in less than 4ms.
16. Common mode noise attenuation:
 - a. -65dB up to 20kHz, -40db up to 100kHz
 - b. > 100dB with isolation transformer
17. Acoustical noise: Noise generated by the UPS under normal operation shall not exceed 65dbA at one meter from any operator surface, measured at 25 degrees C (77 degrees F) and full load.
18. EMI Suppression: The UPS shall meet IEC 62040-2, EN50091 Class A restricted

Limits

19. Electrostatic discharge (ESD): The UPS shall meet IEC 801-2 specifications. The UPS shall withstand a 25 kV pulse without damage and with no disturbance or adverse effect to the critical load.
20. Efficiency: The UPS efficiency shall be up to 95%. If UPS requires input filters for controlling input THD, manufacturer shall state efficiency of UPS with input filters connected.

2.06 MECHANICAL DESIGN

- A. Ventilation: The UPS shall be designed for forced-air cooling. Air inlets shall be on the front of the unit. Air outlets shall be on the top. Eighteen inches of clearance over the UPS outlets shall be required for proper air circulation. .
- B. No back or side clearance or access shall be required for the system. The back and side enclosure covers shall be capable of being located directly adjacent to a wall.
- C. Cable entry: Standard cable entry for the UPS cabinet shall be through either the enclosure bottom or top. A dedicated wireway shall be provided within the UPS cabinet for routing user input and output wiring.
- D. Front access: All serviceable subassemblies shall be modular and capable of being replaced from the front of the UPS (front access only required). Side or rear access for installation, service, repair or maintenance of the UPS system shall not be required.
- E. Service area requirements: The system shall require no more than forty-two (42) inches of front service access room and shall not require side or rear access for service or installation.

2.07 CONTROLS AND INDICATORS

- A. Microprocessor controlled circuitry: The UPS controls shall have the following design and operating characteristics:
 1. Fully automatic operation of the UPS shall be provided through the use of microprocessor controlled Digital Signal Processing. DSP shall eliminate variances from component tolerance or drift, and provide consistent operational responses.
 2. All operating and protection parameters shall be firmware controlled, thus eliminating a need for manual adjustments. The logic shall include system test capability to facilitate maintenance and troubleshooting. Printed circuit board replacement shall be possible without requiring calibration.
 3. Start-up and transfers shall be automatic functions.

- B. Digital Front Panel Display: The UPS control panel shall be a digital front panel display that features an 8x40 (8 lines, each with 40 characters) backlit LCD display. The LCD shall display UPS status, metering, battery status, alarm/event queue, active alarms and UPS configurations. The front panel display shall show a system mimic diagram with an outlined power path, current operating mode and event logs.
- C. Control Panel Indicators: The UPS control panel shall provide the following monitoring functions with indicator LED's:
 - 1. NORMAL: This shall indicate that the commercial AC utility or generator source is supplying power to the rectifier and the inverter is supporting the critical load. A text message shall indicate if the bypass line is not within tolerance.
 - 2. BYPASS: This shall indicate that the UPS has transferred the load to the bypass circuit.
 - 3. BATTERY: This shall indicate that the commercial AC utility or generator source has failed and the battery is supplying power to the inverter, which is supporting the load. A text message shall indicate if the battery charge is low or if the battery is installed but disconnected.
 - 4. ALARM: This shall indicate that the UPS detects an alarm condition, outlined in detail in the operator's manual.
- D. Control Panel Controls: The UPS control panel shall provide the following functions from front panel push buttons:
 - 1. EVENTS: Displays the list of Active System Events and a historical log of system events. Historical logs shall include a detailed time stamped list of the latest 128 events.
 - 2. METERS: Displays performance meters for the system or critical load. When selected, the front display shall show individual screens of input parameters, output parameters or bypass parameters including; voltage, current and frequency. In addition, the battery display shall show runtime remaining.
 - 3. CONTROLS: Displays a System Controls screen. Allows selection of operating mode, normal, bypass, charger on/off and Power Module on/off.
 - 4. SETUP: Allows display contrast, date and time information serial communication port configuration and display of firmware revision numbers.
 - 5. RETURN: Confirms selection or returns to previous screen.
- E. Interface panel: The UPS shall be equipped with an interface panel, located behind a protective cover, which provides the following signals and communication features in a Class 2 environment:
 - 1. Alarm contact: A dry contact for annunciating a summary alarm shall be provided for customer use. This contact shall be Form "C" capable of supplying both N/O and N/C contacts. Contact ratings shall be 5A max at a voltage not to exceed 28VDC or 277VAC.

2. RS232 (EIA / TIA-232) communications interface: Circuitry shall be provided for one RS232 (EIA / TIA-232) communication port for connection to automated service department diagnostic tools. This port may be used with simple ("dumb") terminals to gain remote access to all unit operation information.
3. Building alarms: Two inputs shall be provided for monitoring the status of external dry contacts. Building alarms shall be set up through the UPS configuration mode function on the RS232 (EIA / TIA-232) port.
4. External EPO contacts: Shall be provided to connect an external remote emergency power off switch to shutdown the UPS and de-energize the critical load.
5. Battery control contacts: Contacts shall be provided to connect the battery shunt trip and auxiliary signals from a battery breaker or battery disconnect switch.
6. External bypass indicator connection: A connection point shall be provided to acknowledge that an external maintenance bypass has been closed around the UPS, placing the critical load on utility power.
7. The system shall have options to add four (4) additional building alarms, 384 logged events, 4 additional languages, Mandarin or Russian as a primary language.

2.08 COMMUNICATIONS

- A. Communications Bay: The UPS shall be equipped with field configurable communications bays that will accommodate four (4) communication devices.
- B. Remote Monitoring:
 1. Includes WEB/SNMP card for communication capabilities.
 2. The UPS shall be able to be monitored remotely via communications devices. UPS manufacturer shall provide optional communications devices capable of communicating via various industry standard protocols such as RS232 and ModBus. Monitoring of UPS status may also be performed through isolated dry contact Form C relays.
 3. Remote monitoring of the UPS shall also be possible through status indicators elsewhere in the same facility through a device that replicates these indicators.
 4. The UPS communication capability should be able to integrate into any industry standard Building Management System (BMS) and/or Network Management System (NMS). The UPS must also be able to be monitored via any standard Internet browser (i.e. Internet Explorer and Netscape).

All optional hardware interfaces shall be "Hot-swappable" (UPS maintains power to critical applications while changing interfaces).
- C. Shutdown:

1. There shall be a mechanism that provides graceful, orderly, unattended, sequential shutdown of one or multiple computers powered by one UPS. This shutdown shall be performed via in-network or out-of-network means. The order of shutdown shall be user-defined, allowing the maximization of runtime on battery for more critical systems.
 - a. Shutdown of AS/400 computers shall be possible through open-collector relay contacts or isolated, dry contact, Form-C relays.
 - b. The UPS shall also be capable of interfacing with an operating system's built-in shutdown routine, e.g. Windows NT. This shall be done through a cable connection to the optional serial port on the UPS.
- A. Notification:
 1. There shall be a mechanism to send alerts to key personnel via email or SNMP traps. An alarm notification may also be sent by a network message.
 2. Dial-out to a computer for alarm notification may be performed. The user may respond by dialing-in to retrieve alarm history and a summary of current meter status.
 3. Management: A remote battery test may be performed via an Ethernet network. The UPS shall be tested through invoking a single command.

2.08 UPS PROTECTION

- A. Rectifier/Charger and Bypass protection shall be provided through fusing.
- B. Battery protection shall be provided by thermal-magnetic molded-case circuit breakers in each battery cabinet (if standard battery pack is provided) or external protective device for an external battery.
- C. Electronic current limiting circuitry and fuses in the Inverter circuit shall provide output protection.
- D. To comply with agency safety requirements, the UPS shall not rely upon any disconnect devices outside of the UPS to isolate the battery cabinet from the UPS.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.02 COMMISSIONING

- A. Factory start-up shall be provided on a 7 x 24 basis. Start-up service shall be provided at no extra charge and shall include one visit to perform all procedures and

tests specified within UPS Installation and Operation manual. UPS manufacturer shall also offer the following optional services:

1. Pre-energize visit to inspect installation and provide guidance to installers as required.
2. Post-start-up visit for alarm notification configuration, operator training, generator testing, etc.

B. The following procedures and tests shall be performed by Field Service personnel during the UPS startup:

1. Visual Inspection:

- a. Visually inspect all equipment for signs of damage or foreign materials.
- b. Observe the type of ventilation, the cleanliness of the room, the use of proper signs, and any other safety related factors.

2. Mechanical Inspection:

- a. Check all the power connections for tightness.
- b. Check all the control wiring terminations and plugs for tightness or proper seating.

3. Electrical Pre-check:

- a. Check the DC bus for a possible short circuit.
- b. Check input and Bypass power for proper voltages and phase rotation.
- c. Check all lamp test functions.

4. Initial UPS Startup:

- a. Verify that all the alarms are in a "go" condition.
- b. Energize the UPS module and verify the proper DC, walkup, and AC phase on.
- c. Check the DC link holding voltage, AC output voltages, and output waveforms.
- d. Check the final DC link voltage and Inverter AC output. Adjust if required.
- e. Check for the proper synchronization.
- f. Check for the voltage difference between the Inverter output and the Bypass source.
- g. Optional on site full-load, step-load, and battery discharge tests using no load banks shall also be offered using a self-commissioning full-load/no-load feature.

5. Operational Training: Before leaving the site, the field service engineer shall familiarize responsible personnel with the operation of the UPS. The UPS equipment shall be available for demonstration of the modes of operation.

3.03 WARRANTY

- A. All components of the UPS system shall be covered by a standard one-year limited factory warranty and service protection package.
- B. One-year limited factory warranty shall include replacement coverage for the UPS parts for a period of 18 months from shipment or 12 months from start-up, whichever occurs sooner.
- C. Three-year service protection package shall include 7x24 on-site repair/replacement labor for UPS parts and batteries; 7x24 technical support coverage; and 7x24 remote monitoring service (with monthly reports for UPS and battery performance). Standard response time shall be 8 hours from receipt of call. Manufacturer shall also provide two battery and one UPS preventive maintenance visits per year.
- D. Manufacturer shall also include Start-up services consisting of: 7x24 Start-up services of UPS and batteries; On-site user training; Site Audit; installation and commissioning of monitoring service; and validation of one-year limited factory warranty will be performed during the start-up.

END OF SECTION

SECTION 16900

ELECTRICAL EQUIPMENT CONNECTIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

Applicable items of all other ELECTRICAL SECTIONS shall apply to this Section.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 MECHANICAL EQUIPMENT

- A. All power wiring associated with the MECHANICAL DIVISION of these Specifications shall be as specified in the Electrical Division.
- B. All HVAC control wiring shall be as specified in the Mechanical Division.
- C. Overload elements in all starters shall be selected according to actual motor nameplate full load current. Responsibility for this coordination shall lie with the Contractor who has furnished the particular starter. Starters, for motors furnished by Mechanical Contractor, shall be furnished by Mechanical Contractor.
- D. All manual starting switches shall be furnished and installed by Electrical Contractor.
- E. All disconnect switches shall be furnished and installed as indicated and as required by the Electrical Contractor.
- F. All firestats will be furnished and set under the MECHANICAL DIVISION electrically connected in the branch circuit wiring by the Electrical Contractor.
- G. Refer to MECHANICAL DIVISION and to MECHANICAL PLANS for any additional electrical work required.
- H. Should the Mechanical or any other Contractor desire to use equipment requiring larger motors than those indicated on the drawings or equipment requiring more elaborate controls than the equipment described in these specifications, the responsible contractor shall reimburse the Electrical Contractor for any extra materials or labor furnished, at no additional cost to the Owner.
- I. All wiring and interconnections necessary for speed controllers on exhaust fans shall be

furnished and installed by the Electrical Contractor.

- J. All wiring between the Fire Alarm control modules and the motor starters shall be provided by the Electrical Contractor.

3.2 ARCHITECTURAL EQUIPMENT

- A. Coordinate all rough-in for all equipment specified by Architect. All mounting heights and locations shall be determined from shop drawing submittals prior to rough-in.

END OF SECTION

DIVISION **17**

INTEGRATED BUILDING SYSTEMS

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17010 - Equipment Racks & Cable Trays

The material and work shall comply with the applicable requirements of the following documents and/or their equivalents:

1. ANSI/TIA/EIA-569-A Commercial Building Standards for Telecommunications Pathways and spaces – February, 1998
2. National Fire Protection Agency (NFPA) – 70, National Electrical Code (NEC) – 1999
3. National Electrical Manufacturers Association (NEMA)-VE1 Metal Cable Tray Systems - 1998
4. National Electrical Manufacturers Association (NEMA)-VE2 Cable Tray Installation Guidelines – 2001
5. American Standard for Testing & Materials (ASTM)-A653/A653M-03 Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process – 2003.
6. Electronics Industries Alliance (EIA) 310-D Cabinets, Racks, Panels, and Associated Equipment.

2.0 Communication Equipment Racks

2.1 Equipment Rack Style

Equipment racks shall be bolted aluminum, EIA channel upright, double side drilled, and floor supported. Racks shall not be painted, but have a natural finish. Racks shall have at least two (2) posts with vertical cable management systems installed. See drawing T208.

Racks must be able to mount side by side and be secured to adjacent racks in a line-up arrangement.

Two (2) post relay racks with 3-inch upright post shall be used. Permanently stamped rack mount unit markings shall be included on each post.

Relay racks shall comply with EIA-310-D and IEC 60297 standards.

The width shall be 19.25-inches and the height shall be 7.5-feet (48 RU). Relay racks construction shall be 6061-T6 extruded aluminum alloy, or better, with two (2) top angles supplied for additional strength.

Universal 5 / 8" – 5 / 8" – 1 / 2" alternating hole pattern for mounting flexibility shall be provided. The hole pattern shall be fully compatible with conventional 1 – 1 / 4" – 1 / 2" alternating hole patterns. Mounting

holes shall be high strength, roll-formed, threaded, and on both sides of the frame.

3.0 Vertical Cabling Sections

Double-sided vertical cabling sections shall be provided. The Contractor shall provide vertical cabling sections that are compatible with frames in size, color, and material. Vertical cabling sections shall be provided two (2) per rack. See Drawing T208

4.0 Power Distribution Units (PDU)

Two (2) vertical (0U) PDU strips shall be provided for each relay rack as designated in drawing T201.

One (1) PDU shall be mounted on each rack post (front side of rack) of each relay rack post.

PDU strips shall contain a minimum of 11 NEMA 5-20R receptacles.

PDU strips shall be securely mounted to the relay racks by use of bolts and not by tie-wraps.

PDU strips shall conform to the following regulatory approvals: cUL listed, CSA, FCC Part 15 Class A, ICES-003, UL 60950, and UL Listed.

PDU strips shall not have an ON/OFF switch in order to reduce the risk of inadvertently switching the power strips off.

One (1) PDU strip shall be connected to one 20-A simplex receptacle. All simplex circuits will be on an individual branch circuit. See drawing T213.

Redundant power supplies and/or equipment shall not be plugged into the same PDU.

The PDU cord length shall be at least 10-feet long and have a NEMA L5-20P plug.

PDU strips shall be rated for an input voltage of 120V & 20A. Output rating shall be 120V & 20A.

5.0 Rack Shelving and Accessories

The Contractor shall coordinate with the OWNER the number and type of shelves and accessories needed. At a bare minimum, the shelves shall be rated for a 40-pound capacity, unless indicated otherwise by the OWNER. The shelving and additional accessories shall be manufactured by the same company that manufactured the equipment racks.

Racks must be capable of accepting the installation of a rack ground bus bar for grounding.

Accessories may include horizontal ring cable management, data/fiber cable duct, horizontal mount surge protector, vertical rails, rack mount keyboards, rack mount LCD monitors, KVM switches, or other accessories provided by the manufacturer.

6.0 Rack Distances

As a minimum requirement, the distance between rows of racks and the distance from the outer most racks of each row to the wall shall be no less than 3' – 6" apart. Room must be allowed for the OWNER'S staff to be able to move around comfortably and freely between rows of racks for maintenance and troubleshooting of equipment. See drawing T201.

7.0 Equipment Configuration

Equipment within the equipment racks shall be configured so that similar equipment (i.e., CPE, CAD, DVL, etc...) may be together in the same area of location for ease of maintenance and troubleshooting. Refer to drawing T201 for the floor plan of the rack layout.

8.0 Equipment Room Cable Trays

The cable trays in the equipment room shall meet the following minimum guidelines:

- A. All overhead cable trays shall be C-CHANNEL FLANGE IN type and made of steel.
- B. Cable trays shall have a pre-galvanized zinc finish per ASTM-A653 SS Gr. 33 G90 standard.
- C. Cable trays shall be installed above the equipment racks. The support method shall be trapeze support as shown in drawing T206. Threaded rods, extending vertically from the ceiling, will act as the support for the cable trays; the equipment racks are not the cable trays support system.
- D. Cable trays shall be mounted to the ceiling by the use of threaded rods and support kits.
- E. A minimum of 6-inches of space shall be maintained between the top of the equipment racks and the bottom of the cable tray.
- F. A minimum of 12-inches of space shall be maintained between the top of the cable tray and the ceiling.
- G. Splice plates shall be installed when connecting cable trays together.

- H. Cable trays shall be 3-inches deep and 18-inches wide. The length will be determined by the Contractor upon installation.
- I. If the cable trays run perpendicular to each other, the cable trays shall use 90° junction splice clamps.
- J. Cable trays shall not be placed under smoke detectors and/or sprinkler heads.
- K. When allowed, cable trays should not be placed under lights, electrical boxes, and/or electrical fixtures.
- L. Installation and storage of cable trays must comply with the NEMA VE 2-2006 guidelines and/or other applicable national, state, jurisdictional, and local codes.
- M. Bonding and grounding of all cable trays shall comply with the Motorola R-56 2005 Standards.
- N. Pre-galvanized zinc barriers shall be installed in the cable trays to separate the Ethernet cables from the coaxial cables.

9.0 Communications Room Cable Trays

Cable trays shall be installed below the communications room raised flooring. Cable trays shall run in parallel with the call-taker and dispatch positions.

Cable trays in the communications room shall meet the following minimum guidelines:

- A. All below floor cable trays shall be WIRE MESH type with a standard 2" x 4" wire mesh pattern.
- B. Cable trays shall have a pre-galvanized zinc finish per ASTM-A653 SS Gr. 33 G90 standard.
- C. Cable trays shall be mounted to the slab underneath the raised computer flooring by use of non-metallic floor supports. Cable trays shall not be mounted to the raised floor pedestals. Cable trays shall be raised between 5-3/4" to 7-1/8" above the floor.
- D. Splice plates shall be installed when connecting cable trays together.
- E. Pre-galvanized zinc barriers shall be installed in the cable trays to separate the Ethernet cables from the coaxial cables.

10.0 Under Floor Patch Panels

All telecom/data patch panels shall be installed in 2' x 2' under floor boxes in the designated areas in drawing T204. The number of telecom/data ports per under floor box are in increments of six (6). The plenum rated boxes shall be made by the same manufacturer used for the raised flooring system.

Individual Ethernet patch panels with the capacity of six (6) ports shall be used in each under floor box. For example, if the capacity for the designated box is 18, then there will be a total of 3 six (6) port patch panels in the under floor box. Patch panels must be installed to handle coax cable as well.

At a minimum, all patch panels shall meet the requirements of EIA/TIA-568-B.

Under floor boxes shall not be installed directly above the under floor cable tray system

Electrical bonding and grounding of all under floor boxes and patch panels shall comply with the Motorola R-56 2005 standards.

11.0 Rack Ground Bus Bars (RGB)

All equipment racks shall space available to mount a RGB on to it. The RGB shall be made of one of the following approved materials: copper alloy, tinned copper, or solid copper.

Each RGB shall have a minimum of eighteen 11mm holes drilled into it for bonding ground wires.

For best practices, standoff insulators shall be used for securely mounting the RGB to the equipment rack. A separation must be maintained between unlike metals and to facilitate conductor attachments.

RGB's shall be mounted vertically and off center of each equipment rack. The RGB's shall be positioned on the rear end of the rack.

17013 - Grounding Services

13.1 General

The overall goal of this section is to provide general grounding information in order to allow appropriate bidding and costing for this project. The provisions listed herein are correct; however, the contractor will be required to adhere to the Motorola R-56: Standards and Guidelines for Communication Sites; Rev 9/1/05-UP. Of particular concern are sections:

- Chapter 4 – External Grounding
- Chapter 5 – Internal Grounding
- Chapter 7 – Surge Protection Devices
- Chapter 9 – Equipment Cabling

In all instances work and equipment will be in compliance with this Motorola standard.

The Contractor shall provide grounding services for the dispatch center. The primary responsibility for the overall building/structure grounding will be with the building general contractor. Additionally grounding for any towers located near the center will be the responsibility of the tower vendor. The Contractor will be providing general building as well as grounding for the equipment room and the dispatch area in the center. For the purposes of this RFP the Contractor shall plan on special grounding in two connecting rooms; a dispatch area of four thousand (6,300) square feet and an equipment room of nine hundred (1,200) square feet.

The Contractor will provide appropriate grounding attachments for all telephone lines, radio/telephone circuits, and radio antenna cabling that enters into the building. The Contractor is to coordinate these activities with the appropriate equipment vendors.

The Contractor will supply appropriate position and cable tray grounding in the dispatch area.

13.2 Purpose

The purpose of this section is to establish minimum requirements for a grounding system that shall provide a measure of personnel and equipment lightning protection. In the event that any item specified within this document conflicts with the Motorola R-56: Standards and Guidelines for Communication Sites; Rev 9/1/05-UP; current National Electrical Code; or local building-grounding related codes, those Codes shall take precedence.

Protective measures to prevent equipment damage and personnel hazards by lightning shall incorporate system grounding and bonding using good RF practices for the conduction of steep wave front currents.

While all conductors and connections have some associated resistance, the inductive reactance is normally much larger.

All grounding and bonding conductors shall have low inductance interconnections to minimize the inductive voltage rise associated with the sharp wave front. All elements of the system and conducting elements in near proximity to the system shall be grounded and bonded together to enable all parts of the radio site to rise above earth equally.

13.3 Submittals

13.3.1 Shop Drawings and Catalog Data

Site-specific shop drawings (SD) and catalog data (CD) shall be submitted for the following items:

- A. Grounding and bonding plan (SD)
- B. Ground rods (CD)
- C. Surge suppression devices (CD)
- D. Bulkhead panel (CD)
- E. Coaxial cable grounding kit (CD)

13.3.2 Test Reports

Test reports for measured ground resistance shall be submitted as specified.

13.4. Equipment Rooms

13.4.1 Bulkhead entrance panel

A weatherproof metal bulkhead entrance panel shall be installed on the equipment room wall.

The panel shall be Andrew ArrestorPort or PolyPhaser Entrance Panels or equivalent, with size determined by the number and size of transmission lines interconnecting through it. The appropriate cable boots shall be used to weatherproof the connections.

The external side of the panel shall also include an external insulated ground bar for transmission line shield ground connections and connections to the external ground system. The ground bar shall be fabricated to avoid dissimilar metal connections.

The external ground bus bar shall be connected to the building external ground system by at least one conductor to form a low resistance and low inductance path to the system ground.

An internal sub-panel or a commercially available substitute, bolted directly to the bulkhead panel with multiple bolts shall be used to mount the transmission line surge suppressors. This sub-panel shall be constructed of metal and avoid a dissimilar metal interface. The sub-panel shall be securely fastened with a low resistance, low inductance path to the bulkhead panel. The bulkhead panel shall be connected to the building external ground system by at least one conductor to form a low-resistance and low impedance path.

13.4.2 Transmission Line Grounding

The following applies only to antenna and transmission lines outside the building, with entry into the building and equipment room. It does not apply where antenna and transmission lines are contained entirely within the building.

13.4.2.1 Shield Ground

The outer conductor of coaxial transmission lines shall be grounded with appropriate coaxial cable grounding kits, such as Andrew Type 204989 or equivalent.

These shall be installed per manufacturer's instructions at a minimum of three locations:

- A. At the top of the vertical run, near the antenna: The tail of the cable-grounding conductor shall be bonded to the tower using the clamp provided by the manufacturer. Additional grounding bonds shall be used for every 75 feet of the vertical transmission line run on the tower.
- B. At the bottom of the vertical run, just above its bend to the support bridge: This point shall be as low to the ground as feasible.
- C. Immediately outside the cable entrance to the equipment building, just prior to the coaxial suppressor.

13.4.2.2 Surge Suppressor Grounding

The surge suppressors used for protecting transmission lines entering the Equipment room shall be connected to the single point ground window, or bus plate. The wires must not be closer than two inches to any other metallic objects, conduits, cable trays, or equipment cabinets or racks to minimize flashovers.

13.4.3 Internal Grounding System

The internal grounding system shall employ current and proven single point grounding methodology. The design of communications equipment rooms should facilitate all external entry points in close proximity on one wall, or adjacent corners. This would include transmission lines, commercial power entry, AC surge suppressors, and telephone company lines. The center of these entry points should be the internal perimeter ring master ground bus bar that is located directly under the transmission line entry.

13.4.3.1 Internal Master Ground Bus Bar

A suitable size ground bus bar shall be installed at the point, or area, where the antenna transmission lines enter the equipment room as a single point ground connection for all internal equipment comprising the communications system.

The ground bus bar shall be a bare solid copper bus bar or plate of 1/4 inch or greater thickness.

Length and width dimensions shall depend on the number of grounding conductors to be connected. Each grounding conductor shall be independently connected to the bar.

This ground bus bar shall be installed inside the equipment room and be connected to an external ground system with a conductor. If this conductor extends below the earth's surface, the conductor shall be tinned and any splices shall be made with an exothermic process such as CADWELD, or equivalent.

There are multiple communications systems in the equipment room, therefore multiple ground bus bars shall be employed, one for each system. Each ground bus bar should be connected to the main, single-point master ground bus bar by a conductor.

The following items shall be connected to the internal master ground bus bar:

- A. Internal Grounding Ring (Halo)
- B. The transmission line surge suppressors (via a conductor)
- C. Equipment Ground Bus

13.4.3.2 Internal Grounding Ring (Halo)

An internal grounding ring (halo) shall be installed in the equipment room to provide a ground path for peripheral or support apparatus and to provide a protective ring around the equipment to minimize flashover to the communications equipment.

A halo grounding ring shall be installed in the areas where there is support apparatus (such as battery racks, HVAC equipment, metal door and metal doorframes, electrical panels, and transfer switches). This shall be connected to the ground window as a single point connection.

The internal halo-grounding ring shall be mounted on a 2-inch standoff from the wall.

The halo-grounding ring shall be installed such that it encircles the interior of the equipment room. The halo-grounding ring shall originate and terminate on the master ground bus bar.

The halo ground ring shall be mounted:

- A. Approximately 8 feet above floor level or 6 inches below the ceiling.
- B. Minimum 2 inch standoff from the wall.
- C. To minimize any potential for flashover or effects of magnetic fields, the halo ground ring shall not be located:
 - Within six inches of any magnetic structures such as ducts or I-beams.
 - Within two inches of any other metallic objects, conduits, cable trays, or equipment cabinets or racks.

13.4.3.3 Equipment Rack Ground

Each equipment cabinet or rack shall have a vertical equipment ground bus, with all units in the cabinet or rack to be connected. The cabinet or rack ground bus shall be secured to the rack at a distance of 6 inches from power and signal leads. Each equipment chassis shall be connected to the rack ground bus using a conductor with appropriate connectors.

Each equipment ground bus shall be connected to the single-point master ground bus bar via the shortest and most direct route. Communications equipment shall not be connected directly to the halo ground ring

An equipment ground bus shall be used to connect equipment racks directly to the master ground bus bar. The individual equipment ground bus from each rack, cabinet, or enclosure in a single row shall be connected to an equipment ground bus. Each single row of equipment shall have a separate equipment ground bus. Each equipment ground bus shall be connected to the master ground bus bar via the shortest and most direct route.

13.4.3.4 Connections to the Internal Ground Ring (Halo)

The following items shall be connected to the internal ground ring.

- A. The AC power panel enclosure and power line protectors.
- B. Telephone terminal block enclosure and telephone protectors.
- C. Metal battery racks.
- D. Other significant metal objects within 6 feet of any other grounded object; such as doors and doorframes, ventilation ducts, water pipes, etc.

13.4.3.5 Equipment Frames and Other Metal Structures

Equipment frames and other metal structures within 6 feet of each other or any point in the grounding system shall be directly bonded together with a conductor to avoid side flashovers and other hazards.

13.4.3.6 Cable Trays

Cable trays shall be connected to the master ground bar or halo ground ring via a conductor or stranded copper wire. Cable tray sections shall also be bonded together using a conductor. Incidental paths through framework, cable trays, building steel, etc. shall not be depended upon for a reliable ground connection.

When compression type connectors are employed at an installed site or system, the Burndy compression system (or equivalent) shall be used. This system consists of connectors for indoor taps, splices, and structural steel terminations.

13.5 Dispatch Area Grounding

A dispatch area ground-bus shall be run under the flooring for each equipment row, in a manner to allow each piece of equipment to tie into this ground. The ground bus shall be short and direct with no sharp bends, and shall not run parallel, within 2 inches, to any power or signal leads. The ground bus shall connect to a single-point master ground bus bar and the central electronics rack ground, and then connect to the exterior building ground, except if no external ground system is being installed as part of the equipment installation. Any ground system installed shall be effectively connected to the existing building ground or electrical service ground.

Console bays shall be bonded together, and shall be connected to the dispatch area ground bus with a short, direct run of a conductor, avoiding sharp bends.

13.6 Ground Resistance Measurement

Unless specified elsewhere, the maximum system ground and earth ground shall be less than five (5) ohms.

Equipment specifically designed for this purpose shall be used to measure the resistance of a point to ground, and the measurement shall be made using the instructions provided with the instrument in making this measurement.

13.7 Surge Protection

13.7.1 Transmission Line Protection

All RF transmission lines, including unused spares, must be protected by PolyPhaser Coaxial suppressors or equivalent and grounded at the internal master ground bus bar to remove surge currents from the center conductor.

The types of coaxial suppressors used shall be based upon the applications and manufacturer's recommendation.

13.7.2 AC Power Protection

All AC suppressors shall be used as Normal Mode (Line-Neutral) protection. The gas tube type of suppressors is not allowed. Common Mode suppression (Neutral-Ground and Line-Ground) violates NEC article 250 if the device self-sacrifices in the (N-G) or (L-G) mode. AC neutral shall be bonded to ground only at the main AC service panel. With proper grounding, Common Mode suppression is not necessary.

13.7.2.1 Main/Branch AC Panel Protection:

AC surge suppressors, TRANSTECTOR Apex series or equivalent, shall be placed at the entrance panels, transfer switches or distribution panels, to protect against power line voltage rising to damaging levels between neutral and line. The suppressor shall be installed parallel via a circuit breaker sized according to the manufacturer's recommendation (typically 60-amp) rated for the interrupting current of the panel. The lead lengths from the protective devices shall be as short as possible. The surge protector enclosure shall be grounded to the internal grounding ring (halo) with a conductor. A remote status indicator must be available.

13.7.2.2 AC power in-line protection

When the above AC surge suppressors are used, no additional AC protectors are required on site. If main/branch panel protector is not available to the level delivered in 13.7.2.1, each AC utility power line shall be equipped with a two-way surge protector, PolyPhaser Models IS-PSP or IS-PLDO or equivalent, to protect both against power line voltage rising to damaging levels line-to-line or line-to-neutral, and line-to-ground. The protector shall be located at the equipment cabinet with a conductor to system ground. The protective device shall not rely on the green ground wire in the AC power cable.

13.7.2.3 Telephone Lines

All telephone lines, T1 lines, data and control lines (excluding all fiber-optic lines) entering a site shall be equipped with Bi-polar, Bi-directional SAD surge protectors, TRANSTECTOR data & telecommunication surge protectors or equivalent. The location for these protectors can be at the equipment or telephone patch panel depending upon the application. In many cases, transient overvoltages can be coupled into both signal lines at the same time. For these hazards, protectors shall be connected with a conductor to either the equipment ground or telephone patch panel ground.

13.7.2.4 GPS Receiver

A GPS receiver with an active antenna mounted outside of the building is employed, therefore a GPS system coaxial protector such as PolyPhaser Model IS-MR50LNZ or equivalent, shall be equipped, to protect against the surge from a GPS antenna. The protector shall be located between the GPS antenna and GPS receiver with a conductor to connect to the equipment rack ground.

13.8 Electrostatic Discharge Protection

The following precautions shall be followed to reduce possible damage caused by ESD during the installation and maintenance process.

- A. Use of body grounding devices (wrist straps, heel straps with grounded conductive floor mats) by all inspection, service and installation personnel.
- B. Use of static free grounded work surfaces (table or floor mats) where appropriate.
- C. Use of anti-static packaging for ESD sensitive electronic circuit or component handling.

17030 – Cabling

1.1 General

1.1.1 Section Includes

Labor, equipment, materials and tools required to fit out the Telecommunications Rooms to allow them to support all associated Work Areas and connect them to Intermediate Cross Connects or the Main Cross Connect.

1.1.2 Related Sections

Communication Backbone Cabling

Communication Horizontal Cabling

1.1.3 Quality Assurance

The materials and work listed in this Section shall comply with the applicable requirements of the following documents:

1. ANSI/TIA/EIA-568-B.2-10-2008 Transmission Performance Specifications for 4-Pair 100 Ohm Category 6 Cabling
2. ANSI/EIA/TIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings - February, 1993
3. ANSI/TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications - August, 1994
4. Building Industries Consulting Services, International (BICSI) Telecommunications Distribution Methods Manual (TDMM)
5. National Fire Protection Agency (NFPA) - 70, National Electrical Code (NEC)
6. Motorola Standards and Guidelines for Communications Sites, R-56

1.1.4 Certifications

- A. Submit certification that installers and technical representatives are certified by their respective manufacturer for installation of all products.
- B. In addition, installer shall be certified by Motorola for installation of communications cabling systems.
- C. All installation shall be certified to meet Motorola Standards and Guidelines for Communications Sites, R56.

1.1.5 Warranty

Provide 25-year performance warranty for complete system.

1.1.6 Submittals

- A. Manufacturer's specifications for all products to be installed within the scope of work included under this contract.
- B. Provide wiring diagrams of interconnections of equipment.
- C. All certificates as stated above.

1.2. Products

1.2.1 Patch Panels

Category 6 patch panels shall meet the following requirements:

- 1. Manufactured by an ISO 9001 certified manufacturer
- 2. Manufacturer in business for at least 10 years
- 3. Category 6 cabling system (including cable, connecting hardware and cable assemblies) manufactured by a single vendor
- 4. Vendor able to provide independent laboratory certification of Category 6 system performance
- 5. Configured as 24 or 48 ports capable of field replacement
- 6. Utilize 110-type insulation displacement termination
 - a. 110 Terminals paired for crosstalk reduction
 - b. 110 Terminals capable of 200 termination cycles
- 7. Universal color code labels permit T568B wiring
 - a. Each panel shall be wired to T568B
- 8. Panel jacks shall:
 - a. Comply with FCC Part 68
 - b. Comply with IEC 60607-3
 - c. Be capable of 750 mating cycles
 - d. Utilize secondary circuit board for crosstalk compensation
- 9. UL Listed
- 10. Meet all TIA/EIA-568-B.2 requirements for Category 6

11. Meet or exceed the performance characteristics listed in the following table (in addition to Category 6):

Freq. MHz	Insertion Loss, dB	Return Loss, dB	NEXT, dB	FEXT, dB
1	0.02	52.4	84.8	83.7
4	0.02	53.7	80.3	74.8
8	0.02	55.3	77.4	69.4
10	0.03	56.1	76.4	67.5
16	0.03	57.6	72.0	62.9
20	0.04	59.3	71.9	61.7
25	0.04	59.4	69.1	59.8
31.25	0.05	56.8	67.7	58.2
62.5	0.06	42.3	61.5	52.6
100	0.06	33.2	57.7	48.7
200	0.06	21.2	52.5	42.2
250	0.10	17.4	47.9	40.1

12. Shall be 24 or 48 ports (1 or 2 rack units, respectively)
13. Comply with all requirements for: Gigabit Ethernet, 100BASE-Tx, token ring, 155 Mbps ATM, 100 Mbps TP-PMD, ISDN, analog (broadband, baseband) and digital video and analog and digital (VoIP) voice

1.2.2 Termination Blocks

- A. Cross connect fields shall be constructed using 110Connect XC frame kits which include: carbon steel backboards, cable management troughs, wiring blocks, connecting blocks, designation strips and white labels for the pair counts identified.
- B. Cross connect fields shall be constructed using 110Connect XC kits which include: wiring blocks, connecting blocks, designation strips and white labels for the pair counts identified.
- C. 110Connect XC cross connect blocks shall meet the following requirements:
 - 1. Manufactured by an ISO 9001 certified manufacturer
 - 2. Manufacturer in business for at least 10 years
 - 3. UL Listed, CSA and Austel approved
 - 4. Capable of 200 termination cycles
 - 5. Comply with all requirements for: Gigabit Ethernet, 100BASE-Tx, token ring, 155 Mbps ATM, 100 Mbps TP-PMD, ISDN, analog (broadband, baseband) and digital video and analog and digital (VoIP) voice
 - 6. Permit assembly with 110 punchdown tools
 - 7. Meet all TIA requirements for Category 6

8. Meet or exceed the performance characteristics listed in the following table (in addition to Category 6):

Frequency, MHz	Attenuation, dB	NEXT, dB	PS NEXT, dB	FEXT, dB	Return Loss, dB
1	0.05	82.9	79.9	85.1	57.6
4	0.05	71.6	68.6	74.4	48.5
8	0.05	65.8	62.7	68.3	42.8
10	0.05	63.8	60.8	66.4	40.8
16	0.1	59.9	56.9	62.5	36.9
20	0.1	57.9	54.9	60.5	35.0
25	0.1	55.9	52.9	58.4	33.0
31.25	0.1	53.9	50.9	56.4	31.0
62.5	0.15	48.0	45.0	50.3	25.1
100	0.2	44.0	41.0	45.9	21.2

1.2.3 Patch Cords

Category 6 patch cords shall meet the following requirements:

1. Category 6 cabling system (including cable, connecting hardware and cable assemblies) manufactured by a single vendor
2. Vendor able to provide independent laboratory certification of Category 6 system performance
3. Meet or exceed TIA/EIA-568-B.2-1 Category 6 requirements
4. Made of 4-pair stranded UTP cable
 - a. Cable jacketing shall be lead-free
5. Have matching color snagless boots

1.2.4 Communication Equipment Racks

- A. The CAT-6 cables should be terminated on and mounted in the 24/48-port patch panel. See drawings T209 thru T212.
- B. Ground Bus Bar: Provide 2 inch by ¼ inch ground bus bar of sufficient length for equipment mounted in rack. Bus bar shall meet EIA/TIA 607. Coordinate with Owner representative for equipment mounted in rack. Bond bus bars to grounding system.

1.3 Execution

1.3.1 Termination and Management Hardware

Termination and management hardware shall be installed in the following manner:

1. Cables shall be dressed and terminated in accordance with the recommendations made in the TIA/EIA-568-B document, manufacturer's recommendations and/or best industry practices.
2. Pair untwist at the termination shall not exceed .5 inch for Category 6 connecting hardware.

3. Bend radius of the installed cable shall not exceed 4 times the outside diameter of the cable.
4. Cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
5. The cable jacket shall be maintained as close as possible to the termination point.
6. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

1.3.2 Cable Testing

Proof of data testing will be required after all network cables have been installed between their respective destination and the patch panels. TIA/EIA Telecommunications System Bulletin 67 or equivalent shall be used for testing network cabling. All cables will require the minimum four (4) test before customer will approve the system:

1.3.2.1 Wire Map Test

Wire map testing will verify all pair to pin terminations at each end of the category 6 cable and check for connectivity errors. All conductors in the cable shall be checked for the following:

1. Shorts between conductors in the cable
2. Continuity of conductors to the remote end of the cable
3. Crossed pairs in the cable
4. Reversed pairs in the cable
5. Split pairs in the cable
6. Any other wiring errors in the cable

1.3.2.2 Length Test

Determines the maximum length of the cable segments of a category 6 cable.

1.3.2.3 Attenuation Test

Measure the amount of signal loss in each cable segment

1.3.2.4 Near-End-Crosstalk (NEXT).

Measure of the signal coupling from one wire pair to another within a single UTP cable.

1.0 Communication Horizontal Cabling

2.1. General

Labor, equipment, materials and tools required to fit out each standard office workstation location as shown in drawings T205 and T207, to allow them to support all associated Work Areas and connect them to Intermediate Cross Connects or the Main Cross Connect.

2.1.1 Related Sections

Communication Backbone Cabling

Communications Equipment Room Fittings

2.1.2 Quality Assurance

- A. The materials and work listed in this Section shall comply with the applicable requirements of the following documents:
 - 1. ANSI/TIA/EIA-568-B Commercial Building Telecommunications Cabling Standard
 - 2. ANSI/TIA/EIA-568-B.2-1 Transmission Performance Specifications for 4-Pair 100 Ohm Category 6 Cabling
 - 3. ANSI/EIA/TIA-569-A Commercial Building Standard for Telecommunications Pathways and Spaces
 - 4. ANSI/EIA/TIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
 - 5. ANSI/TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications
 - 6. Building Industries Consulting Services, International (BICSI) Telecommunications Distribution Methods Manual (TDMM)
 - 7. National Fire Protection Agency (NFPA) - 70, National Electrical Code (NEC)
 - 8. Motorola Standards and Guidelines for Communications Sites, R-56

2.1.3 Certifications

- A. Submit certification that installers and technical representatives are certified by their respective manufacturer for installation of all products.
- B. In addition, installer shall be certified by Motorola for installation of communications cabling systems.
- C. All installation shall be certified to meet Motorola Standards and Guidelines for Communications Sites, R56.

2.1.4 Warranty

- A. Provide 25-year performance warranty for complete system.

2.1.5 Submittals

- A. Manufacturers specifications for all products to be installed within the scope of work included under this contract.
- B. Provide wiring diagrams of interconnection of equipment.
- C. All certifications as stated above.

2.2 Products

2.2.1 Category 6 Cable

- A. Category 6 plenum cable shall meet the following requirements:
 - 1. Manufactured by an ISO 9001 certified manufacturer
 - 2. Manufacturer in business for at least 10 years
 - 3. Category 6 cabling system (including cable, connecting hardware and cable assemblies) manufactured by a single vendor
 - 4. Vendor able to provide independent laboratory certification of Category 6 system performance
 - 5. Comply with all of the performance requirements for Gigabit Ethernet, 100BASE-Tx, token ring, 155 Mbps ATM, 100 Mbps TP-PMD, ISDN, analog (broadband, baseband) and digital video and analog and digital (VoIP) voice
 - 6. UL/NEC CMP rated PVC jacket
 - 7. Jacketing shall be lead-free
 - 8. UL Listed
 - 9. Conductors 100% FEP insulated, 23AWG solid copper
 - 10. Impedance: 100 ohms $\pm$ 15%, 1 MHz to 600 MHz
 - 11. Velocity of propagation: 74%
 - 12. Propagation delay: 536 ns/100 m max. @ 250 MHz
 - 13. Delay Skew: 45 ns max
 - 14. Conductor resistance: 66.58 ohms max/km
 - 15. Mutual capacitance: 5.6 nF max/100 m
 - 16. Voltage: 300 volts AC or DC

17. Cables shall be grey in color
18. Comply with all requirements of TIA/EIA-568-B.2-1 Transmission Performance Specifications for 4-Pair 100 Ohm Category 6 Cabling
19. Meet or exceed performance characteristics in the following table:

Frequency (MHz)	Attenuation (dB/100m)	NEXT (dB)	PSNEXT (dB)	ELFEXT (dB)	PSELFEXT (dB)	RL (dB)	ACR (dB)	PS ACR (dB)
	Maximum	Minimum	Minimum	Minimum	Minimum	Minimum	Minimum	Minimum
0.772	1.8	79	77	70	67	—	77.2	75.2
1	2.0	77	75	68	65	20	75.3	73.3
4	3.8	68	66	56	53	23	64.5	62.5
8	5.4	64	62	50	47	24.5	58.4	56.4
10	6.0	62	60	48	45	25	56.3	54.3
16	7.6	59	57	44	41	25	51.7	49.7
20	8.5	58	56	42	39	25	49.3	47.3
25	9.6	56	54	40	37	24.3	46.8	44.8
31.25	10.7	55	53	38	35	23.6	44.2	42.2
62.5	15.5	50	48	32	29	21.5	34.9	32.9
100	19.9	47	45	28	25	20.1	27.4	25.4
155	25.3	44	42	24	21	18.8	19.1	17.1
200	29.2	43	41	22	19	18	13.6	11.6
250	33.0	41	39	20	17	17.3	8.3	6.3
300	36.6	40	38	18	15	16.8	3.5	1.5
350	40.0	39	37	17	14	16.3	—	—
400	43.2	38	36	16	13	15.9	—	—
450	46.3	38	36	15	12	15.5	—	—
500	49.2	37	35	14	11	15.2	—	—
550	52.0	36	34	13	10	14.9	—	—
600	54.8	36	34	12	9	14.7	—	—

B. Category 6 PVC cable shall meet the following requirements:

1. Manufactured by an ISO 9001 certified manufacturer
2. Manufacturer in business for at least 10 years
3. Category 6 cabling system (including cable, connecting hardware and cable assemblies) manufactured by a single vendor
4. Vendor able to provide independent laboratory certification of Category 6 system performance
5. Comply with all of the performance requirements for Gigabit Ethernet, 100BASE-Tx, token ring, 155 Mbps ATM, 100 Mbps TP-PMD, ISDN, analog (broadband, baseband) and digital video and analog and digital (VoIP) voice
6. UL/NEC CMR rated
7. UL Listed

8. Conductors polyethylene insulated, 24AWG solid copper or approved equal
9. Jacketing shall be lead-free
10. Impedance: 100 ohms $\pm$ 15%, 1 MHz to 600 MHz
11. Velocity of propagation: 70%
12. Propagation delay: 536 ns/100 m max. @ 250 MHz
13. Delay Skew: 45 ns max
14. Conductor resistance: 66.58 ohms max/km
15. Mutual capacitance: 5.6 nF max/100 m
16. Voltage: 300 volts AC or DC
17. Cables shall be grey in color
18. Comply with all requirements of TIA/EIA-568-B.2-1 Transmission Performance Specifications for 4-Pair 100 Ohm Category 6 Cabling
19. Meet or exceed performance characteristics in the following table:

Frequency (MHz)	Attenuation (dB/100m)	NEXT (dB)	PSNEXT (dB)	ELFEXT (dB)	PSELFEXT (dB)	RL (dB)	ACR (dB)	PS ACR (dB)
	Maximum	Minimum	Minimum	Minimum	Minimum	Minimum	Minimum	Minimum
0.772	1.8	79	77	70	67	—	77.2	75.2
1	2.0	77	75	68	65	20	75.3	73.3
4	3.8	68	66	56	53	23	64.5	62.5
8	5.4	64	62	50	47	24.5	58.4	56.4
10	6.0	62	60	48	45	25	56.3	54.3
16	7.6	59	57	44	41	25	51.7	49.7
20	8.5	58	56	42	39	25	49.3	47.3
25	9.6	56	54	40	37	24.3	46.8	44.8
31.25	10.7	55	53	38	35	23.6	44.2	42.2
62.5	15.5	50	48	32	29	21.5	34.9	32.9
100	19.9	47	45	28	25	20.1	27.4	25.4
155	25.3	44	42	24	21	18.8	19.1	17.1
200	29.2	43	41	22	19	18	13.6	11.6
250	33.0	41	39	20	17	17.3	8.3	6.3
300	36.6	40	38	18	15	16.8	3.5	1.5
350	40.0	39	37	17	14	16.3	—	—
400	43.2	38	36	16	13	15.9	—	—
450	46.3	38	36	15	12	15.5	—	—
500	49.2	37	35	14	11	15.2	—	—
550	52.0	36	34	13	10	14.9	—	—
600	54.8	36	34	12	9	14.7	—	—

2.3 Execution

2.3.1 Terminations

- A. Wall Locations:
For each standard office workstation location as shown in drawings T205 and T207, provide four (4) CAT-6 cables terminated and a single RG6 Coaxial cable termination.
- B. Closet Terminations
The CAT-6 cables shall be terminated in and mounted in 24/48-port patch panel as seen in drawings T209 thru T212.
- C. The connectors shall meet the intermateability requirements of TIA/EIA-604-12.
- D. Meet or exceed the performance characteristics listed in the following table:

Test Description	FOTP	Requirement (dB)
Visual and Mechanical Inspection	13	TIA/EIA-604-2 or -3 Intermateability
Attenuation	34	0.75
Return Loss	107	-20
Low Temperature (0 ^o C for 4 days)	188	0.3 change
Temperature Life (55 ^o C for 14 days)	7	0.3 change
Humidity (90 to 95% @ 40 ^o C for 4 days)	5	0.3 change
Impact (8 drops from 1.8 meters)	2	0.75 IL, -20 RL
Durability (500 cycles)	21	0.75 IL, -20 RL
Cable Retention (0 ^o and 90 ^o)	6	0.75 IL, -20 RL
Flex (100 cycles)	1	0.75 IL, -20 RL
Twist (10 cycles)	36	0.75 IL, -20 RL

- E. Category 6 connectors shall comply with the following requirements:
 1. Manufactured by an ISO 9001 certified manufacturer
 2. Manufacturer in business for at least 10 years
 3. Category 6 cabling system (including cable, connecting hardware and cable assemblies) manufactured by a single vendor
 4. Vendor able to provide independent laboratory certification of Category 6 system performance
 5. Comply with all of the performance requirements for Gigabit Ethernet, 100BASE-Tx, token ring, 155 Mbps ATM, 100 Mbps TP-PMD, ISDN, analog (broadband, baseband) and digital video and analog and digital (VoIP) voice
 6. Utilize 110-type insulation displacement termination
 - a. 110 Terminals paired for crosstalk reduction
 - b. 110 Terminals capable of 200 termination cycles
 - c. 110 Terminals oriented 180O to front of jack
 7. Universal color code labels permit either T568A or T568B wiring

8. Each connector shall be wired to T568A or T568B
9. Comply with FCC Part 68
10. Comply with IEC 60607-3
11. Have 50 micron gold plating on contact area
12. Be capable of 750 mating cycles
13. Housing made of 94V-0 rated polyphenylene oxide
14. Jacks shall be grey in color
15. Utilize patent-pending secondary circuit board for crosstalk compensation
16. Utilize bend-limiting strain relief
17. UL Listed
18. Meet all TIA requirements for Category 6
19. Meet or exceed the performance characteristics listed in the following table (in addition to Category 6):

Freq. MHz	Insertion Loss, dB	Return Loss, dB	NEXT, dB	FEXT, dB
1	0.02	52.4	84.8	83.7
4	0.02	53.7	80.3	74.8
8	0.02	55.3	77.4	69.4
10	0.03	56.1	76.4	67.5
16	0.03	57.6	72.0	62.9
20	0.04	59.3	71.9	61.7
25	0.04	59.4	69.1	59.8
31.25	0.05	56.8	67.7	58.2
62.5	0.06	42.3	61.5	52.6
100	0.06	33.2	57.7	48.7
200	0.06	21.2	52.5	42.2
250	0.10	17.4	47.9	40.1

2.3.2 Horizontal Cables

A. Horizontal cables shall be installed in the following manner:

1. Cable and components shall be visually inspected for proper installation.
2. Cable stress, such as that caused by tension in suspended cable runs and tightly cinched bundles, should be minimized.
3. Cable ties used to bundle cables should be applied loosely to allow the cable tie to slide around the cable bundle. The cable ties should not be cinched so tightly as to deform the cable sheath.

4. Cable placement should not deform the cable sheath.
5. The maximum pulling tension of 4-pair 24 AWG UTP cable shall be 25 lbf.
6. The minimum bend radius, under no-load conditions, for 4-pair unshielded twisted-pair (UTP) cable shall be four times the cable diameter.

2.3.3 Cable Testing

Must adhere to the same test requirements in section 1.3.2.

2.0 Communication Backbone Cabling

3.1 General

Labor, equipment, materials and tools required to fit out the Telecommunications Operations and Training Rooms, as shown in drawing T204, to allow them to connect to Intermediate Cross Connects or the Main Cross Connect.

3.1.1 Related Sections

Communications Equipment Room Fittings

Communication Horizontal Cabling

3.1.2 Quality Assurance

A. The materials and work listed in this Section shall comply with the applicable requirements of the following documents:

1. ANSI/TIA/EIA-568-B Commercial Building Telecommunications Cabling Standard
2. ANSI/TIA/EIA-568-B.2-1 Transmission Performance Specifications for 4-Pair 100 Ohm Category 6 Cabling
3. ANSI/EIA/TIA-569-A Commercial Building Standard for Telecommunications Pathways and Spaces
4. ANSI/EIA/TIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
5. ANSI/TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications
6. Building Industries Consulting Services, International (BICSI) Telecommunications Distribution Methods Manual (TDMM)
7. National Fire Protection Agency (NFPA) - 70, National Electrical Code (NEC)
8. Motorola Standards and Guidelines for Communications Sites, R-56.

3.1.3 Certifications

- A. Submit certification that installers and technical representatives are certified by their respective manufacturer for installation of all products.
- B. In addition, installer shall be certified by Motorola for installation of communications cabling systems.
- C. All installation shall be certified to meet Motorola Standards and Guidelines for Communications Sites, R56.

3.1.4 Warranty

- A. Provide 25-year performance warranty for complete system.
- B. All certificates as stated above.

3.1.5 Submittals

- A. Manufacturers' specifications for all products to be installed within the scope of work included under this contract (submit with bid).
- B. Provide wiring diagrams of interconnect of equipment.
- C. All certifications as stated above.

3.2 Products

3.2.1 Copper Backbone – Inside Plant

A. Category 6 Backbone Cable

1. Category 6 plenum cable shall meet the following requirements:
 - a. Manufactured by an ISO 9001 certified manufacturer
 - b. Manufacturer in business for at least 10 years
 - c. Category 6 cabling system (including cable, connecting hardware and cable assemblies) manufactured by a single vendor
 - d. Vendor able to provide independent laboratory certification of Category 6 system performance
 - e. Comply with all of the performance requirements for Gigabit Ethernet, 100BASE-Tx, token ring, 155 Mbps ATM, 100 Mbps TP-PMD, ISDN, analog (broadband, baseband) and digital video and analog and digital (VoIP) voice
 - f. UL/NEC CMP rated PVC jacket
 - g. Jacketing shall be lead-free
 - h. UL Listed
 - i. Conductors 100% FEP insulated 23AWG solid copper or equal
 - j. Impedance: 100 ohms $\pm$ 15%, 1 MHz to 600 MHz
 - k. Velocity of propagation: 74%
 - l. Propagation delay: 536 ns/100 m max. @ 250 MHz
 - m. Delay Skew: 45 ns max
 - n. Conductor resistance: 66.58 ohms max/km

- o. Mutual capacitance: 5.6 nF max/100 m
- p. Voltage: 300 volts AC or DC
- q. Comply with all requirements of TIA/EIA-568-B.2-1 Transmission
- r. Performance Specifications for 4-Pair 100 Ohm Category 6 Cabling
- s. Cables shall be grey in color.
- t. Meet or exceed performance characteristics in the following table:

Frequency (MHz)	Attenuation (dB/100m)	NEXT (dB)	PSNEXT (dB)	ELFEXT (dB)	PSELFEXT (dB)	RL (dB)	ACR (dB)	PS ACR (dB)
	Maximum	Minimum	Minimum	Minimum	Minimum	Minimum	Minimum	Minimum
0.772	1.8	79	77	70	67	—	77.2	75.2
1	2.0	77	75	68	65	20	75.3	73.3
4	3.8	68	66	56	53	23	64.5	62.5
8	5.4	64	62	50	47	24.5	58.4	56.4
10	6.0	62	60	48	45	25	56.3	54.3
16	7.6	59	57	44	41	25	51.7	49.7
20	8.5	58	56	42	39	25	49.3	47.3
25	9.6	56	54	40	37	24.3	46.8	44.8
31.25	10.7	55	53	38	35	23.6	44.2	42.2
62.5	15.5	50	48	32	29	21.5	34.9	32.9
100	19.9	47	45	28	25	20.1	27.4	25.4
155	25.3	44	42	24	21	18.8	19.1	17.1
200	29.2	43	41	22	19	18	13.6	11.6
250	33.0	41	39	20	17	17.3	8.3	6.3
300	36.6	40	38	18	15	16.8	3.5	1.5
350	40.0	39	37	17	14	16.3	—	—
400	43.2	38	36	16	13	15.9	—	—
450	46.3	38	36	15	12	15.5	—	—
500	49.2	37	35	14	11	15.2	—	—
550	52.0	36	34	13	10	14.9	—	—
600	54.8	36	34	12	9	14.7	—	—

2. Category 6 PVC cable shall meet the following requirements:
 - a. Manufactured by an ISO 9001 certified manufacturer
 - b. Manufacturer in business for at least 10 years
 - c. Category 6 cabling system (including cable,
 - d. Connecting hardware and cable assemblies) manufactured by a single vendor
 - e. Vendor able to provide independent laboratory certification of Category 6 system performance
 - f. Comply with all of the performance requirements for Gigabit Ethernet, 100BASE-Tx, token ring, 155 Mbps ATM, 100 Mbps TP-PMD, ISDN, analog (broadband, baseband) and digital video and analog and digital (VoIP) voice
 - g. UL/NEC CMR rated
 - h. UL Listed
 - i. Conductors polyethylene insulated, 24AWG solid copper or approved equal.
 - j. Jacketing shall be lead-free
 - k. Impedance: 100 ohms $\pm$ 15%, 1 MHz to 600 MHz
 - l. Velocity of propagation: 70%
 - m. Propagation delay: 536 ns/100 m max. @ 250 MHz
 - n. Delay Skew: 45 ns max
 - o. Conductor resistance: 66.58 ohms max/km
 - p. Mutual capacitance: 5.6 nF max/100 m
 - q. Voltage: 300 volts AC or DC
 - r. Comply with all requirements of TIA/EIA-568-B.2-1 Transmission Performance Specifications for 4-Pair 100 Ohm Category 6 Cabling
 - s. Cables shall be grey in color.
 - t. Meet or exceed performance characteristics in the following table:

Frequency (MHz)	Attenuation (dB/100m)	NEXT (dB)	PSNEXT (dB)	ELFEXT (dB)	PSELFEXT (dB)	RL (dB)	ACR (dB)	PS ACR (dB)
	Maximum	Minimum	Minimum	Minimum	Minimum	Minimum	Minimum	Minimum
0.772	1.8	79	77	70	67	—	77.2	75.2
1	2.0	77	75	68	65	20	75.3	73.3
4	3.8	68	66	56	53	23	64.5	62.5
8	5.4	64	62	50	47	24.5	58.4	56.4
10	6.0	62	60	48	45	25	56.3	54.3
16	7.6	59	57	44	41	25	51.7	49.7
20	8.5	58	56	42	39	25	49.3	47.3
25	9.6	56	54	40	37	24.3	46.8	44.8
31.25	10.7	55	53	38	35	23.6	44.2	42.2
62.5	15.5	50	48	32	29	21.5	34.9	32.9
100	19.9	47	45	28	25	20.1	27.4	25.4
155	25.3	44	42	24	21	18.8	19.1	17.1
200	29.2	43	41	22	19	18	13.6	11.6
250	33.0	41	39	20	17	17.3	8.3	6.3
300	36.6	40	38	18	15	16.8	3.5	1.5
350	40.0	39	37	17	14	16.3	—	—
400	43.2	38	36	16	13	15.9	—	—
450	46.3	38	36	15	12	15.5	—	—
500	49.2	37	35	14	11	15.2	—	—
550	52.0	36	34	13	10	14.9	—	—
600	54.8	36	34	12	9	14.7	—	—

3.3 Execution

3.3.1 Backbone Cables

A. Backbone cables shall be installed in the following manner:

1. Backbone cables shall be installed separately from horizontal distribution cables.
2. Where cables are housed in conduits, the backbone and horizontal cables shall be installed in separate conduits or in separate innerducts within conduits.
3. Where cables are installed in an air return plenum, the cable shall be installed in conduit, or plenum cable shall be installed in a plenum innerduct to provide protection to the cable.
4. Where backbone cables and distribution cables are installed in a cable tray or wireway, backbone cables shall be installed first and bundled separately from the horizontal distribution cables.
5. The minimum bend radius for multipair copper backbone cables shall be 10 times the cable diameter.

3.3.2 Copper Termination and Management Hardware

A. Copper termination and management hardware shall be installed in the following manner:

1. Backbone cabling shall be terminated at both ends.

2. Cables shall be dressed and terminated in accordance with the recommendations made in the TIA/EIA-568-B document, manufacturer's recommendations and/or best industry practices.
3. Pair untwist at the termination shall not exceed .5 inch for Category 6 connecting hardware.
4. Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.
5. Cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
6. The cable jacket shall be maintained as close as possible to the termination point.
7. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

3.3.3 Cable Testing

Must adhere to the same test requirements in section 1.3.2

SECTION 17451**SOIL RESISTIVITY TESTING**

Soil resistivity directly affects the design of the grounding system. When designing a grounding system, it is important that the area with the lowest soil resistivity is located. The area with the lowest resistivity will be used to determine at what depth a grounding electrode will be driven in order to obtain a low ground resistance.

The preferred soil resistivity testing that shall be performed will be the four-point Wenner method. The proper tools that shall be used to perform this test will include: a calibrated 4-pole digital ground resistance meter, four metallic test probes that are at a minimum of 18 inches in length, four insulated conductors with clips on the end to connect to the digital ground resistance meter, and any other miscellaneous tools needed to set up the equipment (i.e., hammer, safety goggles, tape measure, etc...).

The CONTRACTOR performing said test will obtain, at a minimum, six measurements in different areas around the proposed lot. The areas where testing will be performed will be determined prior to testing. When making measurements, the four test probes must be spaced at an equal distance apart. The test will be performed with the spacing of the metallic test probes at 5 ft., 10 ft. 15 ft., 20 ft. 30 ft., and 40 ft. apart. If soil resistivity measurements exceed 10 k Ω -cm, then the CONTRACTOR may have to increase space between the test rods (probes) up to 100 ft.

Soil resistivity is affected by its content of electrolytes, moisture, and temperature. If capable, it would be best to perform this test during two or more different seasons. If this test is performed during different seasons, then the test with the worst-case measurements shall be used in designing the grounding electrode system. Test shall occur at a minimum of 72 hours after the last rain fall at the site and after the site has been leveled and all soil that will be used at the location has been added. Test shall never be performed in standing water and/or while underneath overhead power lines.

If test are being performed near underground metallic objects, then it is strongly advised that the CONTRACTOR do the following to avoid the possibility of distorted measurements. First, take your first set of measurements parallel to the metallic object. Second, perform another test perpendicular to the metallic object. Lastly, the third set of measurements will be made at a 45 degree angle to the metallic object.

The CONTRACTOR will insert the four probes into the ground in a straight line and the probes will be evenly spaced apart. The spacing of these test probes will allow for the measurement of the average soil resistivity from the surface. Therefore, soil depth (S) is a function of rod spacing (r), "S(r)". For example, if the test rods are evenly spaced 5 ft. apart, then the measurements will be an average of the soil depth from the surface down 5 ft. As the rods become more spaced out, the test results will be for deeper samples. The two outer probes will be used to pass an alternating current through the earth while the two inner probes measure the voltage drop through the earth between them. The test meter shall be able to calculate the resistance by using Ohm's law (Resistance = Voltage / Current).

All test measurements shall be given in Ohms-centimeter (Ω -cm). There are two Wenner formulas that may be used in order to convert resistance measurements into Ω -cm that will be acceptable. The first formula that may be used is:

$$\rho = \frac{4\pi AR}{1 + \frac{2A}{\sqrt{(A^2 + 4B^2)}} - \frac{2A}{\sqrt{(4A^2 + 4B^2)}}}$$

Where:

ρ = Soil resistivity in Ω -cm

A = Distance between electrodes in centimeters

B = Depth of electrode in centimeters

R = Test meter displayed resistance value in Ohms (Ω)

If the distance between electrodes is twenty times greater than the depth of electrode in centimeters, $A > 20B$, then the formula is simplified to:

$$\rho = 2\pi AR$$

Where:

ρ = soil resistivity in Ω -cm

A = Distance between electrodes in centimeters

B = Depth of electrode in centimeters ($A > 20 B$)

R = Test meter displayed resistance value in Ohms (Ω)

In addition to performing soil resistivity testing, a soil pH test must be performed in order to better assist in the design of a grounding electrode system. The soil pH test will be used to determine the measure of the acidity of the soil and how it will affect the life of the grounding electrode system.

Soil pH test will be performed at the same time as soil resistivity testing. Soil pH test shall be performed while using either a calibrated soil pH meter or an approved pH test kit.

Prior to testing, test procedures, calibration data, and test sheets must be submitted, reviewed, and approved. All measurements must be handwritten in black or blue ink. The raw data must be scanned in and submitted with all calculations. Calculations must be submitted electronically and in hardcopy within seven business days after test have been performed. Measurements will be reviewed in the planning of the grounding electrode system prior to construction of the new building.

The material and work shall comply with the applicable requirements of the following documents and/or their equivalents:

- American Standard for Testing & Materials (ASTM) Standard G 57-06, "Standard Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method."
- American Standard for Testing & Materials (ASTM) Standard G 51-95, 2005, "Standard Test Method for Measuring pH of Soil for Use in Corrosion Testing."
- Military Handbook 419A (MIL-HDBK-419A), 1987, "Grounding, Bonding, and Shielding for Electronic Equipments and Facilities."
- Motorola Standard R-56, 2005, "Standards and Guidelines for Communication Sites."
- ANSI/IEEE Standard 81, 1983, "Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System."

SECTION 17900

GENERAL REQUIREMENTS

PART 1

1 - GENERAL

1.1 SUMMARY

- A. Description of Work: The Electronic Systems Subcontractor's (ESS) work shall include all labor, equipment and services necessary to furnish, deliver and install the work associated with the following specification sections:
1. Section 17900 Electronic Security General Requirements.
 2. Section 17910 Security Management System.
 3. Section 17920 Closed Circuit Television System.
 4. Section 17930 Security Intercommunication System.
- B. Section 17900 - General Requirements applies to all of the above listed specification sections in Division 17.

1.2 SCOPE AND RESPONSIBILITY

- A. General Contractor: Coordinate the ESS's work with the work of other trades.
- B. ESS: Furnish and install electronic security system components; cabinets and panels; interior electronic security systems conduit; cabling; power supplies; and terminations for security system signals and communications.
- C. Division 16 Contractor (Electrical Contractor):
1. Furnish and install power distribution panels, wiring, conductors, conduit, raceway systems, and terminations for the supply of 120/230 VAC primary, emergency and UPS power to security system components. The ESS shall make all connections to electronic security systems components requiring high voltage power.
 2. Furnish and install for the ESS's use the following exterior site-based conduits: (1) one empty 1-inch conduit from the CAD Radio Telephone room to each exterior pole mounted CCTV camera, (2) two empty 1-inch conduits from the electronic security equipment room to each of the exterior remotely controlled gate intercom/card reader

pedestals, (3) one empty 1-inch conduit from the exterior gate intercom/card reader pedestal units to the associated gate operators and to each vehicle loop detector location. All empty conduits shall be equipped with pull strings.

1.3 COORDINATION

- A. The ESS shall examine the Drawings and Specifications of other trades whose work may influence the installation of the electronic security system. The ESS shall include in his Bid all services attributed to coordinating the installation of the security system with the work of other trades.
 - 1. The security systems, products, equipment, devices and materials included in the ESS's Work shall include the following:
 - 2. Rough-Ins: The ESS shall take note of requirements noted on the Drawings, if any, or herein regarding "rough-ins" for future installations or expansion, if any.
 - 3. Signage: The ESS shall coordinate the fabrication and installation of signage required by security systems. The Architect shall be requested by the ESS to approve proposed signage.
 - 4. **QUALITY ASSURANCE**
 - 5. The Work specified within Division 17 shall be performed by a qualified ESS, as defined and described herein.
 - 6. Any Firm who submits a bid on this Section of the Specifications ESS shall have a minimum of 5 YEARS EXPERIENCE in successfully completing projects of equivalent scope and magnitude with product categories as herein specified. This experience shall consist of FIVE SIMILAR PROJECTS that have been completed and operational for a MINIMUM OF 2 YEARS.

1.4 RELATED WORK

- A. The General Provisions of the Contract, including General and Supplementary Conditions, General Requirements, Division 1.
- B. Division 6 - Casework / Millwork
- C. Division 8 - Builders Hardware
- D. Division 16 - Conduit, Raceways, Wire and Cable

1.5 APPLICABLE CODES AND STANDARDS

- A. The ESS shall be responsible for compliance with all Federal, State, and local codes, standards and all other Laws within the jurisdictions governing the Project site, as applicable to the extent of his Work. Further, the ESS shall pay all fees and obtain all necessary approvals from governing life-safety code and/or building codes authorities, which may

include approval for variances or waivers, governing the security systems, equipment and devices, before ordering or purchasing any systems, equipment or materials, and before proceeding with any Work. Any problems related to obtaining approvals shall be promptly brought to the attention of the Construction Manager.

1.6 REFERENCE STANDARDS

- A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. Where standards and publications are identified, they shall be the most current version.
- B. Federal Communications Commission (FCC) Publications:
 - 1. Forty seven (47) CFR Part Fifteen (15) and Part Ninety (90) Rules and Regulations, Radio Frequency Devices, Field Disturbance Sensors
- C. American National Standards Institute (ANSI) Publications:
 - 1. ANSI C2 - National Electrical Safety Code.
- D. American Society for Testing and Materials (ASTM) Publications:
 - 1. ASTM F 967 - Standard Practice for Security Engineering Symbols.
- E. National Fire Protection Association (NFPA) Publications:
 - 1. NFPA 70 - National Electrical Code.
- F. National Electrical Manufacturers Association (NEMA) Publications:
 - 1. NEMA 1CSZ - Industrial Control Devices and Assemblies.
 - 2. NEMA 1CSG - Enclosures for Industrial Controls and Systems.
- G. Underwriters Laboratories, Inc., (UL) Standard for Safety:
 - 1. UL 294 - Access Control System Units.
 - 2. UL 603 - Power Supplies For Use With Burglar-Alarm Systems.
 - 3. UL 609 - Local Burglar Alarm Units and Systems.
 - 4. UL 611 - Central-Station Burglar-Alarm Systems.
 - 5. UL 632 - Electrically Actuated Transmitters.
 - 6. UL 634 - Connectors and Switches for Use with Burglar Alarms.
 - 7. UL 639 - Intrusion Detection Units.

8. UL 827 - Central-Stations for Watchman, Fire-Alarm, and Supervisory Services.
9. UL1037 - Anti-theft Alarms and Devices.
10. UL1076 - Proprietary Burglar Alarm Units and Systems

1.7 OWNERSHIP AND SAFEGUARDING OF PROJECT DOCUMENTS

- A. All Drawings, Specifications and copies thereof furnished by Architect are and shall remain the property of the Owner. They are to be used only with respect to this Project and are not to be used on any other project. With the exception of one contract set for each party to the Contract, such documents are to be returned or suitably accounted for to the Architect at the completion of the Work. The ESS recognizes that the documents contain vital and sensitive information about Owner's Project and security systems and equipment. The ESS warrants to exercise due and reasonable care to safeguard this information during the conduct of the Project, as well as all documents lawfully retained after the completion of the Project.

1.8 "REVIEWED FOR CONSTRUCTION" DRAWINGS AND SPECIFICATIONS

- A. No systems, equipment or materials shall be ordered or purchased and no Work shall be performed without Drawings and Specifications clearly marked to indicate that the Architect has conducted appropriate reviews. Such acceptance shall not relieve the ESS of his obligations herein. Such reviews by the Architect shall only be for general compliance with the Contract Documents and shall not be deemed an approval or acceptance of correctness and accuracy of dimensions, details, and related information. Such reviews shall not relieve the ESS of his obligations under this Contract.

1.9 SUBLETTING

- A. If the ESS desires to sublet any portion or portions of the Work, he must submit the names of such subcontractors to the Architect for approval concurrent with the bid and before letting any subcontracts.
1. NO WORK SHALL BE ASSIGNED OR SUBLET TO OTHER PARTIES WITHOUT THE PRIOR WRITTEN CONSENT OF THE CONSTRUCTION MANAGER, but in no case shall such consent be construed as a release from the obligations of the ESS.
 2. The ESS shall be responsible for INSTRUCTING each of his subcontractors with all aspects of the Contract affecting each subcontractor respectively, and shall be responsible for coordinating the work of his subcontractors to prevent any interference or omission whatsoever.

1.10 MATERIAL AND WORKMANSHIP

- A. Unless otherwise specifically provided in this Contract, all equipment, material and articles to be incorporated in the Work shall be new and of the most suitable grade for the purpose intended. Unless otherwise specifically provided in this Contract, reference to any equipment, material, article or patented process, by trade name, make or catalog number shall be regarded as establishing a standard of performance and quality. The ESS shall furnish to the Architect for his acceptance the name of the manufacturer, the model number and other identifying data and information respecting the performance, capacity, nature and rating of the electrical, mechanical and other equipment that the ESS contemplates incorporating in the Work. When required by this Contract or when called for by the Architect, the ESS shall furnish to the Architect for his acceptance full information concerning the material or articles that he contemplates incorporating in the Work. When so directed, samples shall be submitted for approval at the ESS's expense, with all shipping charges prepaid. Equipment, material and articles procured, installed, or used without required approval shall be at the risk of subsequent rejection. Warranties of all Work and installed products shall be in accordance with the Contract General Provisions and as cited herein.

1.11 GENERAL ARRANGEMENT OF CONTRACT DRAWINGS

- A. The Contract Drawings attendant to this Specification indicate approximate locations of equipment and are conceptual and schematic in nature. The installation and locations of equipment and devices shall be governed by the intent of the design and of the security systems concepts presented by the Drawings and herein; Specifications and Contract Drawings, with due regard to actual site conditions; coordination with the work of other trades; manufacturers' recommendations; ambient factors affecting the equipment; and operations in the vicinity. The Contract Drawings are diagrammatic and conceptual and do not show all components, materials, offsets, bends, elbows, and other specific elements which may be required for proper installation. It is the responsibility of the ESS for completing the security systems design and for coordinating the final equipment layout and conduit routing with the complete Architectural and Engineering drawings. If any departure from the Contract Drawings or the Specifications is deemed necessary on these bases, or in the event of conflicts among these bases, details of such departures or conflicts and the bases shall be

submitted in writing to the Architect at the ESS's earliest opportunity since time is of the essence. Any work associated with these departures or conflicts shall be delayed until the Architect or his representatives provide written comment.

1.12 CONFLICTS

- A. Should there be conflicts between these Specifications and their attendant Drawings, between any other project specifications and drawings, between Specifications or Drawings and standards and codes, or any other pertinent conflicts related to the ESS's Work, such conflict shall be brought to the attention of the Architect at the ESS's earliest opportunity. All Work associated with these conflicts shall be delayed until the Architect and/or his representatives can provide comment and approval. The Architect shall be requested to resolve all conflicts, but as general guidance, the written specifications shall govern drawings.

1.13 MANUFACTURERS' REPRESENTATIVES

- A. The services of a qualified manufacturer's technical representative, thoroughly experienced in the installation and operation of the type of system(s) being provided under this Contract and with no less than FIVE CONTINUOUS YEARS OF TECHNICAL EXPERIENCE AS MANUFACTURER'S REPRESENTATIVE, shall be obtained by the ESS, at his own expense, to consult on equipment selection, installation, and testing of the specified systems if and as requested by the Architect.

1.14 SUBSTITUTIONS

- A. No substitutions of equipment or materials where specific models, trade names or manufacturer are identified are permitted without the specific permission of the Architect in accordance with procedures described in Division 1.

1.15 SUBMITTALS

- A. Submit under provisions of Division 1 except as otherwise noted herein.
- B. Shop drawings for all work by the ESS shall be submitted as a single package sixty (60) days after the contract is awarded. The electronic security package shall be complete and all-inclusive, including, but not limited door controls, CCTV, intercommunication system and equipment consoles and casework. Partial submittals will not be reviewed.
 - 1. Shop drawings for all work by and ESS shall show equipment locations, sizes, a material, construction, finishes, spacing of anchors and joinery details, and coordination with adjacent work. The General Contractor shall be responsible for field coordination of the ESS work with the other trades.
 - a. Shop Drawings: Shop drawings on all materials and equipment of these Sections shall be submitted for approval. They shall indicate item location, size, type of materials, construction finishes, spacing of anchors and joinery details with adjacent work. The ESS will extensively check each of the submittal under his scope of work, insuring their correctness and

compatibility not only with each other, but also with the contract documents.

2. The ESS shall submit documentation for approval in accordance with Division 1 which shall include, as a minimum, the following:
 - a. Manufacturers' product cut sheets for required equipment and major components to be provided. The product cut sheets shall be annotated to clearly identify only those specific functions and features that are applicable to the project.
 - b. System theory of operations that clearly define the operating parameters of all systems being supplied.
 - c. A functional systems block diagram showing single line interconnection of all integrated systems and the major components of each system and methods of integration.
 - d. Drawings/artwork that depict video terminal graphics.
 - e. Riser diagrams that show all required cable, wiring, etc. for the interconnection of all systems equipment and devices. As a minimum, diagrams shall include wire type and size, equipment identification and location.
 - f. Schedules of all electronic operated devices and their functional attributes for all systems being supplied. The schedules shall be divided by system (i.e., locking, audio, CCTV, etc.) and shall be formatted in alphanumeric order by architectural identification number. The schedules shall include, as a minimum for each commodity entry:
 - 1) Associated architectural or engineering number (i.e. door A108);
 - 2) Assigned operation number (i.e. D108);
 - 3) Hardware group (i.e. 11W-1); this is a designation given to a standard set of complete hardware being utilized:

EX 1C-1 consists of:

1	5 inch speaker P/N XXX
1	baffle P/N XXXX
4	security screws
- g. Location of the control device.
- h. Functions associated with the controlled device (i.e. unlock switch, door position monitored, on/off switch, lock type, emergency push button, release /egress group, interlock group, interlock monitor etc.);

- i. Panel, enclosure or location of the function (i.e. field, panel F1, panel F2, etc.);
 - j. System designator that the commodity attribute is associated with (i.e., Intercom System 1, etc.);
 - k. Type of function (i.e. input, output, internal PLC function).
- 3. The submittal shall reflect the systems as they are defined by the project plans and specifications, contract and signed/documented clarification, substitutions and changes to the above documents by the Architect.
- 4. Operating/Maintenance Manuals: ESS shall furnish copies of parts manual for all components of the electronic control system. These manuals shall include instructions for the care and operation of the systems and materials. A parts list to aid the Owner and ordering replacement parts, as well as instructions for contacting the appropriate personnel not only during the warranty period, but beyond.
- 5. The ESS shall provide the Owner with a log for troubleshooting purposes. The log shall have space for the Owner to write the day, date and time of the incident, the operator's name, and have space to describe what happened and how the incident was corrected. There shall be a space for the ESS to provide back-up comments and a check off column indicating the day, date, time and technician who responded.
- 6. Packing and Marking: All unique electronic devices (i.e., cameras, monitors, speakers, etc.) shall be packaged and property marked by type.
- C. Spare Parts and Components List: At the conclusion of the ESS Work, the ESS shall submit to the Architect, a complete list of manufacturers' recommended spare parts and components required in order to satisfactorily maintain and service the systems for a minimum of two years, as well as a detailed cost estimate for these parts.
- D. Operation, Maintenance, and Service Manuals: Prior to final acceptance, complete sets of operation, maintenance and service manuals shall be submitted for systems and equipment provided under this contract. The manuals shall be compiled, assembled and indexed, in an easily identifiable hard-cover form. Three (3) sets of the manuals shall be submitted to the Architect prior to final acceptance testing. The manuals shall include the following:
 - 1. Complete operating instructions;
 - 2. Complete maintenance instructions, wiring diagrams, troubleshooting instructions;
 - 3. System service instructions for Work which manufacturers recommend user service;
 - 4. Complete parts lists for each major item of equipment and/or for each system;
 - 5. Complete collection of manufacturers' product and catalog literature for equipment and systems installed under this contract;

6. Manufacturers' warranties;
 7. Operating characteristics, performance data, ratings, and manufacturers' specifications for each item of equipment or system;
 8. Where practical, internal wiring diagrams and schematics;
 9. Name, address, and telephone number for service for each item of equipment or system;
 10. Software User Documentation: Manual shall include operating instructions, programming instructions, technical documentation and maintenance procedures to permit making changes to system configuration, time changes, etc.
- E. Record Drawings:
1. The ESS shall provide, and keep up-to-date, a complete record set of drawings which shall be corrected, and shall show every change from the original Specifications and Contract Drawings through final acceptance. The record set of drawings shall be protected against soiling, tears, and similar damage and defacement. This set of prints shall be kept on the job site and shall be used only as a record set. (This shall not be construed as authorization for the ESS to make changes in the Work without proper approvals.) Upon completion of his Work and before final payment, the ESS shall submit the complete record set to the Architect for review. Upon acceptance, the record set shall be retained by the Owner, or by his representative.
 2. At the conclusion of this project, two sets of black-line mylars of all the ESS's drawings specifically prepared for this Contract shall be provided to the Architect. The drawings shall be instrument drawn and shall contain all changes shown in the record set. Sepia line drawings on paper are not acceptable.
- F. Formal Test Plan and Procedures: 45 days prior to acceptance testing and final inspection, the ESS shall provide ten sets of a formal test plan and test procedures for the Architect's review.
- G. In addition to the submittal described above, other required submittal described in this Specification must be presented prior to final acceptance.

1.16 SUBMITTAL PROCEDURES

- A. Coordinate each submittal with requirements of the Work and of the Contract Documents. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.
- B. The ESS shall review each shop drawing, sample, or item of product data prior to transmittal to the Architect and indicate his (ESS's) review by stamping the submittal with his stamp, initialed or signed, certifying review of submittal, verification of products, field measurements and field construction criteria, and coordination of the information within submittal with requirements of the Work and of the Contract Documents.

- C. Notify the Architect in writing, at the time of submission, of any deviations in submittal from requirements of the Contract Documents.
 - 1. Change Order shall accompany changes shown on the shop drawings and other submittal.
- D. Submittal Preparation: Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block.
 - 1. Provide a space approximately 4" x 5" on the label or beside the title block on Shop Drawings to record the ESS's review and approval markings and the action taken.
- E. Submittal Transmittal: Package each submittal appropriately for transmittal and handling. Transmit each submittal from ESS to the Architect using a transmittal form. Submittal received from sources other than the ESS, or without a transmittal, will be returned without action.
 - 1. NOTE: Submittal shall be returned without review if the ESS's stamp is missing or if submittal is otherwise incorrectly prepared or is incomplete. Extensions of time will not be granted for improperly submitted Work. It is especially essential that all submittal are complete.
- F. Maintain a file copy of each reviewed and accepted submittal at the site.
- G. Do not permit non-complying or unaccepted submittal to be used at the site or elsewhere in execution of the Work.

1.17 ELECTRONIC SYSTEMS SUBCONTRACTOR'S CONSTRUCTION SCHEDULES

- A. Bar-Chart Schedule: Prepare a fully developed, horizontal bar-chart type ESS's construction schedule. Prepare schedule on a sheet (or series of sheets) of sufficient width to show data for the entire construction period.
 - 1. Provide a separate time bar for each significant construction activity. Provide a continuous vertical line to identify the first working day of each week. Use the same breakdown of units of the Work as required for the "Schedule of Values".
 - 2. Within each time bar indicate estimated completion percentage in 10 percent increments. As Work progresses, place a contrasting mark in each bar to indicate Actual Completion.
 - 3. Revise schedule every month and submit to Architect.
- B. Man Loaded Bar Chart: Prepare a fully developed man loaded bar chart concurrent with bar chart schedule above indicating the number of workers required on daily basis to meet the established Construction Schedule."

- C. Phasing: Provide notations on the schedule to show how the sequence of the Work is affected by requirements for phased construction.
- D. Schedule Updating: Revise the schedule after each meeting or activity, where revisions have been recognized or made. Issue the updated schedule concurrently with the periodic monthly report.
- E. Trade Conflicts: Indicate any anticipate conflicts arising from other trades working at the same time or location, particularly if the ESS's Work may interfere or stop the work of other trades. Indicate the estimated duration of the delay or work stoppage.

1.18 SUBMITTAL SCHEDULE

- A. After development and acceptance of the ESS's construction schedule, prepare a complete schedule of submittal. Submit the schedule within 30 days of the date required for establishment of the ESS's construction schedule.
 - 1. Coordinate submittal schedule with the list of subcontracts, schedule of values and the list of products as well as the ESS's construction schedule.
 - 2. Prepare the schedule in chronological order; include submittal required during the first 90 days of construction.

1.19 MAINTENANCE SUPPORT

- A. The ESS shall be capable of providing, or arranging for under a firm contractual basis, all on-going repair, scheduled maintenance, and warranty repair and maintenance support to the Owner for the installed systems on a year-round basis. [Note: This is in addition to the mandatory one-year warranty and repair service required in the base bid by the Specification.] Repair or maintenance services shall be available within FOUR HOURS upon a call by the Owner. The ESS shall submit a cost proposal for a two- year maintenance and service agreement for all equipment furnished within Division 17 - Security Systems. Except for base bid warranty-related repair and maintenance, other repair and maintenance services shall be separately negotiated with the Owner.

1.20 PRICING PRACTICES

- A. The ESS shall be guided by fair mark-up pricing of equipment and labor. The ESS shall be required to "break-out" specific costs from his total cost proposal. This break-out shall be in four (5) categories: quantities, units, labor cost per unit, total labor cost, and equipment cost. Totals shall be provided. Manufacturer's name and model number shall identify equipment. The factors used to "mark-up" for profit, overhead, general costs, administrative costs, and similar increases, shall be identified.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. Equipment and materials furnished shall be new, first grade, standard, current products of the manufacturer and shall be suitable for the systems being installed and the intent of the design.
- B. Any material, device, or equipment damaged prior to or during installation and before acceptance of the completed system by the Owner shall be replaced, unless repairs can be made that are acceptable to the Architect. Any such replacement or repairs, including repairs to the finish, shall be made at no cost to the Owner.
- C. Equipment and materials shall be properly stored, adequately protected and carefully handled to prevent damage before and during installation. Equipment and materials shall be handled, stored and protected in accordance with the manufacturers' recommendations. Equipment provided with a factory finish shall be maintained free of dust, dirt and foreign matter. Dents, marred finishes and other damage shall be repaired to its original condition or shall be replaced, at no additional cost to the Owner. Owner's equipment and materials, as well as the ESS's tools and materials, shall be protected against theft and vandalism.

2.2 PRODUCT SELECTION

- A. General Product Requirements: Provide products that comply with the Contract Documents.
 - 1. Provide products complete with all accessories, trim, finish, safety guards and other devices and details needed for a complete installation and for the intended use and effect.
- B. Components required to be supplied in quantity within a specification section shall be the same, and shall be interchangeable.
- C. For products specified by naming one or more manufacturers (if ever), submit a request for substitution for any manufacturer not specifically named.
- D. For products specified by naming one or more manufacturer with a "no substitution" statement, substitutions are not allowed.
- E. For products specified by performance requirements, provide products that comply with these requirements.
- F. Where Specifications require matching or conforming to an established sample or quality standard or objective, the Architect's decision will be final on whether a proposed product or installation practices matches satisfactorily. Requirements for inconspicuous or concealed installation, as one example, establish such a standard and objective.

2.3 SYSTEM COMPONENT DESIGN AND PERFORMANCE CRITERIA

- A. Within the context of the overall system performance previously described, the system components shall be designed to operate as described herein.
- B. Modularity: Provide components designed for modular increase or decrease of system capability by installation or removal of plug-in modules. System components shall be designed to facilitate modular subassembly and part replacement.
- C. Reliability: Provide only new, unused components free from flaws or imperfections, which are in current manufacturing production. Components shall be manufactured to meet all the requirements specified herein and shall be free from characteristics or defects that affect the appearance or which might affect the serviceability or render the equipment unsuitable for the intended purpose. The workmanship shall be of superior quality. The MTBF for any sensor component shall not be less than five-thousand (5000) hours. Provide components designed for continuous operation. Electronic components of the system shall be of the solid-state type, mounted on printed circuit boards conforming to UL seven-hundred-ninety-six (UL-796). Boards shall be plug-in, quick-disconnect type. Circuitry shall not be so densely placed as to impede maintenance. Power-dissipating components shall incorporate safety margins of not less than twenty-five (25) percent with respect to dissipation ratings, maximum voltages, and current-carrying capacity. Light duty relays and similar switching devices shall be solid-state type or hermetically sealed electro-mechanical type.
- D. Maintainability: The components shall be capable of being maintained using commercially available standard tools and equipment. Components shall be so arranged and assembled that they are readily accessible to maintenance personnel without compromising the defeat resistance of the various security subsystems.
- E. Availability: Provide products and services available within the project schedule established for the ESS's Work. Delays due to a manufacturer's inability to deliver the required products and materials within the established schedule shall be regarded as a default in the Agreement between the ESS and the Owner, subject to the terms and conditions within this Agreement governing default or terms of comparable intent.

2.4 ENVIRONMENTAL CONDITIONS

- A. Interior Conditions: Equipment installed in environmentally protected interior areas shall meet performance requirements specified for the following ambient conditions:
 - 1. Temperature: 40 to 95 degrees Fahrenheit. Components installed in unheated protected areas shall meet performance requirements for temperatures low as zero (0) degrees F.
 - 2. Relative humidity: Five (5) to ninety-five (95) percent.
- B. Exterior conditions: Equipment installed in all exterior locations shall be housed in weatherproof enclosures and/or mounts. All equipment mounted outdoors shall be provided with all necessary features and treatments to create an environmental condition that allows all equipment to operate in accordance with the manufacturer's environmental specifications. All

equipment shall be capable of satisfactorily performing outdoors in accordance with the manufacturer's specifications and instructions for temperatures between -20 degrees F and 120 degrees F and between relative humidity of five (5) to ninety-five (95) percent. Further, the equipment shall satisfactorily perform in heavy rain, snow, pollen, dust, and ice conditions. The equipment and materials shall be protected against the effects of ultra-violet light from sunlight and against access by insects, mold, and fungus.

2.5 LIGHTNING/SURGE SUPPRESSION

- A. General: The work required under this section of the specifications requires that furnishing and installation of Transient Voltage Surge Suppression (TVSS) devices, for protection of electrical systems, communication and data lines. TVSS devices shall protect all AC and DC circuits from the effects of lightning induced over voltages, internally generated transients and utility switching transients. Catalog numbers have been taken from Northern Technologies, Inc., and are meant to set a standard for quality.
- B. TVSS Technology - AC Power Applications:
 - 1. The primary suppression path shall be pure Silicon Avalanche Diodes.
 - 2. Silicon Avalanche Diodes must be bi-polar, of grade A, $\pm 5\%$ tolerance and meet the Defense Electronics supply Center (DESC), specification requirements.
 - a. Surge suppression devices shall provide "power-on" and "failure" indication lights. An optional remote status capability for indication of primary suppression path failure shall be available.
 - b. All AC TVSS devices shall be U.L. listed and bear the U.L. label on each product. All AC TVSS devices shall be tested in accordance with the ANSI/IEEE Testing Standard, M.O.V. or Hybrid type suppressors will not be accepted.
 - c. Gas tubes, Selenium plates, M.O.V. or Hybrid type suppressors will not be accepted. AC power protection units shall be Northern Technologies TCS-HW or approved equal.
 - d. AC protection shall be placed in front of the UPS.
 - 3. TVSS Technology - DC Applications:
 - a. The primary suppression path shall be pure Silicon Avalanche Diodes.
 - b. Silicon Avalanche Diodes must be bi-polar, of grade A, $\pm 5\%$ tolerance and meet the Defense Electronics Supply Center (DESC) specification requirements.
 - c. Surge suppression devices shall operate in a parallel to the circuit, not employing switching components and have no series resistance.

- d. Surge suppression devices shall provide a minimum of 5 joules of silicon Avalanche Diode per line, not per device.
- 4. Initial clamping voltage shall not exceed the signal line voltage by more than 25% unless recommended or authorized by the security equipment manufacturer.
- 5. Gas tubes, selenium plates, MOV, or hybrid type suppressors will not be accepted.
- 6. Coaxial Transient Suppressor: TCS-CP-1 or approved equal.
- C. Installation:
 - 1. Install TVSS devices on All AC, data and communication lines to protect against surges induced on all control lines, sensors, data lines and cables that enter and exit building(s).
 - 2. Data and Communication protection devices shall be mounted in a NEMA 1 enclosure with all wiring in the enclosure to be kept in plastic wiring troughs. The incoming cables shall be kept separate from the outgoing cables. There shall be a ground buss in the lower corner of the enclosure and shall be sized to accept a #6 BCW. The Bare Copper Wire shall be terminated to the nearest ground rod system, see Division 16.
 - 3. AC protection devices can be located in the equipment cabinet and must be placed before any distribution (i.e., multi-outlets) can be utilized. Grounding shall be the same as indicated in the Data and Communication specification preceding.

2.6 WIRE AND CABLE

- A. Cable tags shall be pre-marked, self-adhesive, wraparound, self-laminating Panduit brand or equivalent.
- B. Interior CCTV Coaxial Video Cable:
 - 1. Coaxial video cables shall have a solid copper center conductor and a copper shield providing a minimum 93% coverage.
 - 2. Nominal attenuation at 10 MHZ shall not exceed:
 - 1.0 dB/30 m for RG-59/U-type cables,
 - 0.8 dB/30 m for RG-6/U-type cables, and
 - 0.5 dB/30 m for RG-11/U-type cables.
 - 3. Nominal impedance shall be 75 ohms.
 - 4. Cable runs shall not exceed manufacturer's recommendations and shall not exceed:
 - 750' for RG-59/U-type cables,
 - 1,250' for RG-6/U-type cables,

3,000' for RG-11/U-type cables.

- C. Intercom Station Cable: All intercom station cable shall be single or multiple twisted, shielded pairs minimum 22 AWG.
- D. Special Cable:
 - 1. Special cable not specified in this section shall be as specified in the appropriated section and/or as recommended by the equipment manufacturer.
- E. Cable Installed in Exterior Duct Banks
 - 1. All signal conductor cable installed in exterior conduits, raceways and/or duct bank systems shall be fiber optic cabling conforming to the following specification:
 - a. The fiber optic cable shall consist of color code multimode graded index fibers contained in gel filled loose buffer tubes. Each color-coded buffer tube shall be filled with a gel to prevent moisture penetration. All other areas around the buffer tubes and cable core components shall be filled with water-blocking compounds for added moisture blocking protection. A glass-reinforced plastic (GRP or epoxy matrix rod) shall be used for central strength member. High tensile yarns shall be utilized over the cable core for additional tensile strength. A medium density polyethylene outer jacket shall be applied overall. The fiber optic cable shall conform to the following specifications as a minimum:
 - a. 62.5/125 microns: Loose tube dielectric cable
 - b. Fiber Type: Multimode, Graded Index
 - c. Core Diameter: 62.5 ± 3.0 microns
 - d. Cladding Diameter: 125 ± 2.0 microns
 - e. Buffer Coating Diameter: 250 ± 15 microns
 - f. Operating Wavelengths: 850 nm and 1300 nm
 - g. Maximum Attenuation @ 850 nm: 3.75 dB/km
 - h. Maximum Attenuation @ 1300 nm: 1.75 dB/km
 - i. Minimum Bandwidth @ 850 nm: 160 MHZ km
 - j. Minimum Bandwidth @ 1300 nm: 500 MHZ km
 - k. Numerical Aperture: 0.275
 - l. Proof Test: 344 MPa (megapascals)
 - m. Tensile Strength During Installation: 2700N (newtons)
Long Term: 500N
 - n. Crush Resistance: 440N/cm (armored) (newtons per centimeter)
220N/cm (non-armored)
 - o. Operating Temperature: -40°C to +65°C
 - p. Storage Temperature: -50°C to +70°C

2.7 COMPONENT ENCLOSURES

- A. Consoles, annunciator housings, power supply enclosures, terminal cabinets, data gathering panels, wiring gutters, and other component housings, collectively referred to as enclosures, shall be so formed and assembled as to be sturdy and rigid. Thickness of metal in cast and

sheet metal enclosures of all types shall not be less than those in Tables I and II, UL six-hundred-eleven (UL-611). Sheet steel used in fabrication of enclosures shall be not less than fourteen (14) gauge. Consoles may be sixteen (16) gauge. Doors and covers shall be flanged. Where doors are mounted on hinges with exposed pins, the hinges shall be of the tight pin type or the ends of hinge pins shall be tack welded to prevent ready removal. Doors having a latch edge length of less than twenty-four (24) inches shall be provided with a single lock. Where the latch edge of a hinged door is twenty-four (24) inches or more in length, the door shall be provided with a three (3)-point latching device with lock; or alternatively with two (2) locks, one (1) located near each end. Any ventilator openings in enclosures and cabinets shall conform to the requirements of UL six-hundred-eleven (UL-611). Unless otherwise indicated, sheet metal enclosures, excluding control console enclosures, shall be designed for wall mounting with top holes slotted. Mounting holes shall be in positions that remain accessible when all major operating components are in place and the door is open, but shall be inaccessible when the door is closed. Covers of pull and junction boxes provided to facilitate initial installation of the system shall be held in place by tack welding, brazing, or one-way screws. Zinc labels shall be affixed to such boxes indicating they contain no connections. These labels shall not indicate that the box is part of the security system.

2.8 EXPOSED COMPONENTS IN PUBLIC ACCESSIBLE AREAS

- A. Components, such as intercom station face plates, exposed and accessible to public shall be of a design and construction typical and suitable for correctional facilities. Intercom station face plates shall be stainless-steel, 11 gage minimum. CCTV housings shall be cold rolled steel, 10 gage minimum. Vision panels in CCTV housings shall be polycarbonate, 1/3-inch minimum. All fastened devices shall be an approved security type. All components and materials shall be resistant to vandalism and waterproof.

2.9 TAMPER PROVISIONS

- A. Enclosures and cabinets having hinged doors or removable covers which contain programmable system components shall be provided with corrosion-resistant tamper switches, arranged to initiate an alarm signal when the door or cover is moved as little as one quarter (1/4) inch from its normally closed position. Tamper switches shall be mechanically mounted to maximize the defeat time when enclosure covers are opened and removed. The minimum amount of time required to depress or defeat the tamper switch after opening or removing the cover shall be greater than one (1) second. Enclosure and tamper switch shall function in such a manner as to not allow direct line of sight to any internal components or the tampering of the switch or circuit wiring. Tamper switches shall be inaccessible until the switch is activated; have mounting hardware concealed so that location of the switch cannot be observed from the exterior of the enclosure; be under electrical supervision at all times, irrespective of the protection mode in which the circuit is operating; shall be spring-loaded and held in the closed position by the door or cover protected; and shall be wired so that they break the circuit when the door or cover is disturbed. Tamper switches on doors which must be opened to make normal maintenance adjustments to the system and to service the power supplies shall be of the push/pullset, automatic-reset type.

2.10 ALARM ANNUNCIATION

- A. Alarm annunciation shall include intrusion detection, tamper, fail safe, line fault, and power loss.
1. Intrusion Detection: Intrusion detection alarms shall include the full range of interior point protection sensors, volumetric space, access control protection sensors, and duress alarms. Duress alarms shall be annunciated to clearly distinguish them from other intrusion detection alarms.
 2. Tamper: Enclosures, cabinets, housings, boxes, raceways, and fittings having hinged doors or removable covers and which contain circuits of the intrusion detection system and its power supplies, shall be provided with cover operated, corrosion-resistant tamper switches, arranged to initiate an alarm signal when the door or cover is moved as little as one quarter (1/4) inch from the normally closed position. Tamper switches shall be mechanically mounted to maximize the defeat time when enclosure covers are opened or removed. The minimum amount of time required to depress or defeat the tamper switch after opening or removing the cover shall be one (1) second. Enclosure and tamper switch shall prevent direct line of sight to any internal components and prevent switch or circuit tampering. Tamper switches shall be inaccessible until the switch is activated; conceal mounting hardware so that location of the switch cannot be observed from the exterior of the enclosure; be under electrical supervision at all times, irrespective of the protection mode in which the circuit is operating; shall be spring-loaded and held in the closed position by the door or cover protected; and shall be wired to break the circuit when the door or cover is disturbed. Tamper switches on doors that must be opened to make normal maintenance adjustments to the system and to service the power supplies shall be of the push/pullset, automatic reset type. Tamper alarms shall be annunciated to be clearly distinguishable from intrusion detection alarms.
 3. Fail-Safe Alarms: Provide a fail-safe capability in all critical elements of the system. Fail-safe is defined as the capability to monitor for proper system functions and to report an alarm when a failure is detected in any critical system function. This shall include, but not be limited to, the capability to monitor communication link integrity and to provide self-test. When diminished functional capabilities are detected, the system shall provide annunciation of the fault. Fail-safe alarms shall be annunciated to clearly distinguish them from other types of alarms.
 4. Fail-Secure Locking: All locking shall be fail-secure to the extent that such locking is permitted by appropriate and pertinent life-safety and building codes. Fail-secure locking shall be understood to mean that upon failure, locks shall fail in the "locked" and "secure" position.
 5. Line Fault: As a minimum, fault isolation at the systems level shall have the same geographic resolution as provided for intrusion detection. The communication links of the security system shall have an active mode for line fault detection. Active mode is defined as that in which some type of signal is continuously sent across the link, resulting in simple link breaks being readily detected. The system shall be either a static system or a dynamic system. In a static system, the "no-alarm" condition shall always be represented by the same signal, which shall be different

than the signal originally transmitted. The dynamic system shall represent "no-alarm" with a signal that continually changes with time.

6. Power Loss: Provide the capability to detect when any critical component of the system experiences temporary or permanent loss of power and to declare an alarm. The alarm shall be annunciated to clearly identify the component experiencing the power loss.

2.11 LINE SUPERVISION

- A. Communication interconnection lines between the local control units and the central control shall be electrically supervised for both opens in the wiring and/or shorted wiring, and loss of data communication for all subsystems.
- B. Interconnecting lines from input sensors and tamper switches shall be provided with electrical line supervision for opens in the wiring.

2.12 KEY-LOCK SWITCHES

- A. Key-lock operated switches not part of security door mechanisms and assemblies, such as console cabinet doors and panels, and certain terminal cabinets, shall be UL-listed, round-key type, with three (3) dual, one (1) mushroom, and three (3) plain pin tumblers, or have pick resistance equal to a lock having a combination of five (5) cylinder pin and five (5)-point, three (3)-position side bar in the same lock. Keys shall be stamped DO NOT DUPLICATE. All key-lock operated switches shall be keyed differently. Two (2) keys shall be furnished for each switch. Maintenance locks shall be of the one (1)-way; key-pull type so arranged that the key can be withdrawn only when the lock is in the locked position. All locks on components for maintenance access shall be keyed alike and only two (2) keys shall be furnished for all these locks. During performance of the Work, every precaution to protect the security of keys shall be exercised. These precautions shall include procedures for accounting for all keys at the end of each work day, storing keys in a security container during nonworking hours, and rigid controls to prohibit employees from removing keys from the job site. Upon completion of the Work, all keys, properly and permanently tagged with metal tags, shall be delivered and accompanied by a manufacturer's certificate that records the number of each key made.

2.13 ELECTRONIC COMPONENTS

- A. All electronic components of the system shall be of the solid-state type, mounted on printed circuit boards conforming to UL seven-hundred-ninety-six (UL796). Boards shall be plug-in, quick-disconnect type. Circuitry shall not be so densely placed as to impede maintenance. All power-dissipating components shall incorporate safety margins of not less than twenty-five (25) percent with respect to dissipation ratings, maximum voltages, and current-carrying capacity.

2.14 RELAYS AND LOGIC CONTROLLERS

- A. Light duty relays, programmable logic controllers, if any, and similar switching devices shall be solid-state type or hermetically sealed electro-mechanical type.

2.15 MATERIALS NOT LISTED

- A. Furnish all necessary hardware, materials, and supporting equipment required to place in full operation the specified major subsystems. Some supporting equipment, materials, and hardware may not be described in the Contract Drawings and may not be identified herein. Depending on the manufacturers selected by the ESS, some equipment, materials, and hardware may not be contained in either the Contract Drawings or these written Specifications, but are required by the manufacturer for full and complete operation in accordance with the intent of the design and these Specifications. In such cases, the Architect shall be given the opportunity to approve the additional equipment, hardware and materials that shall be fully identified in the bid and in the equipment list submittal. The Architect shall be consulted in the event that there is any question as to which supporting equipment, materials, or hardware are intended to be included.

2.16 LIKE ITEMS

- A. Where two (2) or more items of equipment performing the same function are required, they shall be exact duplicates produced by one (1) manufacturer. All equipment provided shall be complete, new and free of any defects.

2.17 WARRANTY

- A. The ESS shall, as a condition precedent to the final payment, execute a written guarantee (warranty) to the Architect certifying that all the contract requirements have been completed in accordance to the final Specifications and Contract Drawings and warranting all materials and equipment furnished by him under this contract to remain in satisfactory operating condition (ordinary wear and tear, abuse and causes beyond his control for this Work excepted) FOR A PERIOD OF ONE (1) YEAR FROM THE DATE OF FINAL ACCEPTANCE OR BENEFICIAL OCCUPANCY, WHICHEVER IS LATER. All defects or damages due to faulty materials or workmanship shall be repaired or replaced without delay to the Architect's satisfaction at the ESS's expense. The ESS shall provide for periodic inspections at his cost during the warranty period. When equipment and labor covered by the ESS's warranty or by a manufacturer's warranty have been replaced or restored because of his failure during the period of that warranty, the warranty period for the replaced or repaired equipment or restored Work shall be reinstated for a period of time equal to the original warranty period, and commencing with the date of completion of the replacement or restoration work. In the event that any manufacturer customarily provides a warranty period greater than one (1) year, the ESS's warranty shall be for the same period of time.

2.18 PROTECTION OF CONTRACT DOCUMENTS

- A. The ESS shall protect all documents and materials that identify the Owner's security systems and equipment. All such documents and materials shall be uniquely numbered for identification. They shall not be transferred to subcontractors or others without assurances in

writing that the same level of protection will be provided. Discarded documents (such as drawings) shall be destroyed by burning or by other means rendering the document unreadable and precluding the reconstitution of the document to a readable state.

PART 3 - EXECUTION

3.1 INSTALLATION OF PRODUCTS

- A. Comply with manufacturer's instructions and recommendations for installation of products in the applications indicated. Anchor each product securely in place, accurately located and aligned with other Work. Conflicts between the manufacturer's instructions and the Specification shall be promptly brought to the attention of the Architect by the ESS prior to the initiation of any related Work.
- B. Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- C. Thoroughly clean areas and spaces where work is performed or used as access to work. Remove completely point, mortar, oils, putty and items of similar nature. Thoroughly clean piping, conduit and similar features before painting or other finishing is applied. Restore all surfaces to their original condition.
- D. All wall-mounted equipment shall be mounted square and plumb.

3.2 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store and handle products in accordance with the manufacturer's recommendations, using means and methods that will prevent damage, deterioration and loss, including theft. Materials delivered to the Project site shall be stored and protected to effectively prevent theft or damage from weather or physical abuse, either deliberate or inadvertent.
 - 1. The Owner assumes no responsibility or liability for the loss by theft, vandalism, or burglary of material or equipment stored on or at the Project site.
 - 2. Materials shall be received, receipted for and handled by the ESS's personnel.
 - 3. Access to the Project site for on and off-loading of all materials, structures, and equipment shall be coordinated with and approved by the Architect, or their authorized representatives.
 - 4. Before any Work is started, the ESS shall coordinate with the Architect or their authorized representatives, use of areas for staging and storage of materials and equipment.
 - 5. The ESS shall keep all route and site areas free and clean at all times of any dirt, debris, or other material resulting from his operation.

6. Schedule delivery to minimize long-term storage at the site and to prevent overcrowding of construction spaces.
7. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft and other losses.
8. Deliver products to the site in the manufacturer's original sealed container or other packaging system, complete with labels and instruction for handling, storing, unpacking, protecting and installing.
9. Inspect products upon delivery to ensure compliance with the Contract Documents, and to ensure that products are undamaged and properly protected.
10. Store products at the site in a manner that will facilitate inspection and measurement of quantity or counting of units.
11. Store heavy materials away from the Project structure in a manner that will not endanger the supporting construction.
12. Store products subject to damage by the elements above ground, under cover in a weather-tight enclosure, with ventilation adequate to prevent condensation. Maintain temperature and humidity within range required by manufacturer's instruction.

3.3 COMMENCEMENT, PROSECUTION, AND COMPLETION OF WORK

- A. Commencement, prosecution and completion of Work shall be in accordance with the General Provisions of the Contract, including General and Supplementary Conditions, General Requirements, Division 1, and Section 16000, General Requirements, and this Section. Separate Work tasks shall be properly time-phased and carried out so as not to interfere with or delay other required Work tasks and to promote overall efficiency and timeliness of completing the total project.

3.4 INSTALLATION - EQUIPMENT

- A. The ESS shall install the security system in accordance with the standards for safety, UL one-thousand-thirty-seven (UL-1037) and UL one-thousand-seventy-six (UL-1076), and the appropriate installation manual for each equipment type. Components within the system shall be configured with appropriate "service points" so that system trouble can be pinpointed in less than twenty (20) minutes.

3.5 INSTALLATION - CABLE/WIRES/CONDUIT

- A. ESS-provided cable/wire runs and conduit shall be installed in accordance with applicable electrical Work standards, national and local codes, and NFPA seventy (70), as well as manufacturers' specifications of installed equipment.

3.6 INTERIOR WIRING

- A. In addition to requirements specified in other sections of the Specification, as a minimum, the ESS's Work for Division 17 shall conform to the following. Conflicts, if any, shall be promptly brought to the attention of the Architect.
- B. All exposed security systems conductors and/or associated cabling that is routed within interior wall systems shall be installed in conduit or other approved raceway. Wiring and cable located in concealed areas over ceiling spaces are not required to be enclosed in conduit, however, shall be approved for the specific use. Conductors not enclosed in conduit shall be mounted and secured in accordance with requirements set forth in the electrical drawings and notes for low voltage wiring. Exceptions shall require the Project Manager's approval.
- C. All conductors that are required to meet fire-safety ratings and electrical and building code requirements shall satisfy such requirements. As one example, in the event that Architect was to approve the installation of exposed conductors for certain locations, conductors installed in plenums shall be fire-rated for such applications, such as by means of rated Teflon-jacketed conductors.
- D. Security system conductor shall be color coded (in colors other than black or gray) and marked in such a manner so as to be readily identified as security conductor and not part of any other building wide low voltage system. The ESS shall submit the wire/cable color code schedule to the Architect for review and approval during the shop drawing submittal.
- E. All security systems conductors shall be separated from one-hundred-twenty (120) VAC primary power lines by no less than twelve (12) inches; security systems conductors shall not share any conduit in which primary power conductors are run. Junction and receptacle boxes carrying 120 VAC, or higher voltage, shall not in any way be attached to or carry security systems conductors.
- F. Conductors shall be copper, and shall not have a diameter less than eighteen (18) AWG unless otherwise indicated. Exceptions will be made for vendor-provided leads and internal equipment wiring. If required, the ESS shall modify equipment wiring fittings that will not accept eighteen (18) AWG minimum conductors. Conductors for the intercom/PA system shall be a minimum of twenty-two (22) AWG. Other exceptions may be granted for use of smaller gauge conductors upon approval by the Architect.
- G. Conductors interconnected to equipment subject to movement shall be stranded or shall be of a type manufactured specifically for such interconnections.
- H. Wire fill, conductors, and conduit shall be sized by the ESS in compliance with the National Electrical Code.
- I. In the event that security conductors must share conduit with other low voltage conductors, prior approval of the Architect is required. All system conductors shall be run concealed wherever practical, and shall be placed in conduit.
- J. All conductors shall be run continuously between sensors, processors, junction boxes, terminal strips or panels, and other approved devices. Splices between such locations are not

- to be permitted. Necessary junctions shall be made using screw-type terminal blocks, or in accordance with manufacturer's requirements for equipment connections.
- K. Line supervision requirements shall be observed.
- L. All conductors shall be color coded and tagged consistently. Coordination with Construction Manager of exact wire coding and tagging is mandatory. Transposing or changing color coding of conductors shall not be permitted. Conductor identification shall be provided within each enclosure where a tap, splice or termination is made, and at the equipment terminal of each conductor. Terminal and conductor identification shall match that shown on approved shop drawings. Hand lettering or marking will not be accepted. Marking shall be an approved permanent type utilizing an approved method. Tagging devices shall be approved and shall be permanent, not subject to inadvertent separation. All conductors at control consoles shall be bundled, neatly fanned out, and tagged. Cables and wires shall be tagged to clearly indicate their electrical characteristics, circuit number and panel designation. Tagging shall be such that several conductors may be disconnected and reconnected without the use of drawings.
- M. If required by manufacturers' specifications, shielding requirements shall be observed.

3.7 CLEAN, SQUARE INSTALLATION

- A. All equipment shall be clean and free of paint and other defacing materials. All installations shall be square and plumb. The ESS shall take care that other trades do not deface equipment and do not move equipment out of square and plumb. If equipment is moved, the ESS shall re-install the equipment to be square and plumb.

3.8 ELECTRICAL POWER

- A. High Voltage (120/230 VAC) Power:
1. All designated security equipment requiring 120 VAC shall be powered from a UPS as specified in Section 17110. The UPS shall be connected to the normal commercial or base electrical distribution system. If equipped with battery back-up, field mounted devices may be powered via the base electrical system.
 2. The Electrical Contractor shall furnish and install the power supply panels, wiring, conductors, conduit, raceway systems, and terminations for the supply of 120 VAC power to security system components. It shall be the responsibility of the ESS to provide the Electrical Contractor with complete information regarding 120 VAC requirements.
- B. Low Voltage Power: Through the use of two-winding isolation-type transformers and rectifier circuits, supply DC voltages where required. Voltage levels shall be as required for the various system's operation. All low voltage power shall be provided with battery back-up, capable of supporting the operation of all equipment for a minimum of four hours. Provide a separate, lockable, fused safety switch adjacent to the power distribution panel.

- C. Batteries: Provide backup by dedicated batteries in remotely located system elements such as remote data gathering panels, relay cabinets, control units or individual sensors. Batteries shall be sized to provide continuous stand-by operation for a minimum of four (4) hours without recharge or replacement.

3.9 ADJUSTMENT/ALIGNMENT/SYNCHRONIZATION/CLEANING

- A. Subsequent to installation, the ESS shall clean each system component of dust, dirt, grease or oil incurred or accrued from other project activities, and prepare for system activation by manufacturer's recommended procedures for adjustment, alignment, or synchronization. Each component shall be prepared in accordance with the appropriate provisions of the component's installation, operations, and maintenance manuals.

3.10 INSTRUCTION TO OWNER

- A. The following establishes basic and minimum training requirements. The ESS shall provide technical services and materials to instruct operators and maintenance/programmers/database set-up personnel to operate, maintain and program the system.
 - 1. Software and user-database programming, CPU set-up, access control system set-up, and card reader set-up, shall be included as part of the training up to five qualified personnel selected by the Owner. The ESS shall provide 40 hours of instructions to this group that shall be separate from the other trainees.
 - 2. Training time to be furnished by the ESS to console operator personnel shall be 12 hours (8 hours in initial training and 4 hours in follow-up refresher training);
 - 3. Fully qualified personnel who are thoroughly knowledgeable of the installation, equipment and software of the system shall accomplish training. Instructions shall cover the material presented in the manuals through the use of classroom presentations and on-equipment training.
 - 4. Information on each course (operator, maintenance, or programmer) concerning class schedules, number of students per class, course outlines and a copy of the instructor's manual and handouts shall be provided by the ESS AT LEAST THIRTY (30) DAYS IN ADVANCE OF THE FIRST CLASS. Instructions shall be provided on-site and shall commence after the system is fully operational and shall be completed prior to system acceptance and turnover to the Owner.
 - 5. If agreed to by the Owner, attendance at equipment manufacturer's maintenance training schools may be substituted for on-site training. Costs associated with such schooling, less travel and per diem will be borne by the ESS.
 - 6. Provide an indexed recorded video cassette tape of the training sessions segmented into modular components corresponding to individual subsystems so that future personnel may be self-trained after the initial training period and so that personnel already trained may refer to the tapes as a refresher to their training.

3.11 TESTS AND VERIFICATIONS

- A. General: The ESS shall verify that all requirements of this specification are met. Verification shall be through a combination of inspections, demonstrations and tests, as described below.
- B. Pre-installation Software Demonstration Test: The ESS shall conduct a demonstration test of the control system software associated with the security management system and related CCTV and security intercom functions prior to the installation of head-end components (i.e. CPU's, Video Terminals, etc.). This test shall demonstrate screen configurations, graphic layouts/design, and other specified performance features such that it simulates the actual installed configuration of the system.
- C. Verification by Inspection: Verification inspections shall include examination of an item and the comparison of pertinent characteristics against the qualitative or quantitative standard set forth in the cited paragraph. Inspection may require moving or partially disassembling the item to accomplish the verification. Inspection shall be made of all equipment installations, proper functioning of all locking hardware and lock controls, mounting and wiring of electrical and signal distribution cabinets and components, and mounting and placement of sensors, CCTV cameras, etc. to ensure requirements of the specifications are complied with and that the overall installation is accomplished in a professional and workmanlike manner. The Owner's quality control representative(s) shall have full opportunity to witness the required ESS inspections or to conduct his own inspections of the installation.
- D. Test Verification Requirements: Paragraphs 1-3 below list specific requirements that shall be verified by formal demonstration/test. THE ARCHITECT SHALL BE AFFORDED A FOURTEEN (14) DAY ADVANCE NOTICE OF ALL SUBSYSTEM DEMONSTRATIONS/TESTS. The Architect reserve the right to witness any of the tests described below.
 - 1. Preliminary Tests: Following installation, the ESS shall individually test each sensor and other components and verify the proper functioning of each component within a particular subsystem. Each subsystem shall be similarly tested until all detection zones, alarm assessment components, alarm reporting and display, and access control functions have been verified. Any deficiency pertaining to these requirements shall be corrected by the ESS prior to final functional and operational tests of the system. When subsystem verification is complete, the entire system shall be tested to assure that all elements are compatible and function properly as a complete system.
 - 2. System Operation Test: Following completion of the preliminary tests and the security system and component formal demonstrations, the ESS shall conduct a formal test, to be known as the "System Operation Test", in which all components and subsystems of the security system are demonstrated to operate together as a system. THIS TEST SHALL BE PERFORMED OVER A CONTINUOUS SEVENTY-TWO (72) HOUR PERIOD. A formal test plan and test procedures for each portion of the test shall be prepared by the ESS and submitted for Architect approval in accordance with this Specification. The ESS shall demonstrate that the security system components and subsystems meet specification requirements in the "as-installed" operating environment during the "System Operation Test". While no formal environmental testing is required, the ESS shall measure and record temperature, humidity, and other environmental parameters, and shall include this data in the test report to document the environmental parameters and the environment

conditions that were encountered during the "System Operation Test".

3. Tests Upon Completion of Work: Upon completion of the ESS's Work, the system shall be subjected to complete functional and operational tests. When all required corrections have been accomplished, the system shall be re-tested and the Architect NOTIFIED IN WRITING FOURTEEN DAYS IN ADVANCE OF THE PROPOSED FINAL ACCEPTANCE TESTING AND INSPECTION DATE. The advance notice shall include certification that the installation is complete and operable and has satisfactorily performed the final tests specified herein. The acceptance testing and final inspection will be accomplished in the company of the Architect, and/or the Owner's representatives. FOURTEEN DAYS PRIOR TO THAT DATE, the ESS shall prepare and submit for approval of the Architect, a complete and detailed final acceptance test check-off list ("punch list"). The list shall be a complete representation of all specified functions and conditions, including contingency, priority, and abnormal modes of operation. The arrangement of the list shall be such as to provide an orderly method of tabulating checks of system features, response and operation. The tests shall be structured so that all sensors and controls are stimulated directly in their installed and finally adjusted positions and all audible and visual displays, signals, alarms and other responses are observed and printed. At the time of final acceptance testing all required tests shall be repeated and all defects will be corrected until the system is found to be acceptable to the Architect. A log of all test activities and results shall be maintained by the ESS. Typed copies of this log shall be submitted to the Architect within seven days of the testing. Final tests shall include, but not limited to the following:
 4. Test of all central CPU's, peripherals, and all panel control functions;
 5. Test all LCD-based graphic control functions and displays.
 6. Test electrical supervision of all input/output sensor and data communication bus circuits;
 7. Test of all alarm initiating devices;
 8. Test of CCTV system components, cameras, switchers, and monitors;
 9. Test of battery and battery chargers;
 10. Test of access control system
 11. Complete operation tests under emergency power;
 12. Visual inspection of all wiring;
 13. Verification that all required submittals have been provided and have been accepted;
 14. Test of all intercommunications system components including amplifiers, staff stations, administrative stations, call stations, and wiring system;

15. Demonstrate software and programming/reprogramming functions of all microprocessor systems;
 16. Verification of systems response time.
 17. The ESS shall carefully plan and coordinate the final acceptance tests so that all tests can be satisfactorily completed within eight (8) cumulative hours of testing. The ESS shall provide all necessary instruments, labor and materials required for tests, the equipment manufacturer's technical representative, and qualified technicians in sufficient numbers to perform the tests within the time limits imposed by this Specification.
 18. In the event that the Owner, Architect, Construction Manager, or Owner's authorized representatives are required to witness a re-test at a later date because the ESS is either not adequately prepared to conduct the acceptance tests or because the systems being tested are failing such tests, which shall be solely determined by the Owner's representatives witnessing the tests, the costs of witnessing additional tests (based on time and materials at the established rates of the Owner's representatives) shall be borne exclusively by the ESS. In such an event, the ESS shall directly compensate the Owner's representatives witnessing the tests; compensation shall be provided within thirty calendar days of such, and all, additional tests.
- E. Reliability/Maintainability Data: The ESS shall record hours of component, subsystem and system operation, together with failure and repair data. This information shall be incorporated into the System Test Report to be submitted to the Architect.

3.12 REMOVE UNFIT MATERIAL

- A. The ESS shall proceed within twenty-four hours after receiving notice from the Architect, or their authorized representative, to remove from the Project site all materials condemned by the Architect, or their authorized representative, as failing to conform to the Contract Documents whether incorporated in the Work or not, and ESS shall promptly replace and re-execute his Work in accordance with the Contract Documents and without expense to the Owner and shall bear the expense of making good all Work of other contractors destroyed or damaged by such removal or replacement.

3.13 REPAIR AND CLEAN-UP

- A. Refuse resulting from the ESS's Work shall be removed from the Project site daily. Each immediate work areas shall be maintained in an orderly condition.

- B. Any damage to the Project site, its equipment, or its contents that occurs in the course of the ESS's Work shall be brought to the attention of the Architect and shall be repair to its original condition by the ESS at no cost to the Owner.

3.14 PROJECT CLOSEOUT

- A. General: This Section specifies administrative and procedural requirements for project closeout, including but not limited to:
1. Inspection procedures.
 2. Project record document submittal.
 3. Operating and maintenance manual submittal.
 4. Submittal of warranties and bonds.
 5. Final cleaning.
 6. Operational tests as may be required by jurisdictional authorities.
- B. ESS's Closeout Submittals: Submit evidence of compliance with the requirements of governing authorities, including the Certificate of Occupancy and, where applicable, copies of Certificates of Inspection.
- C. Record Document Submittals:
1. General: Do not use Record Documents for construction purposes; protect from deterioration and loss in a secure, fire-resistive location; provide access to Record Documents for the Architect/Engineer's reference during normal working hours.
 2. Record Drawings: Maintain a clean undamaged set of blue or black line white-prints of Contract Drawings and shop drawings. Mark the set to show the actual installation where the installed Work varies substantially from the Work as originally shown. Mark whichever drawing is most capable of showing the actual "field" condition fully and accurately. Where shop drawings are used for mark-up, record a cross-reference at the corresponding location on the working drawings. Give particular attention to concealed Work that would be difficult to measure and record at a later date.
 - a. Mark record sets with red erasable pencil and, where feasible, use other colors to distinguish between variations in separate categories of work.
 - b. Mark-up new information that is known to be important to the Owner, but was not shown on either Contract Drawings or shop drawings.
 - c. Note related change-order and addendum number where applicable.
 - d. Organize Record Drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on cover of each set.
 3. Record Specifications: Maintain one complete copy of the Project Manual, including Addenda, and one copy of other written construction documents such as Change Orders and modifications issued in printed form during construction. Mark these

documents to show substantial variations in the actual Work performed in comparison with the text of the Specifications and modifications. Give particular attention to substitutions, selection of options and similar information on Work where it is concealed or cannot otherwise be readily discerned at a later date by direct observation. Note related Record Drawing information and product data, where applicable.

4. Submit Record Specifications and Record Drawings to the Architect for the Architect's records upon completion of the Work.

3.15 MAINTENANCE AND OPERATING MANUALS

- A. Prepare four (4) copies of maintenance and operating instruction manuals prior to application for final payment. Organize operating and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual heavy-duty 2", 3 ring vinyl-covered binders, with pocket folders for folded sheet information. Mark appropriate identification on front and spine of each binder.
- B. Include the following information:
 1. Table of Contents.
 2. List of all subcontractors; indicate trade and submit name, address and telephone number of each.
 3. List of all manufacturers; indicate product and submit name, address and telephone number of manufacturer and the manufacturer's representative.
 4. For each material or system submit:
 - a. Inspection procedures.
 - b. Maintenance and cleaning instructions.

3.16 GUARANTIES, WARRANTIES, AND BONDS

- A. Assemble warranties, bonds, and service and maintenance contracts executed by each of the respective manufacturers, suppliers, and Subcontractors.
- B. Table of Contents: Neatly typed, in orderly sequence. Provide complete information for each item as follows:
 1. Product or work item.
 2. Firm, with the principal's name, address, and telephone number.
 3. Scope.

4. Date of the beginning of warranty, bond, or service and maintenance contract shall be the date established by the Architect for Final Acceptance.
5. Duration of warranty, bond, or service and maintenance contract.
6. Proper procedure in case of failure.
7. Instances that might affect validity of the warranty or bond.
8. The ESS, responsible principal's name, address, and telephone number.

3.17 FINAL SUBMITTALS

- A. The ESS shall furnish to the Architect the following items prior to final payment:
 1. Project Record Documents.
 2. All Guarantees and Warranties.
 3. All Maintenance and Operation Manuals.
- B. The ESS's final Application for Payment will not be processed by the Architect pending receipt of closeout submittals.

3.18 FINAL CLEANING

- A. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to the condition expected in a normal, commercial building cleaning and maintenance program. All stains, soil marks, dirt and other forms of defacement resulting from the ESS's Work shall be removed or repaired. The ESS shall remove from the Project site all tools, appliances, debris, and packing materials; remove all paint stains, blemishes, and foreign materials; clean all mechanical and electrical equipment. Use only materials and cleaning agents recommended by the material supplier. The ESS shall assume responsibility for damage caused by his cleaning operations.
- B. Immediately prior to Final Completion and the final inspection visit, the ESS shall thoroughly clean the project work area. The ESS shall schedule and attend the Architect's inspection visit.

END OF SECTION

SECTION 17910

SECURITY MANAGEMENT SYSTEM

PART 1

1 GENERAL

1.1 SECTION INCLUDES

- A. Description of Work: The Electronic Systems Subcontractor's (ESS) work shall include all labor, equipment and services necessary to furnish, deliver and install the following items of electronic security equipment:
- Security Management Server
 - Security Management Terminals
 - Security Management System Software
 - Data Gathering Panels
 - Proximity Card Readers
 - Proximity Cards
 - Access Control Card Printer
 - Request-to Exit Sensors
 - Overhead Door Position Switches
 - Vehicle Loop Detectors
 - Local Door Control Release Switches
 - Keyed Shunt Switches
 - Duress / Panic Device
 - Conduit and Supports
 - Wire and Cable
- B. Except as otherwise specified herein, the equipment and materials of this Section shall be products of the following manufacturers or approved equals:
- 1. Security Management System
 - a. Lenel International
 - b. Galaxy Controls.
 - c. Software House, Inc
 - d. Andover Controls
 - e. GE Security
 - f. HID

2 - PRODUCTS

2.1 GENERAL

- C. The automated card access and monitor and control system shall be an integrated security management system which shall provide subsystems which perform the following general services:

1. Access control
2. Alarm monitoring
3. Camera Call-up
4. Reporting functions

1.2 SYSTEM HARDWARE

- A. Security Management Server / Central Processing Unit

1. An IBM[™] compatible PC with an Intel[™] Pentium 4 microprocessor chip set or equivalent. The operating speed shall be a minimum of 1.2 gigahertz and incorporate a minimum 512 megabytes of high speed RAM memory.
2. One 1.44mb three and one half inch (3.5") floppy drive, two 18 gigabyte hot-swap internal hard drives, one 48X CD-ROM drive shall be provided and fitted with the proper controller(s) for all associated drives.

- B. Security Management Video Terminal:

1. An IBM[™] compatible PC with an Intel[™] Pentium 4 microprocessor chip set or equivalent. The operating speed shall be a minimum of 3.8 gigahertz and incorporate a minimum of five hundred twelve megabytes (512 mb) of high speed RAM memory. Video terminals shall be equipped with 128 MB of high speed RAM, a twenty gigabyte (80 GB) hard drive, and a 48x CD-ROM drive.
2. The video terminal shall include off an off-the-shelf color monitor which has the ability to generate curves and other irregular shapes. Provide a video system Liquid Crystal Display (LCD) and video driver card that shall be VGA compatible and shall have a minimum resolution of 1024 x 768. In graphics mode it shall be capable of 32 colors; in video capture mode it shall be capable of 16 thousand plus colors. The LCD shall be a minimum of 19-inches.

- C. Printer: Printer shall be a Hewlett Packard or approved equal laser printer capable of printing up to 15 pages per minute, 1200 x 1200 dpi with 8MB of memory, a 250 sheet paper tray capacity, 90 MHz processor compatible with the Security Management Terminal.

- D. Data Gathering Panels (DGP): Communication between individual card reader sensors and the security management CPU shall be through intelligent field controllers daisy chained together as independent nodes on a communication buss capable of distributing card holder transactions through a network back to the CPU in a data format compatible with the system software.
- E. Card Access Card Reader Sensors: The system shall utilize proximity type card reader sensors and cards at all card reader locations shown on the drawings. The readers shall be capable of reading the cards when the cards are presented to the reader at a distance of approximately 4" to 6" and shall be compatible with HID ISOProx II cards.
- F. Access Control Cards: Access control cards shall be a PVC plastic laminate type card that includes both proximity based and magnetic stripe reader technologies in a single card. The proximity portion of the card shall be based on an industry standard 26-bit Weigand format. The card shall be of a type that is capable of receiving graphics and/or photographs on the front face of the card using a direct image or thermal transfer printer. Slot punch vertically or horizontally for easy use per Owner's direction. Two hundred fifty (250) access control cards shall be furnished and provided to the Owner at the time of system delivery. Cards shall be HID ISOProx II cards number sequentially beginning with 6500.
- G. Access Control Card Printer/Encoder : Provide model DTC400 as manufactured by Fargo, Minneapolis, MN or approved equal. Options shall include dual-sided printing module, magnetic strip encoding module, Ethernet networking with internal print server.
- H. Request-to Exit (REX) Passive Infrared Sensor: The system shall utilize a wall / ceiling surface mountable passive infrared sensor with two Form "C" time adjustable latching relay outputs. The unit shall have the minimum pattern coverage of 8 feet x 10 feet. The REX sensor shall be a Sentrol Model RTE 1000 or approved equal.
- I. Overhead Door Position Switches: The system shall utilize a track mounted magnetic contact switch with armored cable designed for curtain door applications as indicated on the drawings and mounted a minimum of eighteen (18) inches above finished floor. The Overhead Door Position Switch shall be a GE Security Model 2302A-L or approved equal.
- J. In-ground Vehicle Loop Detector:
1. The vehicle loop detector shall utilize a magnetic field for sensing motion of ferrous metal objects to initiate intercom call-ins from the vehicle sally port intercom station.
 2. The Vehicle Loop Detector shall allow for easy installation into small operator housings. All the controls must be accessible from the outside for ease of installation and operation. Provide metal housing for maximum durability and RF blocking. Surge protection shall be provided on all inputs and outputs.

3. The vehicle loop detector shall be installed such that it can be replaced without destroying concrete/asphalt i.e.: PVC conduit tube under drive with access box to the side. The area of coverage shall be adjustable from 0 to 15 feet and shall have the capability of being located up to 100 feet away from its control unit. The detector shall operate within the temperature range of -40 degrees to + 180 degrees Fahrenheit. The probe shall not be activated by pedestrians, bicycles and the sliding gate. The vehicle loop detector shall be D-Tek as manufactured by EMX Industries, Cleveland, OH or approved equal.
 4. The loop wire should be 16 gauge stranded tinned copper wire with crosslinked polyethylene (XLPE) insulation rated for 600V. Use only a commercial type of loop sealant designed for traffic loops with a backer rod to ensure that the wires are in place and do not vibrate under the backer rod. Connect safety loops in series.
- K. Local Door Control Switch: Local door control switches shall be a momentary SPDT push button type mounted on a stainless steel cover plate on a single gang back box. The push button shall be interconnected to the associated locks PLC I/O.
- L. Keyed Shunt Switch: The keyed shunt switch shall be a heavy-duty, flush-mount DPDT key switch equipped with a mortised cylinder and a single red LED on a narrow single gang die-cast aluminum face plate. The shunt switch shall be configured to locally disarm the associated door monitor switch and provide an authorized access signal to the Security Management System. The keyed shunt switch shall be a Camden Manufacturing Model CM -1100 or approved equal.
- M. Fixed Panic / Duress Switch: "Under the desk" switches shall be surface mounted at a location under the desk or counter as indicated on the drawings. The switch shall be of a type that cannot be accidentally activated. The switch shall be SPDT and shall reset when in the closed position.

1.3 OPERATING SYSTEM SOFTWARE

- A. The operating system software shall be Microsoft Windows XP Professional, Microsoft 2000 Professional, or an approved equivalent graphical user interface windows type program.

1.4 SOFTWARE CHARACTERISTICS

- A. The system software shall be written to run under an approved multi-user operating system.
- B. The software shall be constructed with attention paid to human factors; i.e., factors which effect how efficiently the software can be used by people. The software shall interact with the user through menu selections. Data tables which are selected for editing by the user, shall be shown in graphic tabular form, and/or may be printed for storage.

- C. Where use by non-technical level personnel is expected, such as at officer stations, the system shall accept inputs from labeled keys on the officer station terminal keypad, and shall prompt the operator for additional input data.
- D. System Software Support:
1. The system software shall be updated with new features at least yearly, and the updates made available to the owner. The written documentation and on-line documentation shall be updated to reflect the new software when released.
 2. The system shall be capable of connecting a modem through which, at the user's request, software can be downloaded from the system supplier, and faults diagnosed. The purpose of the diagnostic modem is to save time and expense in detecting and correcting faults system-wide.
 3. The system shall be provided with a set of on-line diagnostics including dynamic system performance monitoring tools. The system shall support the execution of diagnostic programs while the system is running; i.e., the system should not have to be taken off-line to run diagnostics or monitor performance.
 4. The system shall provide a facility by which users can report problems to the software supplier by entering problem descriptions at the terminal and having those descriptions forwarded to the supplier electronically (by modem).
- E. Graphics
1. The system shall support a minimum of 200 user programmable color graphic map displays capable of showing the floor plan, location of alarm device, and alarm instructions. Floor plans shall be created in a .PCX or .BMP format and shall be capable of being imported from other systems.
 2. The system shall provide the ability to drop dynamic object icons onto the drawings. These dynamic object icons shall allow the system operator to perform tasks/issue commands related to the object, by double clicking on the icon.
 3. All of the graphic maps are to be centralized in the system configuration and shall be displayed on the security management video terminals. Systems requiring separate display monitors or PC are not acceptable.
- F. Documentation and Help Facility:
1. The system shall be provided with a complete installation guide that details all steps necessary to install the system software and computer system hardware. A user's reference manual shall also be provided. The user's reference manual shall detail all aspects of programming and operation of the system.
 2. The system shall have an interactive help facility built into the software such that a user of the system shall be able to recall instructional text describing use of any

permitted feature of the system while at a system terminal. The interactive help facility shall be entered by pressing the HELP key from any menu in the system.

3. The on-line documentation in the system shall be of sufficient depth that the user need not refer to the written documentation supplied with the system, when he is at the system terminal.

G. Multi-User Capability:

1. The system shall be capable of accepting multiple CRT terminal consoles. Each CRT terminal shall be capable of executing the full range of system commands concurrent with other terminal users.
2. Each CRT terminal connected to the system shall be capable of accepting a printer connected to the system through the terminal (i.e., the system shall not require an individual I/O port for each printer).
3. The system shall support the use of modems to locate CRT terminals at remote sites. The system shall recognize the loss of carrier condition on the modems, and shall automatically log off any user connected to a modem when the carrier signal is lost.

H. On-Line System Diagnostics:

1. The system shall provide the capability of running diagnostic software for the purpose of determining the source of a fault in the system hardware or tuning the performance of the system software.
2. The system shall provide on-line diagnostics which may be run without impairing function of the security system software. The on-line diagnostics to be provided shall cover CPU loading, virtual memory use, disk access, and I/O operations.
3. A set of off-line diagnostic programs shall also be provided for the purpose of isolating faulty computer system components. A diagnostic program for each device (to the board level) in the system shall be provided.
4. The system software shall maintain an error log which shall contain failure related information written when the software encounters errors in execution. The error log shall contain English language explanations of the errors detected, and any relevant error specific data.

1.5 ACCESS CONTROL SUBSYSTEM

- A. General: The access control subsystem shall support up to 64 card readers connected discretely to the CPU via the Control System. The system shall support a card population of at least 2000 cards. The system hardware shall support the following access control technologies:

1. Access control cards and card reader sensors.
2. The system software shall support the operation of a door switch monitor and request-to-exit (REX) monitor for access control areas. The door switch monitor shall detect the opening of an access controlled door, and shall have the following operation:
 - a. When the door is opened following an activation of the card reader or REX input, the door switch shall be shunted by the software for a user-defined period of time.
 - b. When the door is opened without a valid access at the associated card reader sensor, or an activation of the REX input, then the system shall declare an alarm because the door has been forced open.
 - c. When the door is held open past a user-specified time period following a valid access or activation of the REX input, then the system shall declare an alarm because the door has been held open too long.
3. For each card reader defined to the system, the user shall define:
 - a. An 8 character abbreviated reader name.
 - b. A 64 character reader description.
 - c. The number of the alarm point for monitoring the door switch associated with the reader (if any).
 - d. The number of the monitor point used as the REX monitor point associated with the reader (if any).
 - e. The maintenance status (on-line/off-line) of the reader.
4. Cardholder Database:
 - a. For each card entered, the system shall store a database record that includes the card number, name of the person to whom the card was issued, and additional numeric and text data fields as the user may wish to define. The system shall offer the following special card data fields:

Expiration date/time: The user may specify the date and time after which either the card will become invalid, or (at the user's option) the first level of access clearance will become invalid.

Activation date/time: A date/time in the future when the card will be reactivated. This feature is used when a card is disabled; for example, when an employee goes on vacation.

Name of operator who last edited the card: The name of the operator who last changed data in the card may be selected for view, but may not be changed by the viewer.

Date/time of last card edit: The date when the data in the card record was last changed by an operator.

Trace of most recent card accesses for this card: The user may select from zero to three most recent accesses performed by the cardholder to be automatically displayed along with other card data (A complete access history is available through the system journal and reporting mechanisms).

Customized access privileges: The user may specify up to five location/time pairs for granting specific limited access rights by card (This mechanism works as an adjunct to the standard system-wide clearance code mechanism).

- b. In addition to the standard system supported data fields, the system shall allow the user to define up to 4 numeric user defined data fields and up to 8 user defined alphanumeric data fields of length from 1 to 28 characters. For each user defined data field, the system shall allow the specification of a data field label as provided by the user.
- c. The system shall support a query facility which allows a qualified user to retrieve data from the cardholder database by selecting fields to match. The facility shall allow the user to retrieve cardholder data based on all user defined or system defined data fields.
- d. The system shall have the ability to print reports of cardholder data sorted by card number or by cardholder name. These reports may be made either on the CRT or printer of the terminal requesting the information.
- e. Because of the critical nature of the database, the system shall be provided with a database reconstruction program which may be used by the system manager to repair the database should it become damaged by failure of the hard disk. In addition, a streamer tape back-up system shall be included within each CPU to provide for periodic back-up of the complete program and database. The size of the tape streamer drive shall match the size of the hard disk unit.

5. Access Privileges:

- a. The system shall allow the user to define 10 access clearance codes for general system use. Each clearance code shall have a user-defined name

for reference, and shall represent three pairings of locations and times. Each cardholder record shall have the capacity of six clearance codes.

- b. The system shall have the capability for the user to change the clearance codes for a large number of cardholders with a single command, avoiding a card by card search.
- c. In addition to the 10 clearance codes which operate system-wide, the system shall also allow each cardholder record to maintain a unique list of up to five individual readers and time specifications, which can override the clearance codes for the specific card.

6. Monitoring of the Access Control Subsystem:

- a. The access control subsystem shall be monitored from the standard integrated Master Station video alarm terminals.
- b. The system manager shall have the ability to restrict which, if any, access messages appear on the individual terminals. All access events shall be permanently recorded in the historical journal kept by the system on disk.
- c. When the system displays invalid access attempt messages, it shall include in the text of those messages the location of the event, reason for rejection, and name of the cardholder, if known.
- d. In addition to access related messages, the monitoring terminals shall indicate problems in the access control hardware related to communications failures, tampering of individual components, and supervision failures.

7. Segregated Access Control Database:

- a. The system shall support the ability to segregate access to cardholder database records based upon the privilege of the operator requesting database access. By using the database segregation facility, it shall be possible to grant access to specified database records while prohibiting access to all others.
- b. The system shall be capable of associating a classification with each cardholder record, and with each operator and card reader in the system. The system shall only permit access to cardholder data by those operators with a matching classification.
- c. The system shall prohibit the assignment of access control clearances that grant access to readers whose classification does not match that of the operator assigning the clearance code.

1.6 REPORT SUBSYSTEM

A. System Historical Journal:

1. The system shall maintain a history file on the hard disk. The history data shall be organized into a logically circular file such that the most recent 1.5 million transactions are accessible directly from the hard disk without having to resort to archival media.
2. The system shall store the history data in a compact form, and not as text. Each history entry in the journal shall be marked with the date and time of its occurrence, the name of the operator involved (if applicable), and the terminal from which the event was initiated (if applicable).
3. The system shall provide a method by which incremental sections of the historical journal may be backed up to magnetic tape media for storage and later recall. The system journal archive method shall be sufficient to assure that no events are lost in the transfer from hard disk to the archive media.
4. In addition, the journal archive method shall preserve the contents of all data in the on-line portion of the historical journal until the disk space occupied by data must be reclaimed for use in an oldest-first order.

B. Historical Reports:

1. The system shall be capable of producing the following reports of historical events over a specified time range, both individually and in any combination, from the historical journals:
 - a. Report of accesses for a selected cardholder or group of cardholders.
 - b. Report of rejected access attempts for a cardholder or group of cardholders.
 - c. Report of accesses through a selected door or group of doors.
 - d. Report of alarm activation for a selected alarm or group of alarms.
 - e. Report of alarm acknowledgments for a selected alarm or group of alarms.
 - f. Report of operator comments.
 - g. Reports of manual operator override actions (alarm arming, manual door unlocks, etc.).
 - h. Report of automatic system actions (automatic door unlocks).

- i. Report of visitor arrivals and departures.
2. In addition to reports of accesses made by an individual cardholder or designated cardholders, the system shall be capable of producing reports listing only the cardholder records of cardholders involved in selected events (e.g., list of cardholders who accessed a particular location over a specified time period). The system shall be capable of generating these reports in a format that is user defined. Search and sort capacity shall include sorts by the field parameters defined by the user, sorts alphabetically and sorts numerically.
3. Cardholder Reports:
 - a. The system shall be capable of producing lists of selected cardholder data records on a CRT screen and/or a printer. The system shall allow the user to select sorting by card number, cardholder name, or other fields.
 - b. The system shall allow the user to select the subset of cardholder record data which is to appear in the reports.

1.7 NETWORKING CAPABILITIES

- A. The system shall be capable of acting as part of a local area network or wide area network with other computer systems. The network media shall include, but not be limited to, Ethernet over coaxial cable, asynchronous communications over hard wire cable or modems and asynchronous communications over fiber optic cable.
- B. It shall be possible to utilize broadband communications to network systems on the same cable with video and voice communications.
- C. When connected to a network, users on remote systems shall have the ability to log onto the security system and to transfer files to and from the security system over the network. It shall be possible to add additional user terminals by connecting them to a terminal server device connected to the network rather than to an I/O port on the security system.

1.8 DATA GATHERING PANEL FUNCTION:

- A. Each DGP shall serve as the electrical interface between the reader sensors and shall perform the following functions:
 1. Continuously monitor the status (secure or alarm) of the alarm sensors connected to each transponder zone input by monitoring the current through the four wire circuit, terminating end-of-line resistor, or resistor network.
 2. Continuously supervise the lines connecting each alarm sensor to each transponder zone input.

3. Continuously supervise the lines connecting each card reader sensor to the transponders reader electronics card.
 4. Supervise and respond to monitor interrogation.
 5. Store in an internal microprocessor-based memory, access information for 500 cardholders.
 6. When the reader electronics receives an access card code from the reader sensor, the reader retransmits the code to the host CPU to determine whether access should be granted or denied. If valid, the host CPU sends a signal back to the reader electronics to unlock the door and shunt the magnetic door alarm contact.
 7. In the event of lost communications with the host CPU, the reader electronics shall operate in a distributed processing mode and will make the decisions to grant and/or deny access into the controlled areas from within the reader's memory. In addition, all security sensor input alarms will be stored in this memory to be downloaded to the host CPU upon restoration of communications.
- B. All DGP's shall be mounted within lockable, tamper monitored cabinets or electronic racks and located where shown on the contract drawings. Each transponder shall provide screw terminals for termination of all wiring. Each cabinet shall be provided with adequate filtered and conditioned power supply capacity as recommended by the manufacturer, including auxiliary power supplies for the peripheral sensors if voltage requirements are different. Each location shall include a battery standby power back-up to support the operation of all peripheral devices (including locks) interconnected into the multiplexer for a minimum of 4 hours in the event of an AC power outage.

1.9 VEHICLE LOOP DETECTOR

- A. The vehicle loop detector shall utilize a magnetic field for sensing motion of ferrous metal objects to initiate intercom call-ins from the vehicle sally port intercom station.
- B. The Vehicle Loop Detector shall allow for easy installation into small operator housings. All the controls must be accessible from the outside for ease of installation and operation. Provide metal housing for maximum durability and RF blocking. Surge protection shall be provided on all inputs and outputs.
- C. The vehicle loop detector shall be installed such that it can be replaced without destroying concrete/asphalt i.e.: PVC conduit tube under drive with access box to the side. The area of coverage shall be adjustable from 0 to 15 feet and shall have the capability of being located up to 100 feet away from its control unit. The detector shall operate within the temperature range of -40 degrees to + 180 degrees Fahrenheit. The probe shall not be activated by pedestrians, bicycles and the sliding gate. The vehicle loop detector shall be D-Tek as manufactured by EMX Industries, Cleveland, OH or approved equal.
- D. The loop wire should be 16 gage stranded tinned copper wire with crosslinked polyethylene (XLPE) insulation rated for 600V. Use only a commercial type of loop

sealant designed for traffic loops with a backer rod to ensure that the wires are in place and do not vibrate under the backer rod. Connect safety loops in series,

PART 2

3 - EXECUTION

2.1 SEE SPECIFICATION SECTION 17900, PARAGRAPH 3.1

2.2 WIRING

- A. Connection to the reader sensors shall be through multi-conductor shielded wire. Minimum conductor criteria for reader sensors shall be that all conductors are twisted and shielded pairs with an overall shield, sized at #18 AWG, unless otherwise specified by the manufacturer.
- B. Conductors for all alarm sensor inputs and/or outputs shall be twisted and shielded pairs with an overall shield, minimally sized at #18 AWG, unless otherwise specified by the manufacturer.
- C. Lock and strike power wiring shall be twisted and shielded pairs, sized at #14 AWG, unless otherwise specified by the manufacturer.
- D. Primary AC input power to all component cabinets within this subsystem shall be furnished and installed by the Division 16 subcontractor, where indicated on the drawings. If the equipment furnished by the security electronic systems integration subcontractor exceeds the AC input power to be supplied as shown on the drawings, then it shall be the responsibility of the security electronic systems integration subcontractor to coordinate any changes or modifications through the Architect.

END OF SECTION

SECTION 17920

CLOSED CIRCUIT TELEVISION SYSTEM

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The Request for Proposal and Instructions to Bidders form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.02 SUMMARY OF WORK

- A. The Electronic Security Subcontractor's (ESS) work shall include all labor, equipment and services necessary to furnish, deliver and install the work associated with the following items:

Color CCD Cameras
Lenses
Color Monitors
Housings / Mounts
Matrix Switcher
Switcher Controllers
Video Multiplexer/ Digital Recorder
Fiber Optic Transceivers
Wire & Cable
Conduit

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Except as otherwise specified herein, the equipment and material of this Section shall be products of the following manufacturers:

1. Bosch, Fairport, NY.
2. Integral Technologies, Indianapolis, IN
3. Panasonic, Secaucus, NJ.
4. Pelco, Clovis, CA

2.02 INTERIOR FIXED COLOR CCD CAMERAS

- A. Ceiling Mount Camera: Ceiling mount cameras shall be a mini-dome type consisting of an optically clear polycarbonate spherical dome with integrated fixed color camera and

lens. The integrated camera and lens shall consist of a camera and lens module that is packaged separately for shipment and which shall allow the installation of the enclosure to precede installation of the camera and lens. Provide Model VDC-445V Series as manufactured by Bosch Security systems, Lancaster, PA or approved equal.

- B. The integrated camera and lens assemblies shall meet the following requirements:
1. The product specified shall be a color dome camera designed using a 1/3-inch format CCD imager that produces 540 TVL of horizontal resolution. The unit shall be prepackaged in a standard indoor enclosure made of a polycarbonate/ABS blend. The dome bubble is clear polycarbonate material with a UV blocking anti-scratch coating. The camera comes complete with one of the following automatic iris, integral, varifocal lenses, as required by the application, to allow manual zoom and focus adjustment:
 - a. 2.6 to 6 mm, F1.4-360, varifocal lens
 - b. 4.0 to 9 mm, F1.6-360, varifocal lens
 2. The specified color camera, when using the 2.6 to 6 mm, F1.4 lens, shall be sensitive enough, when in the color mode, to produce a usable picture (50 IRE) with 0.98 lx (0.091 fc) of scene illumination. A full video picture (100 IRE) shall be produced with 3.9 lx (0.36 fc) of scene illumination. When in the monochrome mode (Bosch NightSense feature), a usable picture (50 IRE) will be produced with 0.39 lx (0.036 fc) of scene illumination and a full video picture (100 IRE) will be produced with 1.6 lx (0.15 fc) of scene illumination.
 3. The specified color camera, when using the 4 to 9 mm, F1.6 lens, shall be sensitive enough when in the color mode to produce a usable picture (50 IRE) with 1.3 lx (0.12 fc) of scene illumination. A full video picture (100 IRE) shall be produced with 5.1 lx (0.48 fc) of scene illumination. When in the monochrome mode (Bosch NightSense feature), a usable picture (50 IRE) will be produced with 0.5 lx (0.48 fc) of scene illumination and a full video picture (100 IRE) will be produced with 2.0 lx (0.19 fc) of scene illumination.
 4. The camera module position shall be adjustable along three (3) axes to provide an adjustment range of 360° pan, 90° tilt, and ±90° azimuth.
 5. The manufacturer of the specified dome camera shall provide an adjustment cap for the lens to be used during setup to ensure that the image sharpness (focus) and the field of view remain the same when the setup is complete and the dome bubble is installed.
 6. The camera setups and adjustments shall be made using an on-screen display in conjunction with push button keys. A miniature 2.5 mm jack socket that provides composite video output shall be available at the camera to allow connection of a CCTV video monitor to be used for camera setup. An optional cable [Bosch S1460] shall be available from the camera manufacturer for making this connection to a setup monitor.

7. The dome camera specified shall be equipped with a coaxial communications transceiver that incorporates a technology [Bosch Bilinx] that allows camera setup via the coaxial cable using bi-directional communication. The manufacturer shall offer optional configuration software [Bosch VP-CFGSFT] that operates in conjunction with the bi-directional communication technology that allows the camera to be adjusted from the head-end side of the coaxial cable.
8. The manufacturer shall offer models of the color camera for use in NTSC (60Hz) or PAL (50Hz) CCTV systems. The cameras shall operate within the voltage range of 10.8 to 39 VDC or 12 to 28 VAC, 45-65Hz and require no more than 4 watts of power to operate.
9. The camera shall have line-lock capability when powered by AC to synchronize the camera to the power line zero crossing for roll-free vertical interval switching. For vertical synchronization in multiphase power installations, the camera shall provide 0 to 358° of continuously adjustable vertical phase delay. Crystal-lock shall be selected when DC voltage is supplied or line-lock function is switched off.
10. A UTP (unshielded twisted pair) adapter, that allows a balanced video signal to be transmitted over UTP video cable, shall be available as an optional accessory from the manufacturer to allow a UTP video cable to be connected to the standard BNC connector.
11. The manufacturer of the specified color dome camera shall provide optional hardware to allow the camera to be surface mounted, wall mounted, interior corner mounted, or pendant pipe mounted. The camera shall be designed to be mounted to a standard 4S electrical box or a suspended ceiling.
12. The product specified shall be tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules.

C. Color Dome Camera Components

1. The specified product shall consist of the following components:
 - a. A camera module and mounting base
 - b. An inner liner to disguise the viewing position of the lens
 - c. A clear polycarbonate dome bubble
 - d. A trim ring

D. Electrical Specifications:

1. Voltage range: 10.8 to 39 VDC or 12 to 28 VAC, 45-65Hz.
2. Power: 4 watts
3. Composite Video Output: 1.0 Vp-p, 75 ohms.
4. Sync: Line lock with phase adjust (0-358 degrees) or Internal crystal.

5. Sync format: NTSC (60Hz) or PAL (50Hz) as required by the application and the model selected.
 6. Horizontal Resolution: 540 TVL.
 7. Imager: 1/3-inch, interline transfer CCD
 8. Signal to noise ratio: >50 dB.
 9. Backlight compensation: Center window weighting, On/Off selectable.
- E. Mechanical Specifications:
1. Weight: 440 g (1.1 lb)
 2. Connectors: Video Out- BNC on flying leads. Power- flying leads.
 3. Viewing adjustment: pan 360°: tilt 90°: azimuth (rotation) ±90°
- F. Environmental Specifications:
1. Temperature:
 - a. Operating: -10°C to +45°C (+14°F to +113°F)
 - b. Storage: -40°C to +70°C (-40°F to +158°F)
 2. Humidity: 5% to 93% relative, non-condensing.
- G. Product Regulatory Compliance
1. A. EMC Requirements:
 - a. Immunity: CE (EN50130-4)
 - b. Emission: CE (EN50022 class B), FCC class B part 15
 2. Product Electrical Safety: UL1950, CSA 22.2 No. 950 and CE

2.03 OUTDOOR CEILING MOUNTED FIXED COLOR CCD CAMERAS

- A. Ceiling mounted prepackaged cameras shall be The product specified shall be the Model VDC-455V Series as manufactured by Bosch Security Systems, Lancaster, PA or approved equal.
- B. The product specified shall be a vandal/tamper resistant, 540 TVL resolution color dome camera designed for outdoor applications using a 1/3-inch format CCD imager. The unit is prepackaged in a cast aluminum housing with a heater, a polycarbonate dome bubble, and a hardened inner liner capable of withstanding the equivalent of 120 lbs of force. The dome bubble is supplied with a UV blocking anti-scratch coating. The camera comes complete with one of the following automatic iris, integral, varifocal lenses, as required by the application, to allow manual zoom and focus adjustment:
1. 2.6 to 6 mm, F1.4, varifocal lens
 2. 3.7 to 12 mm, F1.6, varifocal lens

- C. B. The specified camera, when using the 2.6 to 6 mm, F1.4 lens, shall be sensitive enough to produce a usable picture (50 IRE) with 0.98 lx (0.091 fc) of scene illumination. A full video picture (100 IRE) shall be produced with 3.9 lx (0.36 fc) of scene illumination. When in the monochrome mode (Bosch NightSense feature), a usable picture (50 IRE) will be produced with 0.39 lx (0.036 fc) of scene illumination and a full video picture (100 IRE) will be produced with 1.6 lx (0.15 fc) scene illumination.
- D. The specified camera, when using the 3.7 to 12 mm, F1.6 lens, shall be sensitive enough to produce a usable picture (50 IRE) with 1.3 lx (0.12 fc) of scene illumination. A full video picture (100 IRE) shall be produced with 5.1 lx (0.48 fc) of scene illumination. When in the monochrome mode (NightSense feature), a usable picture (50 IRE) will be produced with 0.5 lx (0.48 fc) of scene illumination and a full video picture (100 IRE) will be produced with 2.0 lx (0.19 fc) of scene illumination.
- E. The camera module setups and adjustments shall be made using an on-screen display in conjunction with push button keys. In addition, the dome camera specified shall be equipped with a coaxial communications transceiver that incorporates a technology [Bosch Bilinx] to allow camera setup via the coaxial cable using bi-directional communication. The manufacturer shall offer optional configuration software [Bosch VP-CFGSFT] that operates in conjunction with the bi-directional communication technology for adjustment of the camera from the head-end side of the coaxial cable.
- F. The camera module positioning shall be adjustable along three (3) axes to allow a viewing adjustment range of 360° pan, 90° tilt, and ±90° azimuth.
- G. The manufacturer of the specified dome camera shall provide an adjustment cap for the lens to be used during setup to ensure that the image sharpness (focus) and the field of view remain the same when the setup is complete and the dome bubble is installed.
- H. The specified camera shall be equipped with a heater and be capable of operating in the temperature range of -50°C to 50°C (-58°F to 122°F).
- I. The manufacturer shall offer models of the camera for use in NTSC (60Hz) or PAL (50Hz) CCTV systems. The cameras shall operate within the voltage range of 10.8 to 39 VDC or 12 to 28 VAC, 45-65Hz and require no more than 6 watts of power to operate.
- J. The camera shall have line-lock capability when powered by AC to synchronize the camera to the power line zero crossing for roll-free vertical interval switching. For vertical synchronization in multiphase power installations, the camera shall provide 0 to 358° of continuously adjustable vertical phase delay. Crystal-lock shall be selected when DC voltage is supplied or the line-lock function is switched off.
- K. The manufacturer of the specified color dome camera shall provide optional hardware to allow the camera to be surface mounted, wall mounted, pendant pipe mounted, and internal corner mounted. The camera shall be designed to mount to a standard 4S electrical box and a suspended ceiling.
- L. A UTP (unshielded twisted pair) adapter, that allows a balanced video signal to be transmitted over UTP video cable, shall be available as an optional accessory from the manufacturer to allow a UTP video cable to be connected to the standard BNC connector.

- M. The product specified shall be tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules.
- N. Color Dome Camera Components
 - 1. The specified product shall consist of the following components:
 - a. A camera module and mounting base
 - b. An inner liner to disguise the viewing position of the lens
 - c. A clear polycarbonate dome bubble
 - d. An aluminum trim ring
- O. Electrical Specifications:
 - 1. Voltage range: 10.8 to 39 VDC or 12 to 28 VAC, 45-65Hz.
 - 2. Power: 6 watts with heater operation.
 - 3. Composite Video Output: 1.0 Vp-p, 75 ohms.
 - 4. Sync: Line lock with phase adjust (0-358 degrees) or Internal crystal.
 - 5. Sync format: NTSC (60Hz) or PAL (50Hz) as required by the application and the model selected.
 - 6. Resolution: Horizontal: 540 TVL.
 - 7. Imager: 1/3-inch, interline transfer CCD
 - 8. Signal to noise ratio: >50 dB.
 - 9. Backlight compensation: Center window weighting, On/Off selectable.
- P. Mechanical Specifications
 - 1. Weight: 740 g (1.63 lb)
 - 2. Connectors: Video Out- BNC on flying leads. Power- flying leads.
 - 3. Viewing adjustment: pan 360°: tilt 90°: azimuth (rotation) ±90°
- Q. Environmental Specifications:
 - 1. Temperature:
 - a. Operating: -50°C to 50°C (-58°F to 122°F)
 - b. Storage: -40°C to +70°C (-40°F to +158°F)
 - 2. Humidity: 5% to 93% relative, non-condensing.
- R. Product Regulatory Compliance
 - 1. EMC Requirements:
 - a. Immunity: CE (EN50130-4)
 - b. Emission: CE (EN50022 class B), FCC class B part 15
 - 2. Product Electrical Safety: UL1950, CSA 22.2 No. 950 and CE (EN60950).

3. Water/dust protection: IP66 (NEMA-4X) rated.
4. Impact Protection: IEC 60068-2-75 test Eh, 50J; EN50102, exceeding IK10.

2.04 EXTERIOR FIXED AUTODOME CAMERA

- A. The product specified shall be the AutoDome Fixed Color Modular Camera System 100 Series as manufactured by Bosch security Systems, Lancaster, PA or approved equal.
- B. The camera dome will be a rugged, vandal resistant surveillance camera system that allows upgrades by means of interchangeable CPU, communication, and hot-swap camera modules with built-in surge protection. The camera housing will be available in in-ceiling, or indoor/outdoor pendant versions, as the application requires.
- C. The dome bubble will meet stringent strength requirements able to exceed the UL 1598 horizontal impact standard for lighting fixtures. The bubble will be made of 2.6mm thick polycarbonate and be able to withstand a 100 foot-pound impact or the equivalent of a 10 lb. sledgehammer dropped from a height of 10 feet. The dome bubble will be available in clear or tinted versions, as the application requires.
- D. The camera dome will be available in wall mount, roof (parapet) mount, mast (pole) mount, corner mount, pipe mount, and in-ceiling versions, as the application requires.
- E. The pendant camera system will be a NEMA 4X or IP66 certified, rugged, weather-resistant package.
- F. The camera system will ensure that any advanced commands required to program the dome are accessed via three levels of password protection ranging from low to high.
- G. H. Fine tuning or special settings of the camera setup will be accomplished by using a simple on screen display (OSD) menu tree operated by control buttons on the side of the camera. The camera will provide a seventeen (17) character camera ID.
- H. The camera system on-screen display menus will support English, French, German, Spanish, Portuguese, Polish, Italian, and Dutch.
- I. The camera dome will be Bosch Bilinx™ compatible where remote configuration, and camera firmware updates can be done over the video signal of the coaxial cable. Bilinx operation can also be functional via other modes of video transmission including fiber optic and passive UTP.
- J. The camera system will be designed so that an optional hybrid analogue/IP communication module will be available to simultaneously stream IP video across a local or wide area network, and analogue video via coaxial cabling to support existing analogue equipment.
- K. An optional integral fiber optic transceiver module will also be available that will be capable of transmitting and receiving video and Biphase signals up to 2.5 miles (4 km). The fiber optic module will be compatible with 50/125 mm, 62.5/125 mm, low-loss multimode glass fiber, rated for minimum system bandwidth of 20 MHz (video 850nm/data 1300nm).
- L. The camera system will be compatible with Bosch Allegiant series switcher/controller, Divar and DiBos digital video recorders, and Bosch IP network video solutions like the VIDOS video management system, and Bosch Video Management System (BVMS).

M. The camera will incorporate the following features:

1. XF-Dynamic technology to extend the dynamic light range of the camera by 90db, and automatically processes the digital signal produced by the 15-bit digital signal process (DSP) technology to optimally, and simultaneously, capture the picture detail in both the highlight and lowlight areas to maximize the information visible in the picture.
2. NightSense1 which automatically activates under low-light conditions to boost sensitivity by 9db (a factor of 3) during monochrome operation. The NightSense feature can be switched on manually through a camera menu selection, or by using Bilinx coaxial control interface. The camera can also be forced from the color mode to monochrome mode.
3. Day/Night2 mode to enhance night viewing by increasing the IR sensitivity. An internal IR filter will switch from color to monochrome mode automatically by sensing the illumination level. An internal through-the-lens IR detector will enhance the monochrome mode stability by preventing the camera from reverting to color mode when IR illumination is dominant.
4. SensUp to enhance sensitivity by increasing the integration time on the CCD by a factor of 10.
5. Back Light Compensation (BLC) to selectively amplify an area of interest in the image to compensate for large contrast differences when only a portion of the image is brightly lit.
6. Auto Black to enhance contrast by compensating for reduced contrast due to fog, mist, or glare.
7. Default Shutter to eliminate motion blur caused by fast-moving objects by automatically adjusting the lens opening at fast shutter speeds.

N. Specifications

AutoDome	100 Series
Interchangeable CPU, Camera and Communication Modules	Yes
Cameras	Color, Day/Night
Lenses	2.7 mm to 13.5 mm, f/1.2 5 mm to 50 mm, f/1.4
Operating Temperature Indoor Housing	14°F to 122°F (-10°C to 50°C)

AutoDome	100 Series
Outdoor Housing	-76°F to 122° (-60°C to 50°C)
Up the Video Control/Configuration	Yes, Bilinx
Warranty	3 years

O. CPU MODULE

1. The CPU module will be interchangeable with any AutoDome Modular Camera System.

P. FIXED CAMERA MODULES

1. The following fixed Camera Modules will be available for the 100 Series Modular Camera System.
2. 5 mm–50 mm DAY/NIGHT CAMERA MODULE
 - a. The camera will be a high performance, 1/3-inch digital CCD color camera capable of producing resolution of 540 horizontal TV lines. The camera design will be based on a 15-bit DSP image processing technology to provide excellent sensitivity and extended dynamic range coverage without artifacts. The camera will be available in NTSC (60 Hz) and PAL (50 Hz) versions, as required by the application.
 - b. The day/night camera will feature Day/Night mode to enhance night viewing by increasing the IR sensitivity. An internal IR filter will switch from color to monochrome mode automatically by sensing the illumination level. The IR filter can be switched manually through a camera menu selection, or by using Bilinx coaxial control interface. An internal through-the-lens IR detector will enhance the monochrome mode stability by preventing the camera from reverting to color mode when IR illumination is dominant.
 - c. The camera module will be hot swappable with any AutoDome Modular Camera System.
 - d. SPECIFICATIONS
 - 1) Imager: 1/3 in. Interline CCD
 - 2) Resolution Horizontal: 540 TVL (NTSC)/540 TVL (PAL)
 - 3) Iris: Automatic
 - 4) Field of View 47.5° to 5°
 - 5) Optical Zoom: 5X
 - 6) Digital Zoom: No
 - 7) Video Output: 1.0Vp-p, 75 ohms

- 8) Gain Control: Off/Auto (with adjustable limit) manual
- 9) Synchronization: Line-lock (0° to 358° vertical phase adjust) or internal crystal
- 10) Aperture Correction: Horizontal and vertical
- 11) Sensitivity: F1.4, 1/60 (1/50) shutter, max AGC
- 12) Color Mode (30 IRE)
- 13) SensUp Off 0.42 lux
- 14) SensUp On 0.042 lux
- 15) Night Mode (30 IRE)
- 16) SensUp Off 0.17 lux
- 17) SensUp On 0.017 lux
- 18) Signal to Noise Ratio: Greater than 50 dB
- 19) White Balance: 2500 K to 9000 K (with AWB hold mode and manual mode)

3. **COMMUNICATION MODULES**

- a. Fiber Optic communication modules will be utilized.
- b. The communication module will also accept Bosch Bilinx™ code where remote configuration, and camera firmware updates can be accomplished via over-the-coax operation. Bilinx operation may also be functional by other modes of video transmission including fiber optic and passive UTP.
- c. An integral Fiber Optic transceiver module able to transmit and receive video and Biphase signals up to 2.5 miles (4 km) will be utilized. The fiber optic module will be compatible with 50/125 mm, 62.5/125 mm, low loss multimode glass fiber, rated for minimum system bandwidth of 20 MHz (video 850nm/data 1300 nm).

4. **HOUSINGS**

- a. Outdoor Pendant housings will be utilized.
- b. All housings will come standard with a rugged impact-resistant polycarbonate bubble, recessed setscrews, and a recessed bubble latch to reduce the chance of damage from vandalism. The housing bubble can be order clear or tinted.
- c. All housings will provide built-in surge protection for power, data, and video and alarm inputs.
- d. The pendant camera system will be a NEMA 4X or IP66 certified, rugged, weather-resistant package.
- e. Outdoor Pendant Housing will be made of cast aluminum for corrosion resistance, and supplied with a built-in heater/blower to provide an operating temperature range down to -40° C to 50° C (-40° F to 122°).

An optional "XT" temperature kit will be available to extend the operational range down to -55° C (-67° F).

- f. The Pendant Housing will use a hinge, in-place of a tether, to make installation easier and safer.
- g. The Pendant Housing will allow the camera to view 18° above the horizon.

5. ELECTRICAL SPECIFICATIONS

- a. Main supply input voltage, as required by the application:
- b. NTSC: 115VAC, 60Hz
- c. NTSC: 24VAC, 60Hz (customer supplied 24VAC, 50 VA power transformer)
- d. PAL: 230VAC, 50Hz
- e. PAL: 24VAC, 50Hz (customer supplied 24VAC, 50 VA power transformer)
- f. Camera input voltage/power requirements: 21 – 30 VAC, 50/60 VA
- g. Heater input voltage/power requirements: 21 – 30 VAC, 50/60 VA
- h. Power Draw (Typical):

<u>Analogue Models</u>	<u>Outdoor</u>
100 Series	43.5 W

- i. Surge Suppression (Protection)

Video	Peak current 10kA (Gas Tube Arrester), peak power 1000 W (10/1000µs)
Power Input (Dome)	Peak current 7.3 A, peak power 600 W (10/1000µs)
Power Output (Arm Power Supply)	Peak current 21.4 A, peak power 1500 W (10/1000µs)

6. MECHANICAL SPECIFICATIONS

Model	Outdoor Pendant
Weight	3.32 kg (7.3 lb)
Pan Range	360° continuous
Tilt Angle	18° above horizon
Power	21 – 30 VAC 50/60 Hz

7. ENVIRONMENTAL SPECIFICATIONS

Model	Outdoor Pendant
Operating Temperature	-40°C to 50°C (40° to 122° C)
Storage Temperature	-40°C to 50°C (40° to 122° C)
Humidity	0% to 90% relative non-condensing
Enclosure ratings	IP66/NEMA 4X

8. Electromagnetic Compatibility (EMC) Complies with FCC Part 15, ICES-003 and CE regulations.
- FCC 47CFR Part 15
 - ANSI C63.4
 - AS/NZS 3548
 - EN 55022
 - EN 61000-3-2 & EN 61000-3-3
 - EN 50130-4 Alarm Standard (CCTV for Security Application)
 - EN 55024 Information Technology Equipment (ITE) Standard
9. Product Safety
- a. Complies with CE regulations, UL, CSA, EN and IEC Standards.
- IEC/UL/CSA 60950
 - cULus and CE Marks.
 - IECEE CB Scheme/CB Test Certificate
10. Environmental Ratings
- IEC 60529 Degrees of protection provided by enclosures (IP Code)
 - IP66 for Pendant and Power Supplies
 - UL 50 Type 4X (NEMA 4X) Enclosures for Electrical Equipment
 - Pendant for outdoor application

2.05 EXTERIOR PAN TILT ZOOM AUTODOME CAMERA

- A. The product specified shall be the Autodome PTX Color Module Camera 300 Series System Day/night Version with 18x zoom lens as manufactured by Bosch security Systems, Lancaster, PA or approved equal.
- B. GENERAL REQUIREMENTS
1. The camera dome will be a rugged, vandal resistant surveillance camera system that allows upgrades by means of interchangeable CPU, communication, and hot-swap camera modules with built-in surge protection. The camera housing will be available in in-ceiling or indoor/outdoor pendant versions, as the application requires.
 2. The dome bubble will meet stringent strength requirements able to exceed the UL 1598 horizontal impact standard for lighting fixtures. The bubble will be made of 2.6mm thick polycarbonate and be able to withstand a 100 foot-pound impact or the equivalent of a 10 lb sledgehammer dropped from a height of 10 feet. The dome bubble will be available in clear or tinted versions, as the application requires.
 3. The camera dome will be available in wall mount, roof (parapet) mount, mast (pole) mount, corner mount, pipe mount, and in-ceiling versions, as the application requires.
 4. The pendant camera system will be a NEMA 4X or IP66 certified, rugged, weather-resistant package.
 5. The camera system will provide a Fast Address method to allow the camera address number used for control to be remotely programmed from the system keyboard.
 6. The camera system will ensure that any advanced commands required to program the dome are accessed via three levels of password protection ranging from low to high.
 7. The camera system will provide a feature that automatically rotates, or pivots, the camera to simplify tracking of a person walking directly under the camera.
 8. The camera system will provide advanced troubleshooting and diagnostics via diagnostic LEDs and on-screen diagnostic displays.
 9. The camera system on-screen display menus will support English, French, German, Spanish, Portuguese, Polish, Italian, and Dutch.
 10. All camera domes will accept Bosch Biphase, RS232 and 485, Pelco "P" and Pelco "D" control protocols.
 11. The camera dome will be Bosch Bilinx™ compatible where remote control, configuration, and camera firmware updates can be accomplished via over-the-coax operation. Bilinx operation can also be functional via other modes of video transmission including fiber optic and passive UTP.
 12. The camera system will be designed so that an optional hybrid analogue/IP communication module will be available to simultaneously stream IP video across a local or wide area network, and analogue video via coaxial cabling to support existing analogue equipment.

13. An optional integral fiber optic transceiver module will also be available that will be capable of transmitting and receiving video and Biphase signals up to 2.5 miles (4 km). The fiber optic module will be compatible with 50/125 mm, 62.5/125 mm, low-loss multimode glass fiber, rated for minimum system bandwidth of 20 MHz (video 850nm/data 1300nm).
14. The AutoDome Modular Camera System is compatible with Bosch Allegiant series switcher/controller, Divar and DiBos digital video recorders, the LTC 5136 AutoDome Controller, and Bosch IP network video solutions like the VIDOS video management system, and Bosch Video Management System (BVMS).
15. SPECIFICATIONS

AutoDome	300 Series
Interchangeable CPU, Camera and Communication Modules	Yes
Operating Temperature	
Indoor Housing	-10°C to 50°C (14°F to 122°F)
Outdoor Housing	-40°C to 50°C (-40°F to 122°F)
Protocol Support	Bosch Biphase, RS232/485, Pelco P or D
Up the Video Control/Configuration	Yes, Bilinx
Privacy Masking/Sector Blanking	Yes
Pre-positions	99
Guard Tour	2 Preset Tours, 2 Recorded Tours
Remote Fast Address	Yes
AutoPivot and AutoScaling	Yes
Cable Compensation	Yes
Alarm Inputs/Relay Outputs	7/4
Warranty	3 years

C. CPU MODULES

1. 300 Series CPU Module. The 300 Series CPU module will have the following features:
 - a. The CPU module will provide fast 360° per second camera pan/tilt speeds; advanced troubleshooting and diagnostics via diagnostic LEDs and on-screen displays; and built in surge protection. The camera's 360° rotation will be divided into 16 independent sectors with 16-character titles per sector. Any or all of the 16 sectors can be blanked from the operator's view.
 - b. In addition to the blanking function, the CPU will provide 24 masks with up to 8 masks per scene that prohibit areas of the field of view from being seen even if the camera is panned, tilted, or zoomed. The masks can be shaped using three (3), four (4) or five (5) anchor points to form different shapes to best fit the area to be masked. Mask selections will be black, white or blurred.
 - c. In addition to the preset tour function, the CPU will allow the recording of two (2) separate tours of an operator's keyboard movements consisting of tilt and zoom activities, for a total combined duration time of 15 minutes. The recorded tours can be continuously played back.
 - d. The CPU will store up to 99 preset scenes with each preset programmable for 16 character titles. Two (2) separate preset tours will be available to display consecutively the preset scenes for a programmed dwell time. Any or all of the presets can be included or excluded from the tour.
 - e. The CPU will provide advanced alarm handling to manage up to seven (7) alarm inputs and four (4) alarm outputs by means of a programmable "Rules" engine. Any or all of the input contacts can be programmed upon activation to automatically move the camera to any preposition location, close an output relay for a programmed period of time, and display an alarm indication on the on-screen display of the monitor.
 - f. When an operator stops manual control of the camera, and a programmed period of time is allowed to expire, the camera will execute one of the following programmable options: 1) return to a preset number, 2) return to the automated tour previously executed, 3) do nothing.
 - g. The CPU will provide an AutoPivot feature to automatically rotate and flip the camera as it tilts through the vertical position to maintain the correct orientation of the image.
 - h. The CPU will provide an AutoScaling feature that will reduce the pan/tilt speed as the camera zooms in on an object, so that the relative speed on the screen remains constant.
 - i. The CPU module will be interchangeable with any AutoDome Modular Camera System.

D. PTZ CAMERA MODULES

The following Camera Modules will be available for the 300 Series Modular Camera Systems.

E. 18X DAY/NIGHT, 12X DIGITAL, PTZ CAMERA MODULE

1. The camera module consists of an integrated high resolution Exview HAD CCD camera using a 1/4-inch imager and an 18X (4.1 – 73.8 mm) F1.4 to F3.0 auto-iris, auto-focus optical zoom lens. It will have a variable high speed, 360° pan/tilt drive with a top speed of 120° per second.
2. The camera module is designed to perform over a wide range of environmental and lighting conditions with a horizontal resolution of 470 TVL (NTSC/PAL) typical and sensitivity down to 0.0041 lux in color mode, and 0.0007 lux in night mode.
3. The camera will automatically switch from daylight color operation to a higher sensitivity nighttime monochrome mode when light levels fall below an adjustable threshold level. Day/night operation can also be manually switched on or off from the system switcher/controller keyboard.
4. A full 12X digital zoom is functional once the maximum 18X optical zoom limit has been reached. The 12X digital zoom lens is on/off selectable from the system controller keyboard.
5. The camera will have a Freeze Frame feature that holds a preposition shot while moving to another preposition.
6. The camera module will be hot swappable with any AutoDome Modular Camera System.
7. **SPECIFICATIONS**
 - Horizontal Resolution: 470 TVL (NTSC/PAL) typical
 - Sensitivity:
 - Color Mode (30 IRE) F1.4, 1/60 (1/50) shutter, max AGC
 - SensUp Off.....0.4 lux
 - SensUp On 0.0041 lux
 - Night Mode (30 IRE) F1.4, 1/60 (1/50) shutter, max AGC
 - SensUp Off.....0.05 lux
 - SensUp On 0.0007 lux
 - Day/Night:..... Yes
 - Lens: 4.1 mm to 73.8 mm (F1.4 to F3.0)
 - Optical Zoom: 18X
 - Digital Zoom: 12X
 - Video Output:.....1.0Vp-p ± 0.1Vp-p, 75 ohms
 - Synchronization: Line-lock (-120° to 120° vertical phase
.....adjust) or internal crystal
 - Signal to Noise Ratio: Greater than 50 dB
 - White Balance: 2000 K to 10,000 K
 - Pan/Tilt Speed 0.1°/s to 120°/s

2.06 CCTV MONITORS

- A. Operational Characteristics: Provide monitors of the size and quantity as specified on the Contract Drawings. Video monitors shall be designed for continuous operation and shall incorporate printed circuit modular construction. Monitors shall have a minimum resolution of 450 horizontal lines.
- B. Additional Characteristics:
 - 1. The design of the monitor shall provide for easy replacement of the printed circuit modules and the electronic circuits shall use all solid-state devices .
 - 2. Each monitor shall be constructed to provide rigid support for its electrical systems so that unintentional changes in alignment will not occur during operation or movement.
 - 3. Circuit design shall incorporate safety margins of not less than 25 percent where possible, with respect to power dissipation ratings, voltage ratings, and current carrying capacity.
 - 4. Provide adequate safeguards to protect personnel from exposure to high voltage during operation and/or adjustment.
 - 5. Controls shall include a monitor power switch, sharpness control, horizontal hold, vertical hold, height, contrast, brightness, and width.
 - 6. The monitor's Liquid Crystal Display (LCD) and other devices subject to burn out or short operating life shall be mounted to facilitate easy replacement. The printed circuit boards shall be labeled as to their function and shall have component numbers and/or markings.
 - 7. To maintain a standard quality and reliability, all components shall be de-rated to operate at a maximum of 80% efficiency.
 - 8. Monitors shall be capable of being mounted as either a desktop or rack mount unit in the space provided at each of the monitoring stations.
 - 9. The monitors shall be protected from circuit overloads by fuse or fuses in the power source line. Power source line fuses shall be mounted in finger operated fuse posts. Fuse holders shall be located in a readily accessible position.
 - 10. Monitor Video Signal and Power Input: Monitors shall operate with a video input requiring a 1.0 volt peak-to-peak nominal composite video signal switchable to either loop-through or internal 75 ohm terminating impedance. Signal input shall be interconnected into the monitors through BNC-type connectors.
 - 11. Operation:
 - a. The monitors shall accept NTSC color standard.
 - b. During brightness and/or contrast adjustments, within reasonable limits, the picture focus or size shall not change and there shall be no blooming. Adjustment of the vertical and/or horizontal synchronization controls, within the hold-in range, shall have minimal effect on picture linearity or size.

2.07 MICROPROCESSOR-BASED MATRIX SWITCHING

- A. The video switcher/controller shall be a microprocessor-controlled matrix switching system designed for closed circuit television applications. The video matrix switching system shall be capable of switching as many as 32 video inputs to any of 16 video outputs. The system shall also provide remote camera control of functions such as, but not limited to pan, tilt, zoom, focus and iris control, and also provide 4 independent auxiliary relays for operator control.
- B. This matrix switching system shall accept up to 32 separate alarm contact points.
- C. The system shall provide manual or alarm activated remote camera call up, multiple pre-position set points, auto pan and random scan.
- D. The system shall be capable of identifying cameras with a 16 character alphanumeric title on the display monitor.

2.08 CCTV SWITCHER CONTROLLER

- A. The switcher controller shall be a rack-mountable keyboard style interface to the matrix switcher that shall minimally include hexadecimal style keypads for the assignment of cameras to monitors, push-button controls for camera environmental functions, and a joystick controller for pan/tilt/zoom functions.

2.09 COAXIAL CABLE

- A. Coaxial video cables shall have a copper center conductor and a copper shield providing a minimum 95 percent coverage.
- B. Nominal DC resistance shall not exceed 12 ohms/1,000 feet for 59U-type cables, 8 ohms/1,000 feet for 6/U-type cables, and 4 ohms/1,000 feet for 11/U-type cables.
- C. Nominal impedance shall be 75 ohms.
- D. Interior cable runs shall not exceed 750 feet for 59/U-type cables, 1,250 feet for 6/U-type cables, and 3,000 feet for 11/U-type cables.

2.10 FIBER OPTIC SIGNAL TRANSMISSION SYSTEM

- A. FIBER OPTIC TRANSMITTER/RECEIVERS
 - 1. All video signals transmitted on cables that exit the interior of the buildings shall utilize fiber optic transmitter, receivers and cabling.

2. Video Transmitter/Data Receiver: Unit shall be capable of transmitting video and receiving RS-422 data for pan/tilt/zoom control over fiber optic cable at the remote camera locations. Unit shall have the following features:

a.	Video Bandwidth:	5 Hz - 10 MHZ
b.	Differential Gain:	<5%
c.	Signal-Noise:	60dB
d.	Video Input:	1V p-p
e.	Wavelength:	850nm
f.	Loss Budget:	14 dB
g.	Data Compatibility:	RS-232, RS-422, TTL & Manchester
h.	Data Rate:	DC-100Kbaud
i.	Operating Temp:	-20 deg C to 70 deg C
j.	Power:	24 VAC @ 5W

3. Video Receiver/Data Transmitter: Unit shall be capable of receiving video and transmitting RS-422 data for pan/tilt/zoom control over fiber optic cable at the switcher location. Unit shall be card cage rack mounted and have the following features:

a.	Video Bandwidth:	5 Hz - 10 MHZ
b.	Differential Gain:	<5%
c.	Signal-Noise:	60dB
d.	Video Output:	1V p-p with AGC
e.	Wavelength:	850nm
f.	Loss Budget:	14 dB
g.	Data Compatibility:	RS-232, RS-422, TTL, Manchester
h.	Data Rate:	DC-100Kbaud
i.	Operating Temp:	-20 deg C to 70 deg C
j.	Power:	24 VAC @ 5W

B. FIBER OPTIC CABLE:

1. The fiber optic cable shall consist of color code multimode graded index fibers contained in gel filled loose buffer tubes. Each color-coded buffer tube shall be filled with a gel to prevent moisture penetration. All other areas around the buffer tubes and cable core components shall be filled with water-blocking compounds for added moisture blocking protection. A glass-reinforced plastic (GRP or epoxy matrix rod) shall be used for central strength member. High tensile yarns shall be utilized over the cable core for additional tensile strength. A medium density polyethylene outer jacket shall be applied overall.
2. The fiber optic cable shall conform to the following specifications as a minimum:
 - a. 62.5/125 microns: Loose tube dielectric cable
 - b. Fiber Type: Multimode, Graded Index
 - c. Core Diameter: 62.5 ± 3.0 microns
 - d. Cladding Diameter: 125 ± 2.0 microns
 - e. Buffer Coating Diameter: 250 ± 15 microns

- f. Operating Wavelengths: 850 nm and 1300 nm
 - g. Maximum Attenuation @ 850 nm: 3.75 dB/km
 - h. Maximum Attenuation @ 1300 nm: 1.75 dB/km
 - i. Minimum Bandwidth @ 850 nm: 160 MHZ km
 - j. Minimum Bandwidth @ 1300 nm: 500 MHZ km
 - k. Numerical Aperture: 0.275
 - l. Proof Test: 344 MPa (megapascals)
 - m. Tensile Strength During Installation: 2700N (newtons)
Long Term: 500N
 - n. Crush Resistance: armored 440N/cm (newtons per centimeter), non-armored 220N/cm
 - o. Operating Temperature: -40°C to +65°C
 - p. Storage Temperature: -50°C to +70°C
 - q. Installation Temperature: -30°C to +60°C
 - r. Minimum Bend Radius During Installation: 20 X Cable O.D. Long Term: 10 X Cable O.D.
- 3. Cable shall be as manufactured by the Pirelli Communications Division or approved equal.
 - 4. Alternative Fiber Optical Cable Technology. As an alternate to the fiber optic cable specification describe in paragraph 2.14.B above, the following manufacturer/model is approved for use in this project: Optical Cable Corporation, Roanoke, VA Model D-Series (OFNR and OFNP) Distribution Fiber Optic Cable.

C. Connectors shall be "ST" type as manufactured by AT&T or approved equal.

2.11 DIGITAL MULTIPLEXER RECORDERS

- A. This section includes the requirements and operational characteristics for a Digital Video Recording System, which is an integral part of the Security Automation System. Digital Video Recording systems included are:
 - 1. Video Acquisition Unit (VAU) equipment.
 - 2. Video Storage equipment.
 - 3. System Database.
 - 4. Client Computer(s).
- B. Provide all labor, equipment, materials, and supervision to install, program, calibrate, adjust, document, and test the total system as required herein and on the drawings.
- C. System Description
 - 1. Provide a Digital Video Recording System to allow:
 - a. Digital video recording of all the cameras in the CCTV system
 - b. Configuration, viewing of recorded images, and ability to record incidents to CD-R discs.

- D. **System Features and Software Requirements**
The DVR System shall have the following system features and software requirements to allow for seamless control and future flexibility.
- E. The DVR system shall allow for the recording, live viewing, archiving, and playback of recorded video and audio for digital CCTV applications. The DVR system shall perform all viewing, playback, and video storage functions simultaneously. The DVR system shall consist of one of more 16-channel recorders. The DVRs shall consist of rack-mountable boxes equipped with one or more XMUX2 multiplexers or internal video inputs. All systems shall also include up to four analog outputs. Video shall be displayed on a standard monitor, and configuration shall be performed with a standard mouse and keyboard. The DVR system shall be capable of recording video continuously, only during alarm events, or only while activity is present. Each camera shall be capable of recording in different modes and on different schedules, or all cameras shall be able to be configured identically. The DVR system shall allow easy search and retrieval of video using a graphical, color-coded interface. User-defined parameters shall allow searches based on the time and date the video was captured, whether alarm or motion events occurred, and the camera that captured the video. The DVR system shall also permit full video storage management, hardware control, alarm configuration, and export of video and individual images. The DVR client software shall allow for the viewing of live or recorded video and audio over a standard network connection.
- F. The DVR system shall be initially configured by the integrator, and coordinated with the owner, to configure system parameters according to the operation of the facility, taking the needs of all cameras (down to an individual basis) into consideration.
- G. The DVR(s) at the CCTV system head-end shall be able to be configured locally through the use of a rack-mounted keyboard/mouse/monitor.
- H. The owner shall have the option of attaching to the DVR network with their administration network without jeopardizing the security of the Security Management Network. Client software shall be made available to the owner for installation on owner-provided computers (which must meet minimum specifications as described herein).
- I. Client software shall be installed on client computers as directed by the Owner.
- J. **Equipment and Materials**
1. The basis for the specification is the Integral Technologies DS XPress Digital Video Management System. The following manufacturers are also acceptable provided compliance with all technical and specification requirements as specified herein. Exceptions to the technical specifications will not be accepted.
 - a. Pelco DX8000 series
- K. **Video Acquisition**
2. General: DS Express shall capture, digitize, compress, and store video onto an internal hard drive or external storage device. The recording software runs as a service on a Windows XPe with a static IP address.

3. **Analog Camera Inputs:** Cameras shall be connected to DS XPress via standard BNC connectors internally or on XMUX2, a 1U EIA 19-inch-wide rack-mountable box that terminates the video inputs and time-base corrects the video signals for the compression channel. DS XPress shall accommodate up to 4 XMUX2 units per computer platform; therefore, each system can accommodate as few as 16 inputs and as many as 128 inputs.
4. **Analog Frame Rates with XMUX2 (frame rates for 1CIF resolution only):** Each DS XPress system shall be capable of being configured with one XMUX2 recording 120 images per second NTSC (100 ips PAL), up to four XMUX2 units recording 480 ips (400 ips PAL). The actual storage rate of each analog camera shall be adjustable; the total storage rate for all cameras on a single XMUX2 unit cannot exceed 120 fps.
5. **Analog Frame Rates with Internal Inputs:** Each DS XPress system shall be configured with 16 or 32 internal inputs and up to four compression boards that capture 120 images per second NTSC (100 ips PAL). The actual storage rate of each camera shall be adjustable; the total storage rate for all cameras on a single compression board cannot exceed 120 ips.
6. **Variable Frame Rates:** The system shall allow the user to assign image capture rates on a camera-by-camera basis. A single XMUX2 unit can capture 120 images per second.
7. **Increased Image Capture Rate on Alarm:** The system shall be capable of automatically increasing the number of images captured by certain cameras during alarm, while the non-alarm cameras continue to record at the standard rate.
8. **Selectable Image Resolution:** The system shall allow the user to assign image resolution settings on VAU-by-VAU basis. All VAU's shall be capable of providing the following resolutions: CIF resolution: 352x240 NTSC (352x288 PAL), 2CIF resolution: 704x240 NTSC (704x288 PAL), 4CIF (full-frame) resolution: 704x480 NTSC (704x596 PAL)
9. **Video Information:** DS XPress shall record information about the time, date, and source of all video for easy search and retrieval. Each image of video shall be stored with a checksum to allow video authentication.
10. **Variable Video Storage Duration:** Recorded video can be saved until all available storage media are filled, and then the oldest video is replaced by new video. Video can also be saved for user-defined durations based on whether the video recorded motion or alarm events.
11. **Motion Recording:** DS XPress shall be capable of being configured to record video only while activity is occurring in the camera's view. Users define DS XPress's level of motion sensitivity and configure DS XPress to ignore subtle changes in light level. Motion masks eliminate areas of the camera view where motion events should not trigger recording. This configuration shall be set on a camera-by-camera basis.
12. **Digital Alarm I/O:** Alarms are connected to a DS XPress system via a trigger block located on XMUX2 or the DS XPress system back panel. Each DS XPress system shall accept up to 16 alarms per XMUX2 or 16 inputs total for systems without XMUX2.

13. **Serial Alarm:** The two serial ports on the DS XPress system shall be capable of being used to accept alarm triggers from access control panels or point-of-sale devices.
14. **PTZ Cameras:** Certain cameras that support pan/tilt/zoom functions can be connected to the system through the serial ports. Up to 10 preset camera positions can be configured. Presets can be called automatically upon an alarm event, selected manually, or toured cyclically.
15. **Analog Outputs:** DS XPress shall contain a multiplex analog output that can display live video from up to 16 cameras simultaneously on an external monitor, along with up to three outputs that can display video from a single camera. One multiplex output exists on each XMUX2 or TX board installed in the DS XPress system. Video on the output includes an onscreen display of the camera name and the current date and time, along with an optional alarm or motion indicator. Video shall be selected for display manually or as part of a user-defined tour sequence. Cameras shall be capable of being displayed automatically if an alarm or motion event occurs. Cameras shall be displayed in default MultiView of 4 to 16 cameras, and different combinations of cameras shall be configured and saved as custom MultiViews. A user must be assigned the Analog Output User right to control the cameras displayed on the output.
16. **Audio Outputs and Inputs:** Four audio inputs and one audio output shall be available on the digital video management system.

L. Video Storage

1. **General:** DS XPress shall store video in segments on its internal hard drive or optional RAID drives. Up to four 250GB drives (1TB total) can be installed. The amount of storage required varies depending on disk size, image capture rate, compression rate, number of cameras connected, recording mode, and the amount of activity occurring in view of cameras. The system shall automatically replace the oldest video stored when the system storage capacity is reached.
2. **External Disk Storage:** DS XPress shall be capable of accommodating up to 4 disk arrays. Each disk array shall be configured in RAID 5 and can provide 750, 1250, 1750, 2500 or 3500 GB of hard drive space. Fully configured, DS XPress shall be capable of accessing 14TB of fast video storage. The drive arrays shall be fault-tolerant.
3. Provide four 250GB drives (1TB total).

M. **System Database:** The default database is Microsoft Database Engine (MSDE), a run-time version of Microsoft SQL Server 2000 Service Pack 3. The system database contains the following information:

1. Hardware configurations
2. Camera configurations
3. Pointers to video clips
4. User configuration data
5. Alarm configurations
6. Recording schedules

7. Video review and retrieval

N. Client Computer (to be provided)

1. General: A client computer is the user interface for viewing and configuring one or more DS XPress systems. Live and recorded video and current event video shall be displayed on any client computer using a proper login and password. DigitalSENTRY client software shall be installed on the client computer.
2. Provide one client computer with the following minimum specifications:
 - a. CPU: 2.8 GHz minimum
 - b. Memory: 512MB
 - c. Storage: 40GB Hard Drive
 - d. VGA Card: Must support resolution of 1024 x 768 true color
 - e. Video Memory: 64MB
 - f. O/S: Windows XP
 - g. 1.44MB 3.5" floppy diskette drive
 - h. 100 Mb base-T network adapter
 - i. 48x CD-RW Drive
 - j. Keyboard & mouse
 - k. Approved manufacturers: Dell, HP
3. Provide a 17" LCD Flat panel Monitor.
4. A laptop computer meeting the above minimum requirements may be substituted.

O. Accessories:

1. Provide one or more KVM switches sized for the number of digital video recorders in the system. Approved KVM switches: Tripp Lite B007-008 (8-port). Provide KVM Switch cable kits as required.
2. Provide 1U Rack Mount LCD monitor keyboard drawer with 15.1" TFT, keyboard and touch pad equal to Acnodes Model KD9151.

P. Quality Assurance

1. Quality Assurance shall be as described in Section 17900.
2. The integrator shall provide a block-switching table that incorporates all requirements of the intercom, video call up and alarming specified in all other sections of this division. The owner shall maintain the right to request modifications at any time during the warranty period at no charge.

PART 2 - EXECUTION

3.01 SEE SPECIFICATION SECTION 17900, PARAGRAPH 3.1

3.02 CABLING

- A. All wiring shall be installed in accordance with National and local codes and shall be installed in conduit where shown on the plans. The Electronic Security Subcontractor shall furnish and install all CCTV hardware and materials
- B. Hardwired Connections: Hardwired connections shall be made from the central control console to the cameras. Unless bundled as a multi-conductor cable, all controls and low voltage power wiring shall be minimum #18 AWG, installed in conduit, type as specified elsewhere in the specifications. Conductors shall be field soldered to the plug connectors furnished by the manufacturer as part of the camera and/or control equipment.

3.03 ELECTRICAL POWER

- A. Video equipment located in consoles and distribution areas shall be powered by 120 VAC via the uninterruptible power supply.

END OF SECTION

SECTION 17930

SECURITY INTERCOMMUNICATION SYSTEM

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The Request for Proposal and Instructions to Bidders form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY OF WORK

- A. Description of Work: The Electronic Systems Subcontractor's (ESS) work shall include all labor, equipment and services necessary to furnish, deliver and install the following items of electronic security equipment:

Door Stations
Master Stations
Central Exchange Units (CEU)
Power Supply
Other External Connections:
a. Access control system.
b. CCTV system.
c. CO line adaptor.
d. Video output.
e. PC.
Vehicle Loop Detector
Wire and Cable
Conduit

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Except as may be otherwise specified herein, the equipment and materials of this Section shall be products of the following manufacturers; or approved equal.

1. Aiphone Corporation, 1700 130th Avenue NE, Bellevue, Washington 98005. Toll Free (800) 692-0200. Phone (425) 455-0510. Fax (425) 455-0071. Website www.aiphone.com. E-mail info@aiphone.com.

2.2 SECURITY AND INTERCOMMUNICATIONS SYSTEM DESCRIPTION

- A. Capacities:
1. Door Stations: Maximum 120 stations with 1 CEU Model AX-248C and 3 add-on exchange units Model AX-320C.
 2. Master Stations:
 - a. Maximum 8 stations with CEU Model AX-248C.
 3. Power Supply:
 - a. Model PS-2420UL: 24 V DC, 2 A.
 - b. For Audio: 1.
 - c. For Video: 2.
 4. Number of Talk Paths: 2.
 5. Number of Video Paths: 2.
 6. All Call: 1, to master stations only.
 7. Video Monitor: 2, same as talk paths and video paths.
 8. Scan Monitor: 1.
- B. Calling Master Station from Door Station and Communicating:
1. Priority Levels for Calls from Door Stations:
 - a. Normal.
 - b. Priority.
 2. Press door station CALL button.
 3. Calling tone rings on master station (for normal call, intermittent tremolo sound; for priority call, rapid intermittent tremolo sound) and selector button LED for individual door station flashes (double-flash for priority call). If door station has camera, video from door station shall be displayed on master station monitor. Call tone continues to ring until answered or is timed out (based on setting). You can stop calling tone by pressing OFF button.
 4. If you press individual door station selector button, LED stops flashing and stays lit and you can talk hands-free to that station. If only TALK button is pressed to answer call, hands-free communication initiates with door station at highest priority call. Talk LED lights when you talk and goes off as you listen to caller.
 5. Press OFF button again to end communication. Call also ends automatically when set talk limit is reached.
 6. If you hold down TALK button for a minimum of 1 second, communication switches to press-to-talk mode. Hold down TALK button to talk and release to listen to caller. You cannot switch back from press-to-talk communication to hands-free communication.
 7. If other master station presses selector button of in-use door station or in-use master station, busy signal is heard at master station.
 8. Microphone is muted while you hold down privacy button on master station while in communication.

9. You can connect footswitch and use it the same manner as TALK button.
10. Master station can display calls up to 8 stations at the same time. If there are more than 8 incoming calls, they will be displayed in order of priority and time of call.
11. You can adjust calling tone, transmit volume, and receive volume with volume controls at bottom of master station.
12. You can use a headset (not included in system) instead of built-in master station's speaker and microphone.

C. Calling Master Station from Another Master Station and Communicating:

1. Press individual selector button of master station.
2. Pre-tone sounds both master stations and starts hands-free communication. Talk LED lights when you talk and goes off as you listen to caller.
3. Press OFF button to end communication. You can end call from either master station. Call also ends automatically when set communication end time is reached.
4. If called master station has privacy mode set (privacy settings button is lit), communication is only 1-way, from calling master station to called master station, and nothing can be heard from called master side. Press TALK button on called master station for a minimum of 1 second. Press-to-talk communication starts. Hold down TALK button to talk and release to listen to caller.
5. You cannot call master station while it is communicating. You will hear a busy signal.

D. Privacy (PRIV) Function:

1. To make master into privacy mode (prevent monitoring from other stations), press privacy button (LED lights up).
2. To cancel privacy mode, press privacy button again (LED goes out).
3. Privacy setting cannot be changed while in communication.

E. CO Line Call from Door Station and Communication:

1. If CALL button is pressed at door station while CO Transfer feature is set (with CO Transfer button lit), call tone rings on master station (for normal call, intermittent tremolo sound; for priority call, rapid intermittent tremolo sound) and selector button LED for individual door station flashes (double-flash for priority call). At same time, telephone call is placed to programmed CO line number.
2. You can communicate with door station from telephone.
3. You can end communication at telephone. Communication also ends automatically when set talk time limit is reached. About 10 seconds before end of call, you will hear alarm sound on telephone.
4. Maximum duration for CO line call is 300 seconds, even if call timer is set to "Infinite".

5. Using this function requires Viking Electronics, Inc. "K-1900-5 Hot-Line Pulse Dialer".
6. If there are multiple calls, call from door station with highest call priority is transferred.
7. Answering at any master station during CO transfer feature will stop CO transfer.
8. There are no functions, such as for door release and dial-in, from telephone.

F. All Call (Normal Master Station Paging):

1. When you press ALL CALL button on master station, all individual master station selector button LEDs flash slowly. You can clear undesired master station from All Call by pressing individual master station selector button with flashing LED, which will turn off LED. Pressing that button again makes that master station part of All Call again and makes LED flash.
2. If you press TALK button, send LED lights up and all individual master station selector buttons stop flashing and stay lit. Pre-tone sounds on target master stations and they can be talked to. At this time, you cannot hear audio from other master stations.
3. Press OFF button to end. You can end call for individual master station by pressing its OFF button.
4. All Call announcements do not go to master stations that are in use.
5. During All Call, if you press individual master station selector button on calling master station or press individual master station selector button or TALK button on 1 of the other master stations, communications switch to hands-free between master stations.
6. There is no function for hands-free reply from called master station during All Call mode.
7. If you press down ALL CALL button but do not start talking within 30 seconds, system goes back to standby mode. You can also return to standby by pressing OFF button.

G. All Call (Priority Master Station Paging):

1. When you press ALL CALL button on master station, all individual master station selector button LEDs flash slowly.
2. If you press ALL CALL button again, flash rate increases. You can clear undesired master station from All Call by pressing individual master station selector button with flashing LED, which will turn off LED. Pressing that button again makes that master station part of All Call again and makes LED flash.
3. If you press TALK button, TALK LED lights up and all individual master station selector buttons stop flashing and stay lit. Pre-tone sounds on all master stations and all can be called. At this time, you cannot hear audio from other master stations.
4. Press OFF button to end. You can end call for individual master station by pressing its OFF button.

5. Communication of master station being used is cancelled and All Call takes priority. Before communication of master station being used is cancelled, you hear cancel warning sound.
6. During All Call, if you press an individual master station selector button on calling master station or press individual master station selector button or TALK button on one of the other master stations, communications switch to hands-free between those two master stations.
7. There is no function for talk back from master station receiving an All Call announcement.
8. If you press down ALL CALL button but do not start talking within 30 seconds, system goes back to standby mode. You can also return to standby by pressing OFF button.

H. Monitor:

1. If you press individual door station selector button, you can hear audio and if that door station has a camera, you can see image.
2. Press OFF button to end. Call also ends automatically when set communication end time is reached.
3. While door station is communicating with or monitored by a master station, you cannot monitor that door station from another master station.
4. If you press TALK button while monitoring, hands-free communication mode starts with that door station.

I. Scan Monitor:

1. When scan monitor button is pressed, door stations that have been enabled for "Scan Monitor" in programming can be monitored sequentially for a specified time interval (configured in programming).
2. Monitoring always initiates from target door station with lowest number.
3. If you press scan monitor button while individually monitoring target door station, monitoring starts with the next door station in line.
4. If you press scan monitor button while monitoring non-target door station, monitoring starts with the first door station enabled for scan monitoring.
5. Press OFF button to end.
6. Communication/video channel 2 is always used for scan monitoring. During scan monitoring, video signal is always outputted from video output port 2 (V2). Scan monitoring is not possible when communication/video channel 2 is being used, even if busy LED is not illuminated.
7. Only one master station at a time can perform scan monitoring.
8. If you press TALK button during scan monitoring, hands-free communication mode starts with that door station.

9. If you press individual door station selector button or scan monitor button during scan monitoring, monitoring switches to monitoring individual door station.
10. If master station receives call from door station during scan monitoring, scan monitor function ends automatically and shall be restarted manually.
11. Scan monitoring continues without limit until it is cancelled, but master station LCD monitor goes out after 10 minutes. Outside video output continues even with LCD off. If you press scan monitor button with LCD off, LCD lights up again.
12. If you press TALK button during scan monitoring, communication mode starts with door station being monitored.

J. Activating Door Release:

1. Press door release button during communication or monitoring with door station.
2. Door release function will be activated, releasing door lock.
3. You cannot operate door from outside telephone.
4. LED stays lit while door release function is activated.
5. Door release contacts can be set to Normally Open or Normally Closed via program configuration.

K. Priority:

1. Calls have priority based on the time the call was initiated. (Earlier call has priority over later call).
2. Communication Priority, from Highest to Lowest:
 - a. Door station, telephone line communication.
 - b. Priority All Call.
 - c. Door station to master station communication.
 - d. Master station to master station communication.
 - e. Normal All Call.
 - f. Monitor.
 - g. Scan monitor.

2.3 SUBMITTALS

- A. Comply with Section 01330— Submittal Procedures.
- B. Product Data: Submit manufacturer's product data, including installation instructions.
- C. Shop Drawings: Submit the following:
 1. Wiring Diagrams: Indicate wiring for each item of equipment and interconnections between items of equipment.

2. Include manufacturer's names, model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.

D. Installation and Operation Manuals:

1. Submit manufacturer's installation and operation manual, including operation instructions and component wiring diagrams.
2. Provide detailed information required for Owner to properly operate equipment.

E. Warranty: Submit manufacturer's standard warranty.

2.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: ISO 9001:2000 certified company.**

2.5 DELIVERY, STORAGE, AND HANDLING

- A. Delivery:** Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
- B. Storage:** Store materials in clean, dry area indoors in accordance with manufacturer's instructions.
- C. Handling:** Protect materials during handling and installation to prevent damage.

2.6 WARRANTY

- A. Warranty Period:** Two years from date of Substantial Completion.

2.7 SECURITY AND COMMUNICATION SYSTEM PRODUCTS

- A. Integrated Security and Communication System: Aiphone "AX Series".**
1. Power Source:
 - a. 24 V DC, 2 A.
 - b. Two PS-2420UL (110 V AC) per video system. One PS-2420UL (110 V AC) per audio system.
 2. Door Station Calling:
 - a. Tremolo call tone programmable from 10 to 600 seconds or infinite.
 - b. LCD monitor remains on for duration of call-in and communication up to a maximum of 10 minutes.

3. Master Station Calling: Select station to call, pre-tone sounds, then speak hands-free or push-to-talk.
 4. Communication:
 - a. Auto: VOX.
 - b. Manual: Press-to-talk, release-to-listen.
 5. Camera: CCD 250,000 pixels.
 6. Video Monitor:
 - a. 3.5-inch direct view TFT color LCD.
 - b. Scanning Lines: 525.
 7. Door Release: N/O or N/C, programmable per station.
 8. Door Release Contact: 24 V AC/DC, 0.5 A.
 9. Wiring: CAT-5e UTP-4 homerun from each station to CEU.
 10. Distance:
 - a. Door Station to CEU: 980 feet maximum.
 - b. Master Station to CEU: 980 feet maximum.
 11. CO Line Transfer Adaptor: Viking Electronics, Inc. "K-1900-5 Hot-Line Pulse Dialer".
- B. Central Exchange Unit:
1. Central Exchange Unit: Model AX-248C.
 - a. Connect: Maximum of 8 master stations and 24 door stations.
 - b. Current Consumption:
 - 1) Video: 1100 mA maximum.
 - 2) Audio: 1250 mA maximum.
 - c. Video Output:
 - 1) NTSC standard 1 Vpp (0.7 to 1.4 Vpp).
 - 2) Two BNC.
 - d. Video Output Trigger:
 - 1) Open collector output.
 - 2) 24 V DC, 30 mA.
 - 3) Two RJ-45.
 - e. Master and door stations homerun to CEU for connection and programming.
 - f. RJ-45 Input Jacks: Station connection, add-on CEU connection, and CO line output.

- g. Quick Release: Dry contact terminals for door release functions and power supply connection.
- h. RS-232 Connection:
 - 1) Input: Programming.
 - 2) Output: Event logging and CCTV/access control interface.
Software as specified in Section 17910
- i. Composite video output (BNC).
- j. Selective door release programmable to N/O or N/C.
- k. CCTV and access integration.
- l. Programmable by PC.
- m. Rack mountable (2U).
- n. Operating Temperature: 32 degrees F to 104 degrees F (0 degrees C to 40 degrees C).
- o. Power switch.
- p. Power/Communications Error Display LED:
 - 1) Off: Power off.
 - 2) Lit: Power on.
 - 3) Flashing: Error in device or wiring.
- q. Ports:
 - 1) Door station ports.
 - 2) Master station ports.
 - 3) Add-on exchange unit ports.
 - 4) CO line port.
 - 5) Setting/log port.
 - 6) Video output ports.
 - 7) Video output trigger ports.
 - 8) Door release relay ports.
 - 9) Power supply ports.

C. Master Stations:

- 1. Master Stations: Audio/Color Video Model AX-8MV.
 - a. CAT-5e homerun wired to CEU.
 - b. Buttons:
 - 1) 8 individual door station selector buttons with LED.

- 2) 8 individual master station selector buttons with LED.
- 3) Door release button with LED.
- 4) Scan monitor button with LED.
- 5) CO line transfer button with LED.
- 6) Privacy button with LED.
- 7) Oversized TALK button with LED to activate VOX or PTT style communication.
- 8) ALL CALL button.
- 9) OFF button.
- c. Occupied LED.
- d. Speaker.
- e. Microphone.
- f. Volume Controls:
 - 1) Receive Switch: Low, medium, high.
 - 2) Transmit Switch: Low, medium, high.
 - 3) Call tone.
- g. LCD brightness control.
- h. Jacks:
 - 1) Headset receiver.
 - 2) Headset microphone.
- i. Headset Volume Controls:
 - 1) Receiver.
 - 2) Microphone.
- j. Directory Cards and Covers:
 - 1) Master station.
 - 2) Door station.
- k. Reset switch.
- l. RJ-45 jack for connection to CEU.
- m. Connector for add-on selector on master station.
- n. Door call-in indicator.
- o. Hands-free or push-to-talk communication.
- p. All Call to master stations.
- q. Scan monitoring.

- r. Selective door release.
- s. Privacy and mute functions.
- t. Wall or desk mount. Metal bracket included for wall mounting.
- u. Multi-Pin Connector:
 - 1) Video output from master station.
 - 2) External signaling of call tones (through IER-2 or activation of TAR-3).
 - 3) Footswitch activation for TALK function.
- v. Operating Temperature: 32 degrees F to 104 degrees F (0 degrees C to 40 degrees C).
- w. Monitor: 3.5-inch color LCD, master station Model AX-8MV.
- x. Outside Video Output: NTSC standard 1 Vpp (0.7 to 1.4 Vpp), master station Model AX-8MV.

D. Door Stations:

- 1. Fixed Color Video Door Station: Model AX-DV-P.
 - a. Proximity Card Reader: Embedded "HID ProxPoint Plus".
 - b. Faceplate: Aluminum die cast.
 - c. Surface mount.
 - d. Call Button: Metal.
 - e. Camera.
 - f. Camera Protection: Clear Lexan lens cover.
 - g. RJ-45 jack.
 - h. Speaker.
 - i. Microphone.
 - j. Directory card.
 - k. White Illumination LEDs: Automatically turn on in low-light conditions.
 - l. CAT-5e homerun wired to CEU.
 - m. Operating Temperature: 14 degrees F to 140 degrees F (minus 10 degrees C to 60 degrees C).
 - n. Vandal resistant.
- 2. Fixed Color Video Door Station: Model AX-DVF-P.
 - a. Proximity Card Reader: Embedded "HID ProxPoint Plus".
 - b. Faceplate: Stainless steel.
 - c. Flush mount

- d. Call Button: Metal.
- e. Camera.
- f. Camera Protection: Clear Lexan lens cover.
- g. RJ-45 jack.
- h. Speaker.
- i. Microphone.
- j. Directory card.
- k. White Illumination LEDs: Automatically turn on in low-light conditions.
- l. CAT-5e homerun wired to CEU.
- m. Operating Temperature: 14 degrees F to 140 degrees F (minus 10 degrees C to 60 degrees C).
- n. Vandal resistant.

PART 3 - EXECUTION

3.1 SEE SPECIFICATION SECTION 17900, PARAGRAPH 3.1

3.2 EXAMINATION

- A. Examine areas to receive integrated security and communication system.
- B. Notify Architect of conditions that would adversely affect installation or subsequent use.
- C. Do not begin installation until unacceptable conditions are corrected.

3.3 INSTALLATION

- A. Install integrated security and communication system in accordance with manufacturer's instructions at locations indicated on the Drawings.
- B. Mount equipment plumb, level, square, and secure.
- C. CAT-5e Cables:
 - 1. Run cables from and homerun to one central location where CEU will be installed.
 - 2. Maximum Cable Runs: Keep each cable run to a maximum of 980 feet from communication device to CEU.
 - 3. Maintain twists of cable pairs to point of termination or no more than 0.5-inch untwisted.

4. Do not remove more than 1 inch of jacket when terminating cables.
5. Cable Bends:
 - a. Make gradual bends of cable, where necessary.
 - b. Do not make bends of cable sharper than 1-inch radius.
 - c. Do not allow cable to be sharply bent or kinked at any time.
6. Cable Ties: Dress cables neatly with cable ties using low to moderate pressure.
7. Cross-connect cables, where necessary, using CAT-5e rated punch blocks and components.
8. Do not splice or bridge cables.
9. Cable Pulling:
 - a. Pull cable with low to moderate force.
 - b. Do not use oil or other lubricants not specifically designed for cable pulling.
10. Keep cables as far away from potential sources of EMI as possible.
11. Do not tie cables to electrical conduits or lay cables on electrical fixtures.
12. Cable Supports:
 - a. Install proper cable supports a maximum of 5 feet apart.
 - b. Do not support cables by ceiling tiles.
13. Label Cable Termination Points: Use unique number for each cable segment.
14. Testing Cables: Test installed cable segments with cable tester.
15. Jacks: Install jacks to prevent dust and other contaminants from settling on contacts.
16. Cable Slack:
 - a. Leave extra slack on cables, neatly coiled-up in ceiling or nearest concealed place.
 - b. Leave a minimum of 1 foot of cable slack at door station side and a minimum of 10 feet of cable slack at CEU side.
17. Do not install cables taught.
18. Grommets: Protect cables with grommets where passing through metal studs or other items that could damage cables.
19. Do not mix TIA/EIA 568A and 568B wiring on same installation. Use TIA/EIA 568B wiring throughout installation.
20. Staples:
 - a. Do not use staples that crimp cables tightly.
 - b. Do not use T-18 and T-25 cable staples.
21. Use firestop cables that penetrate firewalls.
22. Use plenum-rated cables where mandated.

3.4 ADJUSTING

- A. Adjust integrated security and communication system for proper operation in accordance with manufacturer's instructions.

3.5 DEMONSTRATION AND TRAINING

- A. Demonstration:
 - 1. Demonstrate that integrated security and communication system functions properly.
 - 2. Perform demonstration at final system inspection by qualified representative of manufacturer.
- B. Instruction and Training:
 - 1. Provide instruction and training of Owner's personnel as required by Section 17900 for operation of integrated security and communication system.
 - 2. Provide hands-on demonstration of operation of system components and complete system, including user-level program changes and functions.
 - 3. Provide instruction and training by qualified representative of manufacturer.

3.6 PROTECTION

- A. Protect installed integrated security and communication system from damage during construction.

END OF SECTION

