

SECTION 20 00 00

MECHANICAL BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Conditions:

1. Conform to General Conditions, Supplementary Conditions and Division 1 - General Requirements.

1.02 SCOPE

A. Section Includes:

1. Products, assemblies and methods applicable to more than one of the systems specified in Division 23 or shown on the drawings.

1.03 MATERIALS AND EQUIPMENT

A. Products:

1. No hazardous material such as lead or asbestos containing material or equipment shall be used in DIVISION 23. Use products of a single manufacturer where two or more units of same class of equipment are required. Use new equipment.

1.04 CODES AND STANDARDS

- A. Comply with requirements of all governing State and City & County Codes and Standards. Provide products and equipment which comply with all governing State and City & County Codes and Standards, including the Energy Code as adopted by the City. Provide products which meet or exceed criteria for meeting Hawaii Energy rebate program standards. All electric powered equipment and electrical devices shall be listed by UL or comparable listing agency.

1.05 COMMISSIONING

- A. Commissioning is a comprehensive and systematic process to verify that the building's energy related systems are installed, calibrated and perform according to the owner's project requirements, basis of design, and construction documents.
- B. Commissioning is a part of this project and all contractors performing work governed by this division of the specification shall refer to commissioning specification for complete commissioning requirements that apply to all of the work within this division.

1.06 COMMISSIONING HVAC SYSTEMS

A. General Requirements:

1. Provide commissioning of HVAC systems. The purpose of commissioning is to bring the project HVAC system to a state of dynamic operation in accordance with the contract plans and specifications by verifying the operation of individual components, subsystems, and systems.

B. Tools and Equipment:

1. The Contractor shall furnish all special tools and equipment required during the commissioning process. A list of all tools and equipment to be used during commissioning shall be submitted for approval.

C. Commissioning Authority:

1. Submit the "CxA", Commissioning Authority qualification for approval.

D. Commissioning Documentation:

1. The Contractor shall maintain the commissioning documentation in ring binders. Provide commissioning plan and all required forms for review by Architect. The commissioning documentation shall be organized by system and subsystem when practicable. All pages shall be numbered and a table of contents page shall be provided. The commissioning documentation shall include, but not be limited to, the following:
 - a. Approved Test and Balance Report for the building (project) being commissioned.
 - b. All approved shop drawings of HVAC equipment to be commissioned. Shop drawings shall be full size sheets folded as required to fit in binders.
 - c. All pre-commissioning checklists initialed by indicated personnel organized by system and subsystem.
 - d. All functional performance test checklists signed by indicated personnel organized by system and subsystem.
 - e. Three copies of the Operation and Maintenance Manuals specified on other sections of these specifications shall be included with the Commissioning Documentation. The manuals shall be incorporated in the Commissioning Documentation prior to the commencement of the training required in this and other sections of the specifications. Preparation of Operation and Maintenance Manuals shall be as specified in other sections of these specifications.
 - f. HVAC Shop Drawings and As Built Drawings and Specifications shall be assembled after completion of HVAC pre-commissioning phase and prepared as indicated above. Changes as a result of subsequent HVAC Commissioning procedures will be incorporated (as required) at the conclusion of final HVAC Commissioning.
 - g. The Contractor shall be responsible for maintaining the commissioning documentation until final acceptance of the project. All checklists included in this section of the specifications shall become part of the commissioning documentation. The commissioning documentation shall be kept current by the contractor and shall be available for inspection at all times. At the time of acceptance of the project, the Contractor shall furnish 3 copies of the commissioning documentation to the Owner's representative.
 - h. CxA shall document commissioning work and provide a Commissioning Report.

1.07 ON-SITE STORAGE

- A. Protection:
1. Protect against weather, corrosion and dirt.

1.08 MAINTENANCE MANUALS

- A. Meet the applicable requirements of Section 01 77 00 - CLOSEOUT PROCEDURES In addition, include the following:
1. Manufacturers, suppliers, and subcontractors' names, addresses, and phone numbers.
 2. Schedule and description of routine maintenance for each component including oiling, lubrication and greasing data.
 3. Balancing log including complete electrical load data from operation test, belt sizes, types and lengths.
 4. Manufacturers' cuts and rating tables, including brochures for all equipment listed under required submittals.
 5. Part numbers of all replaceable items.
 6. Valve list.
 7. ASME certificate from State Boiler Inspector.
 8. As-built control diagrams and operation sequence with labeling of control piping and instruments to match diagrams.
 9. Written guarantees.
- B. Binders: Black, hard cover, post type with plastic tab index sheets. Submit manuals to Engineer at least 25 normal work days prior to operating and instruction period of Owner's Representative.

1.09 OPERATING AND INSTRUCTION PERIOD

- A. Demonstration:
1. Conducted by Mechanical Contractor for Owner's operational personnel for one day after systems are fully operational and at such time as designated by and under the observation of the Engineer.

1.10 GUARANTEE

- A. Length of Guarantee: Guarantee materials and workmanship for a period of one year from date of final acceptance for the project or through one entire system operating season if this exceeds year date.
- B. Submittal: Submit with maintenance manual written warranty which exceed one year. Five-year product warranty required on domestic hot water heaters and refrigeration compressors.
- C. Guarantee Includes: All material and labor to repair or replace defective items within any system, and extends to material and labor required to repair adjacent surfaces disturbed by malfunction.
- D. Guarantee Does Not Include: Replacement of components which malfunction due to abuse or lack of proper maintenance or operation by Owner.

1.11 SUBMITTALS

- A. General: Comply with the applicable requirements of Section 01 3300 - SUBMITTAL PROCEDURES. Provide shop drawings, product data, and manufacturer's instructions for material and equipment including all items listed in PART 2 - PRODUCTS in each section of Division 23 and listed on the fixture and mechanical equipment schedules on the drawings.
- B. Submittals for this Section: Submit shop drawings, product list, product data, and manufacturer's instructions to Architect for review for:
 - 1. Pipe and Fittings
 - 2. Valves
 - 3. Piping Specialties
 - 4. Mechanical Supporting Devices
 - 5. Vibration Isolation
 - 6. Pumps
 - 7. Motors
 - 8. Motor Starters
 - 9. Motor Control Centers
 - 10. Control Wiring
 - 11. Identification
- C. Shop Drawings shall be for each entire system as specified within this section and other sections within Division 23. Provide coordinated layout drawings minimum 1/4" per foot, which show all piping, sprinkler heads, ductwork, equipment, conduit, cable trays, pull boxes, light fixtures, access panels, architectural, and structural systems. All trades to coordinate in preparation of drawings to establish final locations of work. Areas of extreme congestion shall be shown at 1/2" scale.

1.12 MAINTENANCE

- A. Provide first year of all manufacturer's recommended preventive maintenance for all mechanical equipment, including oil change on chiller or compressor, filter replacement and cleaning for all mechanical equipment.

1.13 CLOSEOUT SUBMITTALS

- A. Submit under provisions of Section 01 77 00 - CLOSEOUT PROCEDURES.
- B. Operation and Maintenance Manuals - Refer to this section.
- C. Submit warranties as specified.
- D. Submit proof of training as specified in other Sections.
- E. Submit As-built drawings for all mechanical systems. Update all shop drawings previously submitted with actual installed conditions.

1.14 SUBSTITUTIONS

- A. Products Considered Equal: Manufacturers and models of fixtures, equipment and material indicated on drawings are those upon which mechanical design is based. Other substitute manufacturers with products considered equal are listed without specific model designation. For substitution of any other manufacturer's equipment, see General Conditions of this specification.
- B. Responsibility: Fixtures, equipment and materials scheduled on drawings are selected and configured to fit in mechanical or ceiling spaces available and to conform to available electrical, architectural, and structural characteristics. It is the Contractor's responsibility to insure, prior to submitting shop drawings, that any substitute fixtures, equipment or materials will fit without change in function or quality and without a redesign of the spaces affected.
- C. Electrical Coordination: It is the Contractor's responsibility to coordinate with the Electrical Engineer and Electrical Contractor any electrical changes required due to substitute equipment and to pay for any required modifications.
- D. Conflicts: Should conflict occur, either mechanical or electrical, due to substitution of fixtures, equipment or materials from those which the mechanical design is based, the Contractor is responsible for all costs incurred. Any redesign required shall be at the Contractor's expense. Redesign and/or modification to the contract documents will be by Notkin Hawaii Inc. on a time and materials basis and paid for by the Contractor.

PART 2 - PRODUCTS

2.01 PIPE AND FITTINGS

- A. Cast Iron Water Pipe: Class 150, ASTM A-377, Type II (Push-On) or Type III (Mechanical) joint Fittings: ANSI A21.12
- B. Ductile Iron Water Pipe: Class 52, ANSI A21.51, Type II (Push-On) or Type III (Mechanical) joint Fittings: ANSI A21.1
- C. Cast Iron Soil Pipe and Fittings: Bell and Spigot: ASTM A-74, No-Hub: CISPI 301
- D. Concrete Pipe: ASTM C-14
- E. Plastic (PVC) Sewer Pipe: ASTM D-3034
- F. Steel Pipe, Black and Galvanized: ASTM A-53, Fittings: Malleable iron screwed; ANSI B16.3 Cast iron screwed; ANSI B16.4 Cast iron flanged; ANSI B16.1 Steel butt welding; ANSI B16.9
- G. Copper Tubing: ASTM B -88, Fittings: Wrought copper; ANSI B 16.22
- H. Copper DWV: ASTM B 306, Fittings: Cast brass; B16.23
- I. Polyvinyl Chloride (PVC): ASTM D –1785

- J. PEX Piping: Cross-linked polyethylene tubing using hot cross linking method (PEX-A), ASTM F876 and F877, Fittings: Dezincification resistant (DZR) brass fittings, ASTM F1960. Stainless steel clamp (SSC) fittings not allowed.

2.02 VALVES

- A. Gate, Globe, Ball, Butterfly and Check Valves: Nibco, Crane, Stockham, Jenkins, Red-White, Anvil International, Walworth or Milwaukee equal to Nibco model numbers listed.

		Potable Domestic	Chilled Water
Gate:	2" and under 2-1/2" and over	T-113-LF F-619-RW	T-134 F-617-0
Globe:	2" and under 2-1/2" and over		T-235 F-718-B
Check: (Horiz.)	2" and under 2-1/2" and over	T-413-Y-LF F-938-33	T-413 F-918
Check: (Vert.)	2" and under 2-1/2" and over	T-480-Y-LF F/W-910-B-LF	T-480 F-910
Check: (Silent)	2-1/2" and under 3" and over	W-910-B-LF F-910-B-LF	W-960-B F-960-B
Ball:	2" and under	T-585-80-LF	T-585-70
Butterfly:	2-1/2" and over	LD-2000	LD-2000

- B. Condenser Water Valves: Same as specified for chilled water service.
- C. Butterfly Valves: Lug Type, 200 psi Cold Water Pressure through 12" size gear operator with indicator on valves 6" and larger, MSS-SP67 design.
- D. Balancing Valves: 2-1/2" and over: Lubricated plug type complete with spare lubricant and operator. DeZurik, Nordstrom 142 or 143. 2" and under: Ball valve as specified above. Provide balancing stops for all sizes.
- E. Flow Balancing Valves: Bronze globe valve with integral calibrated register, pointer, check valve, meter and drain connections. B&G, Taco, Armstrong, Griswold.

- F. Automatic Flow Control Valves:
1. Pressure independent flow control valve to automatically limit the rate of flow to required engineered capacity within 5% accuracy over an operating pressure differential of at least 10 times the minimum required for control. Manufactured by Griswold Controls, Auto Flow, Danfoss or approved equal.
 2. Valve body shall be brass or bronze with stainless steel internal working parts, strainer on inlet and ball valve on outlet and test plugs. Control mechanism shall consist of cartridge and linear coil spring. Pressure control seat shall be brass with EPDM o-ring.
 3. Certified performance data for the flow control valve, based on independent laboratory tests.
 4. Each valve shall be furnished with a valve kit consisting of $\frac{1}{4}$ "x2" minimum size nipples, quick-disconnect valves (to be located outside of insulation) and fittings suitable for use with measuring instrument specified.
 5. Provide a metal identification tag, with chain, for each installed valve. The tag to be marked with zone identification, valve model number and rated flow in GPM.
- G. Relief Valves (ASME - UFPVC): Bronze ASTM B-62 with bottom inlet, side outlet spring loaded top guided type with 10% overpressure and reset. Setting at lesser of 10% or 25 psig over operating pressure, or as required by code for specific application. Threaded inlet. Farris, Consolidated, Lonergan, Watts, Cash-Acme.
- H. Pilot Operated PRV: Consists of two pilot operated pressure reducing valves piped in parallel with shutoff valves for independent use. Zero fall-off pressure, pilot operated, adjustable self-operated type, CRD pressure reducing control, cast iron valve body and cover, epoxy coated interior, flow clean strainer, pressure gauges in the inlet, outlet and cover connections. Cla-Val 910-01G AS and Cla-Val 90-01G BS flanged ends or approved equal.
- I. Backflow Preventer: Reduced pressure principle type, Beeco, Cla-Val, Cash-Acme, Watts, Craneline, Hersey or Febco as approved by Board of Water Supply or agency having jurisdiction.
- J. Valve Components: Material used capable of operating within services required, e.g. hot water heating valve components designed for continued operation at 240 degrees F.
- K. Needle Valves: Brass construction, threaded. Trerice No.735.

2.03 PIPING SPECIALTIES

- A. Strainers: 0.045" perforated 304 stainless steel screen. Armstrong A1SC or equal by Yarway, Sarco; threaded for 2" and smaller. Armstrong A1FL or equal by Yarway, Sarco; flanged for 2-1/2" and larger. Provide blow-off valve on all strainers 2-1/2" and larger with blow-off discharge piped to nearest drain.
- B. Gauges: 4-1/2" case within 7 feet of floor; 6" case if mounted above 7 feet. Cast aluminum black finish. Accuracy 1/2 of 1%. Operating range shall register mid-point on dial. Dial ranges to be submitted for approval. U.S. Gage, Marsh, Trerice, Weiss.
- C. Thermometers: 5" Dial, bimetal, 1% accuracy, separable socket, adjustable angle stainless steel case, recalibrator. Trerice B85600 series. Marsh, Weiss, Moeller.

- D. Thermometers: 9" industrial adjustable angle thermometers with non-toxic, mercury free liquid, brass separable socket, extension socket for insulated piping, permanently graduated scale. Trerice, Marsh, Palmer, Weiss, Moeller.
- E. Unions: 2" and smaller; ground joint, malleable iron type. 2-1/2" and larger; flange type, 150# ANSI forged steel. Anvil International, Crane, Walworth, Syspac.
- F. Gaskets: 1/16" thick service gaskets, asbestos free. Crane Co. "Cranite," Johns-Manville.
- G. Access Panels: Same type and construction as those specified in Architectural Section or as suitable for the type of ceiling or wall construction. Elmdor, J.L. Industries or Milcor with screwdriver operated lock where not specified in other sections. Stainless steel access panels in tile walls.
- H. Insulating Union: Epco, Capitol, Wheeline Machine Products.
- I. Escutcheon: Chrome plated steel, heavy pattern with springs for floor and ceiling. Pasco, Proflo.
- J. Pressure Temperature Test Plugs: 1/2" brass neoprene valve core to accept pressure gauge or thermometer stem. 2" extension for pipe insulation. Pete's XL Plug, Peterson Eng. Co., Inc., Sisco, MG, Universal.
- K. Flow Meters: Provide venturi or calibrated orifice type complete with quick disconnect valves, safety shut-off valves, tag on chain indicating pipe size, station identification and meter reading at various flow rates. Provide one portable meter kit for project. Barco, Griswold, B&G, Gerand.
- L. Expansion Joints: Stainless steel bellows type, Keflex Model 308 or equal by Metraflex.
- M. Alignment Guides: Keflex Series P or equal by Metraflex.

2.04 MECHANICAL SUPPORTING DEVICES

- A. Pipe Hangers: Adjustable threaded rod type in accordance with MSS SP-58, MSS SP-69, and ANSI B31.1, Superstrut, Anvil International. Rod size and spacing shall be as scheduled.

Hanger Rods - Size and Spacing Schedule
Maximum Hanger Spacing
Water and Waste

Pipe	Weight Per Foot	Minimum Hanger Rod Size	Copper Type M	Steel SCH 40	Cast Iron STD	Plastic DWV/S CH 40	Natural Gas SCH 40
1/2"	1.0	1/4"	6'	6'		4'	6'
3/4"	1.4	1/4"	6'	8'		4'	8'
1"	2.1	1/4"	6'	8'		4'	8'
1-1/4"	2.9	3/8"	6'	10'		4'	10'
1-1/2"	3.6	3/8"	6'	10'	10'	4'	10'
2"	5.2	3/8"	10'	10'	10'	4'	10'
2-1/2"	7.9	1/2"	10'	10'	10'	4'	10'
3"	10.8	1/2"	10'	10'	10'	4'	10'
4"	16.5	1/2"	10'	10'	10'	4'	10'
5"	23.5	5/8"	10'	10'	10'	4'	10'
6"	31.6	5/8"	10'	10'	10'	4'	10'
8" to 12"	50.5	5/8"	10'	10'	10'	4'	10'

- B. Concrete Inserts: Malleable iron body and nut, Anvil International , Superstrut.
- C. Duct Hangers: In accordance with SMACNA Duct Construction Standards, Low Pressure or High Pressure as appropriate.

2.05 VIBRATION ISOLATION

- A. Equipment: Provide by a single manufacturer [as scheduled on drawings] and installed in accordance with manufacturer's recommendations. Coordinate vibration isolators with equipment supplied. Submit for review design criteria and shop drawings of proposed vibration isolation equipment. Amber Booth Co., Kinetics, Mason Industries, Virbration Eliminator Co.

2.06 PUMPS

- A. General: Non-overloading throughout the length of performance curve. Furnish as complete unit with base, under-voltage protection on motors and casings tapped for gauges.
- B. In-Line Pumps: Bronze fitted (all bronze for domestic service), mechanical seals, vertical split case, rubber-in-shear mount motor, sleeve bearings. B&G, Paco, Armstrong, Aurora, Taco, Grundfos.
- C. Base Mount Centrifugal Pumps: Horizontal, end suction bronze fitted flexible coupling, lifting lugs, cast iron [or steel] base, drain, venting pet cock, mechanical seals, flexible connection, casing wearing rings. B&G, Paco, Aurora, Armstrong or Taco.

2.07 MOTORS

- A. Temperature Rating: Rated for 40 degrees C environment, continuous duty at full load (Class B Insulation). Class H insulation for severe environment.

- B. Phases and Current, Efficiency Characteristics: Squirrel-cage induction polyphase motors for 1/2 HP and larger, capacitor-start single-phase motors for less than 1/2 HP. At equipment manufacturer's option, 1/6 HP and smaller may be split-phase type. Current characteristics as indicated on equipment schedules. Motors shall be NEMA Premium efficiency. Comply with the State Energy Code and Hawaii Energy rebate criteria.
- C. Service Factor: 1.15 for three-phase motors and 1.35 for single-phase motors.
- D. Enclosure Type: Open drip-proof motors for indoor use where satisfactorily housed, and guarded drip-proof motors where exposed to contact by employees or building occupants. Totally enclosed fan cooled or weather protected Type I for outdoor use, Type II where not housed.
- E. Overload Protection: Built-in thermal overload protection.
- F. Name Plate: Indicate full identification of manufacturer, ratings, characteristics, construction, special features and similar information.

2.08 MOTOR STARTERS

- A. Motor Starter Characteristics: Comply with NEMA standards and NEC. Provide Type I general purpose enclosures with padlock ears, and with frames and supports for mounting on wall, floor or panel as indicated. Provide Type 3R enclosure for outdoor starters. Where starter location is not within sight of motor provide disconnect switch within site of motor. Provide type and size of starter recommended by motor manufacturer and equipment manufacturer for applicable protection and start-up condition; refer to individual equipment sections for basic load requirements.
 - 1. Manual Switches: Provide manual switch for motors 1/3 HP and smaller, except where interlock or automatic operation is indicated. Provide extra switch positions and pilot lights for multi-speed motors.
 - 2. Magnetic Starters: Provide magnetic starters for motors 1/2 HP up to 1-1/2 HP, and for smaller motors where interlock or automatic operation is indicated. Include the following:
 - a. Maintained-contact push buttons and pilot lights, properly arranged for single-speed or multi-speed operation as indicated.
 - b. Trip-free thermal overload relays, each phase.
 - c. Interlocks, pneumatic switches and similar devices as required for coordination with control requirements.
 - d. Built-in 120-volt control circuit transformer, fused from line side, where service exceeds 240 volts.
 - e. Externally operated manual reset.
 - 3. Magnetic Starters: Provide magnetic starters for motors 2 HP and larger. Include the following:
 - a. Maintained-contact push buttons and pilot lights, properly arranged for single-speed or multi-speed operation as indicated.
 - b. Interlocks, pneumatic switches and similar devices as required for coordination with control requirements.
 - c. Built-in 120-volt control circuit transformer, fused from line side, where service exceeds 240 volts.
 - d. Externally operated manual reset.

- e. Microprocessor based electronic overload relay, with phase protection, undervoltage release or protection, undercurrent overcurrent protection, ground fault protection, fault restart delays. Symcon 777.
4. Equipment Connected to Generator: For all "Legally Required" (NEC Article 701) equipment connected to the Generator, provide an integral Time Delay Relay (TDR) within Motor Starter. Initial settings shall be set at 5-second increments so that all "Legally Required" equipment does not restart at the same time. Coordinate with Generator installer for final TDR settings so that all "Legally Required" equipment is on-line within 60 seconds after loss of normal power as required by NEC.

2.09 POWER WIRING

- A. Requirements: See Division 26.

2.10 CONTROL WIRING

- A. Requirements: Provide in accordance with requirements of controlled equipment.

2.11 IDENTIFICATION

- A. Equipment Nameplates: Black bakelite, 1-1/2" x 3" with white 1/4" lettering with equipment schedule designations (e.g. "AHU-1 AIR HANDLING UNIT").
- B. Valve Tags: 1/25" thick, 1-1/2" diameter brass tags stamped to indicate service and valve number, 1/4" lettering, chain hanger. Post valve list under glass in appropriate mechanical room and include in maintenance manual.
- C. Pipe Marking: Semi-rigid plastic coil markers with written legend, color-coded background and flow arrow, all in accordance with ANSI A13.1. Letters to reflect drawing legend designations.

2.12 PAINT

- A. Factory Finished Equipment: See individual equipment specification. Submit color charts for selection by Architect.
- B. Field Application: Provide painting products as specified in Section 09 9100 - PAINTING.

2.13 TESTING AND ADJUSTING

- A. Requirements: Prior to balancing and occupancy, test and adjust all fans, pumps, coils, temperature controls, etc., for proper operation. Recheck all equipment and systems after balancing is complete to confirm operation of all systems is in accordance with plans and specifications. See Section 23 05 93 – TESTING AND BALANCING AIR AND WATER SYSTEMS for additional requirements.

PART 3 - EXECUTION

3.01 CUTTING AND PATCHING

- A. General Contractor: Openings in new construction provided by General Contractor for mechanical under direction of the Contractor.
- B. Mechanical Contractor: Responsible for removal and replacement of gravel, paving, curbs and concrete slabs necessitated by mechanical construction. Replace entire concrete slab between expansion joints, or score joints.

3.02 EXISTING UTILITIES

- A. Existing Utility Lines: Indicated on drawings in accordance with information furnished to the Engineer. Contractor responsible for locating, uncovering, disposing of or maintaining existing utility lines. Abandon existing underground utility lines not required for service. Raise or lower all valve boxes, manholes or other appurtenances of utilities which are to remain in service level with new finished grade indicated on the drawings.

3.03 PIPE AND PIPE FITTINGS

- A. Underground Ferrous Piping and Fittings (except cast iron soil piping): Machine wrap with polyvinyl chloride pressure-sensitive tape 0.020" thick ("Scotchwrap") to include risers at buildings to a minimum of 6" above grade.
- B. Pipes: Remove burrs by reaming. Use Teflon tape on male threads only.
- C. Openings in Pipes: Keep closed during progress of work.
- D. Coordination: Install so as not to interfere with light fixtures or other trade components.
- E. Close Nipples: Not permitted on any part of work. Use standard short nipples for short pipe connections. Use of bushings not permitted.
- F. Piping of Copper Tubing: Continuous. Copper tubing inserts in runs of steel pipe not permitted. Solder joints in copper piping. Do not lay copper tubing on rocks or gravel.
- G. Connections Between Pipes of Dissimilar Metals: Make with insulating unions. (Dielectric.) Include cast iron valve connections to adaptors for copper pipe. Does not apply to waste piping

- H. Cutting of Copper Pipe: Use a cutter. Smooth sharp edges with emery cloth.
- I. Saddles on Pipe and Bending of Pipe: Not permitted.
- J. Equipment Isolation: Provide isolation valves (gate or ball valve) and unions at piping connections to all equipment.
- K. Concealed Piping: Conceal all piping in finished areas unless otherwise noted.

3.04 WELDING

- A. Quality Control: Procedures in accordance with ANSI B31.9. All welders shall have been tested and each welder's performance qualification record in accordance with ANSI B31.9 shall be maintained at job site subject to review upon request of Engineer. Welders shall be assigned symbols to be affixed at each weld.
- B. Procedures: Use butt weld joints. Mechanically bevel pipe ends.
- C. Electrodes: Store in dry heated area. Do not use moist or damp electrodes, or those with chips in coating.

3.05 EXCAVATION AND BACKFILLING

- A. General: Per requirements of the City and County Standards or BWS Standards as applicable for the utility lines.
- B. Excavation: Unnecessary excavation below the required grade is not permitted. Properly shore trenches where required to protect adjacent structures and to safeguard employees. Control all grading in vicinity of excavations to prevent surface ground water from flowing into trenches.
- C. Bedding Material: Compacted select borrow or No. 3B Fine Gravel (ASTM C33, No. 67 Graduation).
- D. Backfill Material: Suitable excavated on site soil or similar imported material may be used.
- E. Bedding Method: Do not backfill trenches until joints in piping have set, piping has been tested and installation has been inspected and approved by governing authority. Do not use crushed rock or gravel within one foot of the pipe material. Reopen any trenches improperly backfilled, or where settlement occurs to a depth required for proper compaction, then refill and compact with surface restored to grade.
- F. Compaction: Water settling is not permitted; mechanically compact to not less than 95 percent relative compaction.
- G. Tanks: Backfill tanks buried underground in same manner as storm and sanitary sewers.
- H. Cleanup: Remove from site all earth, rocks and debris excavated and not reused.

3.06 VALVES

- A. Relief Valves: Install at all points required by code and where required for protection of equipment and piping. Set pressure shall be as indicated or directed. Pipe discharge to nearest floor drain where pressure cannot exceed 30 psig or to safe acceptable terminus.
- B. Pressure Reducing Valve Assembly: Install with a strainer on inlet side and relief valve on low pressure side. Make connections to pressure reducing valve through a gate valve and a union on each side and a full-size globe valve bypass around reducing valve. Install valves so that they are easily accessible for maintenance and removal. Provide pressure gauges on both high and low pressure sides.
- C. Backflow Preventor: Provide on make-up water line for heaters, boilers, chillers, cooling towers and other equipment, and to comply with regulations of the Board of Water Supply in the City and County of Honolulu. Install relief valve on downstream side.
- D. Air Gaps: Distance between inlet pipe and flood level rim twice diameter of supply pipe.
- E. Vacuum Breakers: Use atmospheric type where vacuum breaker is not upstream of shut-off. Install 12" above highest downstream pipe elevation. Use pressure type otherwise. Provide for lawn sprinkling, hose bibbs, and faucets with hose end connections.
- F. Silent Check Valves: Install at discharges of pumps.
- G. Ball and Butterfly Valves: May be used in lieu of gate valves on all services except steam systems.
- H. Expansion Tanks: Provide for all closed domestic hot water and HVAC condenser and chilled water system to account for thermal expansion.

3.07 PIPING SPECIALTIES

- A. Gauges: Mount to be read from floor. Provide needle valves. Cocks not acceptable.
- B. Thermometers: Mount to be read from floor. Provide swivel at neck.
- C. Unions: Install at final connections to equipment and on control side of all valves in mains, branches and risers.
- D. Escutcheons: Install at all places where exposed piping passes through walls, floors or ceilings.
- E. Equipment, Valves and Piping: Tag for identification, indicating equipment, zone and area served. Provide nameplates for access doors and removable ceiling panels to areas containing mechanical equipment, valves, etc. Submit to Engineer for approval proposed list of nameplates.
- F. Drips and Drains for Pumps, Pans, Reliefs, Etc.: Run to floor drain or as noted on drawings. Discharge to floor not permitted.
- G. Pipe Sleeves: Install wherever piping passes through floors, footings or walls of concrete or masonry construction. Sleeves to be not less than 20 gauge galvanized steel or molded polyethylene and to be cast in the concrete. Sleeves for insulated pipe shall be of sufficient size to

allow the covering to pass through sleeve. Use steel pipe extended 1" above finished floor for sleeves in floors of rooms exposed to water. Watch and protect all sleeves and inserts while concrete is poured. Caulk annular space between pipe and sleeve with an oil and resin base type sealant conforming to Fed. Spec. TT-C-598.

In lieu of the above sleeving method, an alternate UL listed cast-in-place, sleeving method such as "ProSet" is allowable, provided the system is listed for the application including retaining the integrity of the floor or wall penetration in terms of UBC and IBC fire stop performance.

- H. Fire Protection: Fire stop pipe penetrations through fire rated walls, floors and ceilings in accordance with current Building Code.
- I. Floor Protection: Where pipes pass through wood floor of spaces containing water heaters, water coils or other equipment containing liquids subject to leaking, caulk or sleeve and caulk around pipe and penetration and to a point 1" above finished floor to make penetration watertight.
- J. Anchors, Alignment Guides and Expansion Joints: Provide at all building expansion joints. Install with provisions for free expansion and contraction of piping without damage to joints, hangers, equipment or building structure.

3.08 MECHANICAL SUPPORTING DEVICES

- A. General: Mechanical equipment and materials are not to be suspended or supported from pipe, electrical conduit, ceiling systems or any nonstructural member.
- B. Housekeeping Pads: Furnish for all mechanical equipment which do not specifically require structural bases or inertia pads. Minimum 4" high, concrete, and extended 4" beyond the equipment base dimensions in all directions. Anchor bolts to secure equipment poured in place in pads.
- C. Concrete Anchoring: Use cast inserts in new construction; stamped metal inserts not acceptable. Expansion shields may be used in existing construction; powder actuated inserts are not acceptable.
- D. Pipe Hangers and Supports: Item selections, hanger spacings, rod diameters, and protection shields in accordance with MSS SP-69 and MSS SP-58, unless otherwise indicated. Pipes shall not be hung or supported from each other. Isolate copper water pipes from dissimilar metals; hangers, steel or aluminum studs, etc.
- E. Multiple Pipe Supports: Where a number of pipes are hung with a common support (e.g. trapeze hanger), submit design criteria/calculation.
- F. Pipe Rolls: Required on pipe 2-1/2" and larger with straight runs greater than 50 feet from an anchor, and as indicated on drawings.
- G. Structural Attachments: Beam clamps where possible.
- H. Vertical Adjusting Device: Provide on all rigid hangers.
- I. Protection Shield/Protection Saddle: Use on insulated pipe.

- J. Risers: Provide support at tee or elbow at base of risers. Provide pipe clamp support at every floor.
- K. Duct Hangers: Install in accordance with SMACNA Duct Construction Standards, Low Pressure or High Pressure as appropriate.
- L. Vibration Isolations provide for all rotating machinery as described in Section 23 0548.

3.09 ACCESS PANELS

- A. Requirements: When not specifically shown on architectural drawings, provide in walls, ceilings, etc., to provide adequate access for service and maintenance of concealed valves, dampers, motors, air vents or any other concealed equipment or accessories. Minimum size 12" x 12".

3.10 HEAD PROTECTION

- A. Padding: Where duct angles, pipe hangers, equipment support angles, etc., are exposed in walkways or in access ways to equipment for maintenance purposes, cover all such potentially injurious protrusions less than 6'-0" above the floor with padding. Secure padding permanently and finish comparable to adjacent surfaces.

3.11 LUBRICATION

- A. Requirements: Lubricate all moving parts per manufacturer's recommendation. Replace ruptured seals caused by excessive lubrication. Attach service record label with space for future service to all major equipment.

3.12 IDENTIFICATION

- A. Equipment Nameplates: Affix prominently on equipment except in finished areas (e.g. unit ventilators in classrooms) where nameplate shall be inside access panel.
- B. Pipe Marking: Where pipe is exposed or accessible, install every 30 feet, at wall or partitions, and at pipe junctions. Lettering oriented to be read from below horizontal centerline. Mark all piping on project except non-acid waste and vent lines.

3.13 PAINTING

- A. Preparation and Application: Conform to requirements of Section 09 9100 - PAINTING
- B. Interior of Ductwork: Apply one coat of flat black enamel to all ductwork and lining which can be seen through grilles, registers or diffusers.

3.14 CORROSION PROTECTION

- A. General: Equipment where indicated elsewhere in these specifications shall be provided with additional coating as shown below.
 1. Condenser and evaporator finned tube coils shall be protected with an aluminum impregnated polyurethane (BLYGOLD POLUAL) coating performed by International Air Conditioning Coating, Inc., Waipahu, Hawaii or pre-approved equal.
 2. Prior to coating, rinse coil to remove dust, dirt or debris. Bent fins shall be adjusted using fin comb. The coil shall then be degreased with pH neutral cleaner and degreaser to remove oils and soiling. Flush the coil with a final rinsing and conditioning solution and allow it to dry before applying the coating.
 3. Apply the coating as specified above with air assisted spray equipment, ensuring total penetration and coverage of all surfaces with the manufacturer's recommended film thickness. Provide minimum of 3 year warranty for the coating.
- B. Cabinet and Exterior Surfaces:
 1. Unit cabinet shall be coated with AMERON PSX 700 Engineering Siloxane by International Air Conditioning Coatings, Inc., Waipahu, Hawaii or pre-approved equal.
 2. All metal surfaces to be coated shall be cleaned and degreased. The Coating shall be applied in strict accordance with the manufacturer's recommendation.
 3. After the coating has totally cured, the equipment shall be assembled using care not to damage the coating. Fasteners shall be stainless steel with bonderized rubber washer attached. Any touchup required shall be performed in accordance with the manufacturer's recommendation.
- C. Outdoor Metal Supports and Hanger: Provide epoxy paint minimum 2 coats, white color on all metal surfaces except those that are specified to be hot-dipped galvanized.

END OF SECTION

SECTION 21 10 00

FIRE SPRINKLER AND STANDPIPE SYSTEMS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Conditions:

1. Conform to General Conditions, Supplementary Conditions and DIVISION 1 – General Requirements.

1.02 SUMMARY

A. This Section includes but is not limited to:

1. The work includes designing and providing new automatic wet pipe fire extinguishing sprinkler systems for uniform distribution of water by hydraulic design to afford complete fire protection coverage throughout entire project area; Sprinkler system shall be 100% sprinkler coverage for all the spaces within these structures including the transformer rooms, trash chute and rooms, electric rooms, elevator shafts and equipment rooms, stair shafts (where required by NFPA 13, and City of Honolulu). The work also includes providing new wet standpipe systems as indicated. The work also includes providing a electric motor driven driven centrifugal, horizontal split-case type fire pump, pressure maintenance pump and related work.
2. The design, equipment, materials, installation, and workmanship shall be in strict accordance with the required and advisory provisions of NFPA 13, City and County of Honolulu and NFPA 14 and IBC Section 903 except as modified herein.
3. Each system shall be provided with earthquake protection and shall include all materials, accessories, and equipment necessary to provide each system complete and ready for use. Design and install each system to give full consideration to blind spaces, piping, electrical equipment, ductwork, and all other construction and equipment to afford complete coverage in accordance with detailed drawings to be submitted. Devices and equipment for fire protection service shall be listed by the Underwriters' Laboratories, Inc. or approved by FM Global. In the NFPA publications referred to herein, the advisory provisions shall be considered to be mandatory, as though the word "shall" had been substituted for "should" wherever it appears; reference to the "authority having jurisdiction" shall be interpreted to mean the Hawaii Insurance Bureau and the Building and Fire Departments.

1.03 GENERAL REQUIREMENTS

- A. Reference Standards: The publications listed below form a part of this specification to the extent referenced. Use the latest edition of each referenced publication. The publications are referred to in the text by the designation only.
1. American Society for Testing and Materials (ASTM) Publications
 - a. A 53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
 - b. A 120 Pipe, Steel, Black and Hot-dipped Zinc-Coated Welded and Seamless for Ordinary Uses.
 2. C104 Cement-Mortar Lining for Cast-Iron and Ductile-Iron Pipe and Fitting for Water.
 - a. C110 Gray-Iron and Ductile-Iron Fittings, 3 in. Through 48 in for Water and Other Liquids
 - b. C151 Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water and Other Liquids
 - c. C500 Gate Valves, 3 Inch Through 48 Inch, for Water and Sewage Systems
 - d. C601 Disinfecting Water Mains Factory Mutual (FM) Publication Approval Guide, 1992 edition
 3. National Fire Protection Association (NFPA) Publications:
 - a. NFPA 13 Sprinkler Systems.
 - b. NFPA 14 Standpipe Systems.
 - c. NFPA 24 Outside Protection.
 - d. NFPA 25 Inspection, Testing, and Maintenance of Water Based Fired Protection System.
 - e. NFPA 70 National Electrical Code
 4. Underwriters' Laboratories, Inc. (UL) Publications:
 5. Fire Protection Equipment Directory
- B. Submittals: Submit the following in accordance with the requirements of Section 01 3300 – SUBMITTAL PROCEDURES. Partial submittals will not be acceptable. Annotate descriptive data to show the specific model, type, and size of each item the Contractor proposes to furnish. Prepare working drawings on sheets not smaller than 30 inches by 42 inches, in accordance with the requirements for "Working Drawings (Plans) as specified in NFPA 13, and 14, and include data essential to the proper installation of each system. Do not commence work until the design of each system and the various components have been reviewed. The Architect, Hawaii Insurance Bureau and the Building and Fire Departments will review all submittals. Before work is commenced, submit complete sets of working drawings and calculations for each sprinkler system and working drawings for the standpipe system. Working drawings and calculations must be stamped by a professional engineer registered in the State of Hawaii.
1. Manufacturer's Data:
 - a. Pipe, fittings, and mechanical couplings
 - b. Valves including gate, check, relief, air release and globe
 - c. Sprinklers
 - d. Pipe hangers and supports
 - e. Earthquake sway bracing
 - f. Alarm pressure switches
 - g. Valve tamper switches and waterflow switches
 - h. Fire department connections
 - i. Standpipe hose valves
 - j. Gages

- k. Pressure regulating zone control valves
 - l. Sprinkler stoppers
 - m. Flow control valves
2. Shop (Working) Drawings:
 - a. Sprinkler and standpipe system layout
 - b. Hydraulic calculations
 3. Samples: One of each type of sprinkler head and escutcheon plates to be used.
 4. Certificates of Compliance:
 - a. Contractor's material and test certificate per NFPA 13.
 - b. Pipe and fittings
 5. Operation and Maintenance Manuals:
 - a. Pressure regulating valves
 - b. Alarm pressure switches
 - c. Valve tamper switches and waterflow switches
 6. Inspection, Maintenance, and Testing Agreement.
- C. Guaranty all work in writing for a period of one year in compliance with the requirements of Section 01 77 00 – CLOSEOUT PROCEDURES.
- D. Record Drawings: Maintain at the project site a copy of drawings to record any additions or changes. After substantial completion of the project, prepare reproducible "as-built" drawings from the site copy and submit them to the Architect in compliance with the requirements specified in Section 01 77 00 – CLOSEOUT PROCEDURES.
- E. Qualifications of Installer: Prior to installation, submit data for review by the Architect, showing that the Contractor has successfully installed automatic fire extinguishing sprinkler and standpipe systems of the same type and design as specified herein, or that he has a firm contractual agreement with a subcontractor having such required experience. The data shall include the names and locations of at least two installations where the Contractor, or the subcontractor referred to above, has installed such systems. The Contractor shall indicate the type and design of each system and certify that each system has performed satisfactorily in the manner intended for a period of not less than 18 months.

PART 2 - PRODUCTS

2.01 DESIGN OF SPRINKLER SYSTEM

- A. Sprinkler System: Design of wet pipe fire extinguishing sprinkler system shall be by hydraulic calculations for uniform distribution of water over the design area and shall conform to NFPA 13 except as modified herein and on plans.
1. Distribution of Water: Distribution shall be essentially uniform throughout the area in which it is assumed the sprinkler heads will open. Variation in discharge from individual heads in the hydraulically most remote area shall be between 100 and 120 percent of the specified density.
 2. Density of Application of Water: Size pipe to provide the specified density when the system is discharging the specified total maximum required flow. Application to horizontal surfaces below the sprinklers shall be as indicated on the drawings.

3. Sprinkler Discharge Area: Area shall be the hydraulically most remote area as defined by NFPA 13.
4. Outside Hose Allowances: Hydraulic calculations shall include an allowance of 250 gpm minimum for outside hose streams.
5. Friction Losses: Calculate losses in pipe in accordance with the Hazen-Williams formula with 'C' value of 120 for steel pipe, and 140 for buried cement-lined ductile-iron pipe.
6. Location of Sprinkler Heads: Heads in relation to the ceiling and walls and the spacing of sprinklers shall not exceed that permitted by NFPA 13, except light hazard applications may not exceed 225 sf and ordinary hazard applications may not exceed 130 sf per head.
7. Water Supply: Base hydraulic calculations on the water supply as indicated on the drawings.

2.02 EQUIPMENT

- A. Sprinkler Heads: Release element of each head shall be of the ordinary temperature rating or higher as suitable for the individual location where it is installed. Provide recessed glass bulb white coated pendent sprinklers, and white coated ceiling plates below suspended ceilings except for areas as indicated on drawings. Sidewall sprinklers shall be white coated with white coated escutcheons except for areas as indicated on drawings.
 1. Provide UL listed quick response sprinklers on all floors containing residential occupancies. Where extended coverage sidewall sprinklers are used they shall be UL listed extended coverage quick response type.
- B. Cabinet: Provide extra sprinkler heads and sprinkler head wrench and three of the proper types of sprinkler stoppers in a metal cabinet in the fire pump room. The number and types of extra sprinkler heads shall be as specified in NFPA 13.
- C. Sprinkler Supervisory Devices: Provide where indicated. Connection of the sprinkler supervisory devices to the building fire alarm system per the requirements of Division 16, Electrical.
 1. Water Flow Switch: Provide listed vane type water flow switches complete with an adjustable pneumatic retard with an adjustable range of 0 to approximately 60 seconds and two sets of Form C electrical contacts.
 2. Valve Tamper Switch: Provide each control valve with a listed tamper switch for the automatic transmittal of a trouble signal. Valve tamper switches which are integral to the control valve will be acceptable.
 3. Water Pressure Alarm Switch: Provide listed pressure alarm switch suitable for indoor outdoor service with two (2) sets of Form C Electrical Contacts. A pressure alarm switch is required on each alarm check valve.
 4. Water Motor Alarm: Provide listed water motor alarm for alarm check valves.
 5. Retard Chamber: Provide retard chamber on each alarm check valve.
- D. Flow Control Valves: Provide flow control valves, CLA-VAL Model 90-21 1-1/2 inch, or listed equal, which are electrically operated via a 24 vdc supervised circuit for control of sprinkler water supplies to the elevator machine room and hoistways. Provide separate flow control valve for each elevator machine room and each elevator hoistway. Flow control valves shall be similar in design to a listed preaction or deluge valve.

2.03 ABOVE GROUND PIPING SYSTEMS

- A. Inspect, test and approve piping before burying, covering, or concealing. Provide fittings for changes in direction of piping and for all connections. Make changes in piping sizes through reducing pipe fittings; the use of bushings will not be permitted. Welding shall be performed in the shop; field welding will not be permitted.
- B. Pipe and Fittings: Provide in accordance with NFPA 13 and NFPA 14 except as modified herein. All piping shall be steel, plastic pipe and copper tubing shall not be permitted except as noted below. Piping less than 2-1/2" in diameter shall be Schedule 40.
 - 1. Fittings into which sprinkler heads, sprinkler head riser nipples, or drop nipples are threaded shall be welded, threaded, or grooved-end type. Use of plain-end fittings with mechanical couplings (which utilize steel gripping devices to bite into pipe when pressure is applied) will not be permitted. Rubber gasketed grooved-end pipe and fittings with mechanical couplings shall be permitted in pipe sizes 1.25 inches and larger; fittings shall be UL listed or FM approved for use in sprinkler systems.
 - 2. Provide an earthquake sway brace within 24 inches of each flexible coupling which is installed in horizontal piping for purposes other than earthquake protection
 - 3. Fittings used in the sprinkler, fire pump and standpipe systems where maximum pressures exceed 175 psi shall comply with NFPA 13 and NFPA 14
 - 4. On resident floors listed CPVC fire sprinkler piping is allowable where installed in accordance with manufacturers recommendations.
- C. Pipe Hangers, Supports, and Earthquake Sway Bracing: Provide in accordance NFPA 13.
- D. Valves: Provide valves as required by NFPA 13 and NFPA 14 and of types approved for fire service. Gate valves shall open by counter-clockwise rotation. Check valves shall be flanged clear opening swing check type with flanged inspection and access cover plate for sizes 4 inches and larger. Provide OS&Y sectional valves as indicated.
 - 1. Where maximum pressures exceed 175 psi valves shall comply with NFPA 13.
- E. Control Valves: Provide floor control valves on each floor with flow and tamper switch and install in accordance with NFPA 13 and provide a water pressure gage at each floor control valve. Where the building is separated into leaseable spaces, each tenant space shall have a separate control valve with tamper switch and flow switch for each floor. UL listed sprinkler control valve assemblies will be acceptable.
- F. Pressure Regulating Zone Control Valves: Provide where maximum pressure exceed 175 psi Zone control valves for use as sprinkler system sectional valves shall be approved indicating straight type with necessary adaptors for connection of a valve tamper switch.
- G. Air Release Valves: Provide approved air release valves at locations where air will be trapped in piping.
- H. Identification Signs: Attach properly lettered approved metal signs conforming to NFPA 13 to each valve and alarm device. Permanently affix hydraulic design data nameplates to the riser of each system.

- I. Inspector's Test Connection: Provide test connections about 6 feet above the floor for each sprinkler system or portion of each sprinkler system equipped with an alarm device and locate at the hydraulically most remote part of each system.
- J. Main and Auxiliary Drains: Provide drain piping to discharge at safe points outside each building or to sight cones attached to drains of adequate size to readily receive the full flow from each drain under maximum pressure. Provide auxiliary drains required by NFPA 13 and NFPA 14.
- K. Pipe Sleeves: Provide where piping passes through walls, floors, roofs, and partitions. Secure sleeves in proper position and location. Provide sleeves of sufficient length to pass through entire thickness of walls, floors, roofs, and partitions. Provide not less than 0.25-inch space between exterior of piping or pipe insulation and interior of sleeve. Firmly pack space with an approved firestopping material.
 1. Sleeves in Masonry and Concrete Walls, Floors and Roofs: Provide ASTM A 53, Schedule 10, Schedule 40 or Standard Weight, zinc-coated steel pipe sleeves. Extend sleeves in floor slabs 3 inches above the finished floor.
 2. Sleeves in Partitions and Other Than Masonry and Concrete Walls, Floors, and Roofs: Provide zinc-coated steel having weight of not less than 0.90 pounds per square foot.
- L. Escutcheon Plates: Provide one piece or split hinge type metal plates for piping passing through floors, walls, and ceilings in exposed areas. Provide chromium-plated finish on plates; in finished areas. Provide paint finish on plates in unfinished areas. Securely anchor plates in place with setscrews or other acceptable positive means.
- M. Fire Department Connections: Provide connections approximately 3 feet above finish grade, of the approved flush-mounted, with chromium-plated wall plate, two-outlet type for automatic sprinkler system, four outlet type wet standpipe system, with 2.5-inch National Standard female hose threads with plug and chain. The function of the connection shall be clearly indicated as AUTOMATIC SPRINKLER or WET STANDPIPE, as applicable, with 1-inch letters cast on the cover plate or fitting. Fire department connections shall be located on a street front as indicated.
- N. Standpipe Hose Valves: Provide approved 2.5-inch polished brass angle valve with red iron hand wheel and female N.P.T. inlet and male National Standard Thread outlet with polished brass cap and chain. Provide roof outlets with two 2.5-inch hose valves as indicated. Provide listed adjustable pressure reducing hose valves as required to reduce pressure to a maximum of 100 psi. Provide means of testing of each hose valve on systems where maximum pressures exceed 100 psi. Rough brass may be used in back of house applications, polished brass to be used in front of house applications, confirm each with architect prior to installation.

2.04 BURIED WATER PIPING SYSTEMS

- A. Pipe and Fittings: Provide outside-coated, cement mortar lined, ductile-iron pipe and fittings conforming to NFPA 24 for piping under the building and less than 5 feet outside of the building walls. Anchor the joints in accordance with NFPA 24; provide concrete thrust block at the elbow where the pipe turns up toward the floor, and restrain the pipe riser with steel rods from the elbow to the flange above the floor. Minimum pipe size shall be inches. Minimum

- depth of cover shall be 3 feet. Piping outside of the building walls shall also be in accordance with the requirements of Division 2 "Site Work".
- B. Valves: Provide as required by NFPA 24. Gate valves shall conform to AWWA C500 or UL 262 with cast-iron body and bronze trim and shall open by counterclockwise rotation.
- C. Valves Boxes: Except where indicator posts are provided, provide each gate valve in buried piping with an adjustable cast-iron valve box of a size suitable for the valve on which it is to be used. Boxes outside of paved areas may be of Acrylonitrile-Butadiene- Styrene (ABS) plastic or of inorganic fiber reinforced black polyolefin plastic. The head shall be round and the lid shall have the word Water Cast on it. The least diameter of the shaft of the box shall be 5.25 inches. Provide each cast-iron box with a heavy coat of bituminous paint.
- D. Buried Utility Warning and Identification Tape: Provide detectable aluminum foil plastic-backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping. Tape shall be detectable by an electronic detection instrument. Provide tape in rolls, 3 inches minimum width, color coded for the utility involved with warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. Warning and identification shall be CAUTION BURIED WATER PIPING BELOW or similar. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material. Bury tape with the printed side up at a depth of 6 inches below the top surface of earth or the top surface of the subgrade under pavements.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Equipment, material, installation, and workmanship shall be in accordance with NFPA 13 and NFPA 14, except as modified herein. Install piping straight and true to bear evenly on hangers. Keep the interior and of new piping and existing piping affected by the Contractor's operations thoroughly cleaned of water and foreign matter. Keep piping systems clean during installation by means of plugs or caps. When work is not in progress, securely close open ends of piping and fittings so that water and foreign matter will not enter the pipes or fittings. Inspect piping before placing into position. Inspect, test, and approve piping before burying, covering, or concealing. Provide fittings for changes in direction of piping and for all connections. Make changes in piping sizes through tapered reducing pipe fittings; do not use bushings.
- B. Pipe Hangers (Supports): Provide additional hangers to support the concentrated loads in piping between hangers, such as for flanged valves.

3.02 CLEAN-UP

- A. Do not allow debris to accumulate. Comply with the clean-up requirements specified in Section 01 77 00 – CLOSEOUT PROCEDDURES.

3.03 DISINFECTION

- A. Provide where required by code. Disinfect the new buried water piping and existing water piping affected by Contractor's operations in accordance with AWWA C601. Fill the piping systems with solution containing minimum of 50 parts per million of available chlorine and allow solution to stand for minimum of 24 hours. Flush the solution from the systems with clean water until maximum residual chlorine content is not greater than 0.2 parts per million.

3.04 FIELD PAINTING

- A. Exposed Sprinkler and Standpipe Piping: Clean, pretreat, prime, and paint new sprinkler systems including valves, piping, conduit, hangers, miscellaneous metalwork, and accessories. Apply coatings to clean dry surfaces using clean brushes. Clean the surfaces to remove dust, dirt, rust and loose mill scale. Immediately after cleaning, provide the metal surfaces with one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, and one coat of primer applied to a minimum dry film thickness of one mil. Exercise care to avoid painting of sprinkler heads or protective devices. Remove materials which are used to protect sprinkler heads, while painting is in process, upon the completion of painting. Remove sprinkler heads which are painted and provide new clean sprinkler heads of the proper type.
- B. Sprinkler Systems in Unfinished Areas and Parking Garage: Unfinished areas are spaces where walls or ceiling are not painted or not constructed of prefinished material. Provide primed surfaces with one coat of red enamel applied to a minimum dry film thickness of one mil.
- C. Sprinkler Systems in All Other Areas: Provide primed surfaces with two coats of paint to match adjacent surfaces.

3.05 FIELD TESTING AND FLUSHING

- A. Preliminary Tests: Hydrostatically test each sprinkler and standpipe system at 50 psi in excess of maximum pressure when the maximum will be in excess of 150 psi, for a period of two hours. Piping above suspended ceilings shall be tested, inspected and approved before installation of ceilings.
 1. Flush sprinkler and standpipe piping in accordance with NFPA 13. Flush all new pump suction and discharge piping at 150 percent of rated pump capacity. For flushing the fire pump the flushing volume shall be the total quantity of water flowing when discharging at 150 percent of the rated capacity. The fire pump may be used to attain the required flushing volume. Continue flushing operations until water is clear, but for not less than 10 minutes.
 2. Test the alarms and other devices. Test the water flow alarms by flowing water through the inspector's test connection.
 3. When tests have been made completed and corrections made, submit a signed and dated certificate, similar to that specified in NFPA 13, with a request for a formal inspection and tests.
 4. Flow test all pressure reducing valves at system design flow.

- B. Formal Inspection and Tests: The Architect, Hawaii Insurance Bureau, and the Building and Fire Departments will witness formal tests and approve all systems before they are accepted. Submit the request for formal inspection at least 15 days prior to the date for formal inspection is to take place. An experienced technician regularly employed by the sprinkler installer shall be present during the inspection. At this inspection, repeat any or all of the required tests as directed. Correct defects in the work provided by the Contractor, and make additional tests until it has been demonstrated that the systems comply with all contract requirements. Furnish appliances, equipment, electricity, instruments, connecting devices, and personnel for the tests.

3.06 INSTRUCTING OPERATING PERSONNEL

- A. Upon completion of the work and at a time designated by the Owner, provide for a period of not less than an 4-hour the services of experienced technicians regularly employed by the manufacturer of the sprinkler system to instruct the fire department and building personnel in the proper operation and maintenance of the equipment.

3.07 INSPECTION, MAINTENANCE AND TESTING SERVICE AGREEMENT

- A. The Contractor shall include one year inspection, maintenance, and testing service agreement in the bid. The one year period shall begin at the date of final system acceptance by the Owner. The agreement shall cover all labor, parts, insurance taxes, fees, and other incidental costs to inspect and test the system in accordance with NFPA 25 and the Honolulu Fire Code. Inspection and testing of the system shall be conducted on a quarterly basis for a total of 4 visits during the one year period.

END OF SECTION

SECTION 21 3000

FIRE PUMP

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Conditions:

1. Conform to General Conditions, Supplementary Conditions and Division 1 – General Requirements.

1.02 SCOPE

- A. The work includes providing an electric motor driven centrifugal horizontal split case type fire pumps, pressure maintenance pump, and related work. Each system shall be complete and ready for operation. Equipment, materials, installation, and workmanship shall be in accordance with NFPA 20 and NFPA 70, except as modified herein. Devices and equipment for fire protection service shall be listed by Underwriters' Laboratories, Inc. or approved by the Factory Mutual System. In the NFPA publications referred to herein, the advisory provisions shall be considered to be mandatory, as though the word "shall" had been substituted for "should" wherever it appears; reference to the "authority having jurisdiction" shall be interpreted to mean the Fire Department, the Hawaii Fire Insurance Rating Bureau and the Building Department.

1.03 APPLICABLE PUBLICATIONS:

- 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.

1. American National Standards Institute (ANSI) Publications:
 - a. B16.1 Cast-Iron Pipe Flanges and Flanged Fittings
 - b. B16.3 Malleable-Iron Threaded Fittings
 - c. B16.5 Steel Pipe Flanges and Flanged Fittings
 - d. B16.9 Factory-Made Wrought Steel Butt welding Fittings
 - e. B16.11 Forged Steel Fittings, Socket-Welding and Threaded
 - f. B16.18 Cast Copper Alloy Solder-Joint Pressure Fittings
 - g. B16.21 Nonmetallic Flat Gaskets for Pipe Flanges
 - h. B16.22 Wrought Copper and Bronze Solder-Joint Pressure Fittings
 - i. B16.26 Cast Copper Alloy Fittings for Flared Copper Tubes
 - j. B16.39 Malleable-Iron Threaded Pipe Unions
 - k. B31.1, Am Power Piping
2. American Society for Testing and Materials (ASTM) Publications:
 - a. A 53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
 - b. A 120 Pipe, Steel, Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless, for Ordinary Uses
 - c. A 193 Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service

- d. A 194 Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service
- e. B 32 Solder Metal
- f. B 88 Seamless Copper Water Tube
- g. C 533 Calcium Silicate Block and Pipe Thermal Insulation
- h. C 610-67 (R74) Expanded Perlite Block and Pipe Thermal Insulation
- 3. American Water Works Association (AWWA) Publications:
 - a. C104 Cement-Mortar Lining for Cast-Iron and Ductile-Iron Pipe and Fittings for Water
 - b. C110 Gray-Iron and Ductile-Iron Fittings, 3" through 48" for Water and Other Liquids
 - c. C111 Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings
 - d. C151 Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids
 - e. C500 Gate Valves, 3 Through 48 Inch NPS for Water and Sewage Systems
 - f. C601 Disinfecting Water Mains
- 4. Factory Mutual System (FM) Publication:
 - a. Approval Guide
- 5. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS) Publications:
 - a. SP-58 Pipe Hangers and Supports - Materials, Design and Manufacturer
 - b. SP-69 Pipe Hangers and Supports - Selection and Application
- 6. National Fire Protection Association (NFPA) Publications:
 - a. 20 Centrifugal Fire Pumps
 - b. 24 Outside Protection
 - c. 37 Stationary Combustion Engines and Gas Turbines
 - d. 70 National Electrical Code
- 7. Steel Structures Painting Council (SSPC) Publication:
 - a. PS 10.01-64T Coal Tar Coating System No. 10.01 Hot-Applied Coal Tar Enamel
- 8. Underwriters' Laboratories, Inc. (UL) Publications:
 - a. Fire Protection Equipment Directory
 - b. 80 Steel Inside Tanks for Oil Burner Fuel
 - c. 142 Steel Aboveground Tanks for Flammable and Combustible
 - d. (Am 85) Liquids
 - e. 262 Gate Valves for Fire Protection Service
 - f. 789 Indicator Post for Fire Protection Service

1.04 QUALIFICATIONS OF INSTALLER

- A. Prior to installation, submit data for approval by the owner, showing that the Contractor has successfully installed fire pumps and associated equipment of the same type and design as specified herein, or that he has a firm contractual agreement with a subcontractor having such required experience. The data shall include the names and locations of at least two installations where the Contractor, or the subcontractor referred to above, has installed such systems. Indicate the type and design of each system and certify that each system has performed satisfactorily in the manner intended for a period of not less than 18 months.

1.05 SUBMITTALS

- A. Partial submittals will not be acceptable. Annotate descriptive data to show the specific model, type, and size of each item the Contractor proposes to furnish. Prepare shop drawings on sheets not smaller than 30" by 42", and include data essential to the proper installation of each system. Do not commence work until the design of each system and the various components have been approved. The Hawaii Insurance Rating Bureau and the Building Department, will review and approve all submittals.
1. Manufacturer's Data:
 - a. Pumps, drivers, and controllers
 - b. Pipe and fittings
 - c. Valves including gate, check, and relief valves
 - d. Gauges
 - e. Hose valve manifold test header
 - f. Pipe hangers (supports)
 - g. Devices and associated equipment
 - h. Flowmeter
 2. Shop Drawings:
 - a. Pumps, drivers, and controllers
 - b. Hose valve manifold test header
 - c. Complete circuit diagrams
 - d. Interior wiring diagrams of each controller
 3. Certificates of Compliance:
 - a. Pumps, drivers, and controllers
 - b. Pipe and fittings
 - c. Valves
 - d. Certificates of each welder's qualifications prior to site welding
 - e. Devices and associated equipment
 4. Certified Data:
 - a. Manufacturer's pump discharge curves
 5. Operation and Maintenance Manuals:
 - a. Pumps, drivers, and controllers
 6. Posted Operating Instructions:
 - a. Pumps, drivers, and controllers

1.06 ELECTRICAL MOTORS, CONTROLLERS, CONTACTORS, AND DISCONNECTS

- A. Furnish motors, controllers, contactors, and disconnects with their respective pieces of equipment, except controllers indicated as part of the motor control centers shall be provided under Division 16, "Electrical". Motors, controllers, contactors, and disconnects shall conform to and shall have electrical connections provided under Division 16, "Electrical." Controllers and contactors shall have a maximum of 120-volt control circuits, and auxiliary contacts for use with the controls furnished. When motors and equipment furnished are larger than sizes indicated, the cost of providing additional electrical service and related work shall be included under this section.

1.07 ELECTRICAL WORK

- A. Work associated with this section shall be provided under Division 26, "Electrical"

1.08 EXCAVATION, TRENCHING, AND BACKFILLING

- A. Provide under this section as specified in Division 2, "Site Work."

1.09 SEQUENCE OF OPERATION

- A. The fire pump shall start automatically whenever the pressure in the main system is reduced to 250 psig, automatically upon tripping of the fire sprinkler system, and manually when the starter is operated. Pump shall continue to run until shut down manually.

PART 2 - PRODUCTS

2.01 SYSTEM COMPONENTS

- A. Fire Pumps: Fire pump shall be automatic start and manual stop. Each pump capacity as rated head shall be not less than that indicated. Each pump shall furnish not less than 150 percent of rated capacity at not less than 65 percent of total rated head. Pumps shall be of the centrifugal horizontal split case with automatic air release and circulation relief valves.
1. Alarm: Provide an audible or visible alarm with electrical power supplied as indicated. Alarm signal shall be activated upon the following conditions: electric motor controller has operated into a pump running condition, loss of electrical power to electric motor starter, engine drive controller has operated into an engine running condition, engine drive controller main switch has been turned to OFF or to MANUAL position, trouble on engine driven controller or engine. Exterior alarm devices shall be weatherproof type. Provide alarm silencing switch and red signal lamp, with signal lamp arranged to come on when switch is placed on OFF position.
- B. Pressure Maintenance Pump: Provide pump to maintain a pressure of 250 psig on the system. Provide pump of the electrically driven, horizontal shaft, centrifugal type with a rated discharge of as shown on plans. Pump shutoff pressure shall not exceed the design working pressure of the system. Pump shall draft from the suction supply side of the suction pipe gate valve of the pump and shall discharge into the system on the downstream side of the pump discharge gate valve. Provide approved indicating gate valves of the outside screw and yoke type in the maintenance pump suction and discharge piping. Provide an approved check valve in the maintenance pump discharge outlet and the discharge gage valve. Provide a pressure switch in the system supply main near the point where it leaves the pump room which shall cause the maintenance pump to start when the pressure drops to 200 psig and to stop when the pressure reaches 250 psig.
- C. Electric Motor Driver: Provide electrical motors, controllers, conductors, and disconnects as specified herein. Power supply to each motor and controller shall be as indicated.
- D. Motors: Motor horsepower shall be not less than pump horsepower requirements at all points on the pump operating curve.
- E. Controllers: Controllers shall be approved for fire pump service and arranged for automatic and manual pushbutton pump starting and manual pushbutton pump shutdown. Controller shall be completely terminally wired, ready for field connections, and mounted in a moisture resistant enclosure arranged so that controller current carrying parts will not be less than 12 inches above

the floor. Provide integral Time Delay Relay (TDR) within motor starter. The electric motor controller shall be UL/FM labeled and arranged to start the fire pump motor automatically on loss of system pressure with automatic stop. It shall be supplied with a circuit breaker rated not less than 100,000 AIC at 3 phase, 60 Hertz, 230/460 volts. The starter shall be reduced voltage type and the magnetic starting contactor shall be of the solid state soft start type.

F. Automatic Transfer Switch:

1. Complies with NFPA 20, **UL 218**, and **UL 1008**.
2. Integral with controller as a listed combination fire-pump controller and power transfer switch.
3. Automatically transfers fire-pump controller from normal power supply to alternate power supply in event of power failure.
4. Allows manual transfer from one source to the other.
5. Alternate-Source Isolating and Disconnecting Means: Mechanically interlocked isolation switch and circuit breaker, with an externally mounted operating handle; circuit breaker shall be provided with non-thermal sensing, solid state type with instantaneous-only short-circuit overcurrent protection to comply with available fault currents.
6. Local and Remote Alarm and Status Indications:
 - a. Normal source available.
 - b. Alternate source available.
 - c. In normal position.
 - d. In alternate position.
 - e. Isolating means open.
7. Audible alarm, with silence push button.
8. Manual mode of transfer.
9. Engine test push button.
10. Start generator output contacts.
11. Timer for weekly generator tests.

2.02 ABOVEGROUND WATER PIPING SYSTEMS:

A. Pipe and Fittings: Provide AWWA.

1. Sizes 4 Inches and Larger: Piping, including suction and discharge piping, shall be steel pipe with flanged end connections. Sections of pipe between flanged end connections shall be continuous; butt welding of short sections of pipe to form a longer section of pipe will not be permitted. Fabrication of pipe fittings by welding will not be permitted, other than the welding of the flanges to the fitting.
 - a. Steel Pipe: ASTM A 53 or ASTM A 120, Schedule 40, black steel, with butt welding end connections. Weld ANSI B16.5, Class 150 steel flanges to each end of the steel pipe. Welding shall be metallic arc process in accordance with ANSI B31.1, including qualifications of welders.
 - b. Flanged Fittings: ANSI B 16.5, Class 150, or ANSI B16.1, Class 125. Provide ASTM A 193, Grade B7 bolts and ASTM A 194, Grade 7 nuts.
2. Sizes 3 Inches and Smaller:
 - a. Steel Pipe: ASTM A 53 or ASTM A 120, Schedule 40, zinc-coated, threaded end connections. Provide ANSI B16.3 zinc-coated threaded fitting and ANSI B16.39 zinc-coated threaded unions.
 - b. Copper Tubing: ASTM B 88, Type K. Provide ANSI B16.18 or ANSI B16.22 solder joint fittings using ASTM B32, 50-50 tin-lead solder.

- B. Pipe Hangers (Supports): MSS SP-58 and MSS SP-69. Provide adjustable type. Finish of rods, nuts, bolts, washers, hangers, and supports shall be zinc-plated after fabrication.
- C. Valves: Provide valves of types listed or approved for fire protection service with flanged or threaded end connections.
 1. Gate Valves: Provide outside screw and yoke type which open by counterclockwise rotation.
 2. Check Valves: Provide flanged clear opening swing check type valve with flanged inspection and access cover plate for sizes 4 inches and larger.
- D. Hose Valve Manifold Test Header: Construct header of steel pipe conforming to ASTM A 53 or ASTM A 120, Schedule 40, black steel, with buttwelding end connections. Provide buttwelding fittings conforming to ANSI B16.9 of the same material and weight as the piping. Provide ANSI B16.5, Class 150 flanged inlet connection to hose valve manifold assembly. Each test header outlet shall have approved bronze hose gate valve with 2.5" National Standard male hose threads with cap and chain; locate 3 feet above grade. Welding shall be metallic arc process in accordance with ANSI B31.1, including qualifications of welders.
- E. Pipe Sleeves: Provide where piping passes through walls, floors, roofs, and partitions. Secure sleeves in proper position and location. Provide sleeves of sufficient length to pass through entire thickness of walls, floors, roofs, and partitions. Provide not less than 0.25" space between exterior of piping or pipe insulation and interior of sleeve. Firmly pack space with insulation and caulk at both ends of the sleeve with plastic waterproof cement which will dry to a firm but pliable mass, or provide a segmented elastomeric seal.
 1. Sleeves in Masonry and Concrete Walls, Floors, and Roofs: Provide ASTM A 53 or ASTM A 120, Schedule 10, Schedule 40, or Standard Weight, zinc-coated steel pipe sleeves. Extend sleeves in floor slabs 3" above the finished floor.
 2. Sleeves in Partitions and Other Than Masonry and Concrete Walls, Floors, and Roofs: Provide zinc-coated steel sheet having a nominal weight of not less than 0.90 pounds per square foot.
 3. Escutcheon Plates: Provide one piece or split hinge type metal plates for piping passing through floors, walls, and ceilings in exposed areas. Provide chromium-plated finish on plates in finished areas. Provide paint finish on plates in unfinished areas. Securely anchor plates in place with setscrews or other approved positive means.

2.03 BURIED WATER PIPING SYSTEMS:

- A. Pipe and Fittings: Provide outside-coated, cement mortar-lined, ductile-iron pipe and fittings conforming to NFPA 24 for piping under the building and less than 5 feet outside of the building walls. Anchor the joints in accordance with NFPA 24; provide concrete thrust block at the elbow where the pipe turns up toward the floor, and restrain the pipe riser with steel rods from the elbow to the flange above the floor. Minimum pipe size shall be 6 inches. Minimum depth of cover shall be 3 feet. Piping more than 5 feet outside of the building walls shall be outside coated, AWWA C104 cement mortar-lined, AWWA C151 ductile-iron pipe, and AWWA C110 fittings conforming to NFPA 24.
- B. Valves: Provide as required by NFPA 24. Gate valves shall conform to AWWA C500 or UL 262 with cast-iron body and bronze trim and shall open by counterclockwise rotation.

- C. Post Indicator Valves: Provide with operating nut located about 3 feet above grade. Gate valves for use with indicator post shall conform to UL 262. Indicator posts shall conform to UL 789. Provide each indicator post with one coat of primer and two coats of red enamel paint.
- D. Valve Boxes: Except where indicator posts are provided, provide each gate valve in buried piping with an adjustable cast-iron valve box of a size suitable for the valve on which it is to be used. Boxes outside of paved areas may be of Acrylonitrile-Butadiene-Styrene (ABS) plastic or of inorganic fiber reinforced black polyolefin plastic. The head shall be round and the lid shall have the word WATER cast on it. The least diameter of the shaft of the box shall be 5.25 inches. Provide each cast-iron box with a heavy coat of bituminous paint.
- E. Buried Utility Warning and Identification Tape: Provide detectable aluminum foil plastic-backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping. Tape shall be detectable by an electronic detection instrument. Provide tape in rolls, 3" minimum width, color-coded for the utility involved, with warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. Warning and identification shall be CAUTION BURIED WATER PIPING BELOW or similar. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material. Bury tape with the printed side up at a depth of 6" below the top surface of earth or the top surface of the subgrade under pavements.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Equipment, materials, installation, and workmanship shall be in accordance with NFPA 20, except as modified herein. Install piping straight and true to bear evenly on supports.
- B. Cleaning of Piping: Keep the interior and ends of new piping and existing piping affected by the Contractor's operations thoroughly cleaned of water and foreign matter. Keep piping systems clean during installation by means of plugs or other approved methods. When work is not in progress, securely close open ends of piping and fittings so that water and foreign matter will not enter the pipes or fittings. Inspect piping before placing into position.

3.02 PIPE AND FITTINGS

- A. Inspect, test, and approve piping before burying, covering, or concealing. Provide fittings for changes in direction of piping and for all connections. Make changes in piping sizes through tapered reducing pipe fittings; do not use bushings.
- B. Threaded Connections: Jointing compound for pipe threads shall be polytetrafluoroethylene (PTFE) pipe thread tape, pipe cement and oil, or PTFE powder and oil; apply only on male threads. Provide exposed ferrous pipe threads with one coat of primer applied to a minimum dry film thickness of one mil.

- C. Pipe Hangers (Supports): Provide additional hangers to support the concentrated loads in piping between hangers, such as for flanged valves.
1. Piping to receive Insulation: Provide temporary wood spacers between the insulation protection shield and the pipe in order to properly slope the piping and to establish final elevations. Temporary wood spacers shall be of the same thickness as the insulation to be provided.
 2. Maximum Spacing Between Hangers:
 3. Vertical Piping: Support metal piping at each floor, but at not more than 10-foot intervals.
 4. Horizontal Piping: Support ductile iron piping at 5-foot intervals equal to the pipe length but not exceeding 10 feet. Support steel piping as follows:

Maximum Spacing (Feet)

Nominal Pipe Size (inches)	1 and under	1.25	1.5	2	2.5	3	3.5	4	5	6
Steel Pipe	7	8	9	10	11	12	13	14	16	17

3.03 NAMEPLATES:

- A. Provide laminated plastic nameplates for equipment, gages, thermometers, and valves; stop valves in supplies to fixtures will not require nameplates. Laminated plastic shall be 0.125" thick Melamine plastic, black with white center core. Surface shall be a matte finish. All corners shall be square. Accurately align lettering and engrave into the white core. Minimum size of nameplates shall be one inch by 2.5". Lettering shall be a minimum of 0.25" high normal block lettering. Key the nameplates to a chart and schedule for each system. Frame charts and schedules under glass and place where directed near each system. Furnish two copies of each chart and schedule. Each inscription shall identify its function. Equipment nameplates shall show the following information:
1. Manufacturer, type, and model number
 2. Contract number and accepted date
 3. Capacity or size
 4. System in which installed
 5. System which it controls.

3.04 DISINFECTION

- A. Disinfect the new water piping and existing water piping affected by Contractor's operations] in accordance with AWWA C601. Fill the piping systems with solution containing minimum of 50 parts per million of available chlorine and allow solution to stand for minimum of 24 hours. Flush the solution from the systems with clean water until maximum residual chlorine content is not greater than 0.2 parts per million.

3.05 INSTRUCTING OPERATING PERSONNEL

- A. Upon completion of the work and at a time designated by the owner, provide for a period of not less than one 4-hours the services of an experienced technician regularly employed by the manufacturer of the pumps and the drivers to instruct operating personnel in the proper operation and maintenance of the equipment.

3.06 FLUSHING

- A. Flush all new pump suction and discharge piping at 150 percent of rated pump capacity. Where the pump installation involves more than one pump, the flushing volume shall be the total quantity of water flowing when all pumps are discharging at 150 percent of their rated capacities. The new pumps may be used to attain the required flushing volume. Continue flushing operations until water is clear, but for not less than 10 minutes. Submit a signed and dated flushing certificate with a request for field testing.

3.07 FIELD TESTING

- A. Preliminary Tests: Hydrostatically test each piping system at 200 psig for a period of 2 hours. Perform tests on pumps, drivers, and equipment, including visual equipment checks to insure compliance with approved shop drawings; pump start-run to insure proper operation and to detect any leakage of piping, valves, and fittings; sequence of operation check; verification that all required pump accessories have been provided; test of pump alarm devices; and additional inspections and tests necessary to insure that the entire pump installation is correct, complete, and ready for operation. When preliminary tests have been completed and corrections made, submit a signed and dated certificate with a request for a formal inspection and tests.
- B. Formal Inspection and Tests: The Hawaii Insurance Rating and the Special Inspector shall have the option of witnessing, formal tests and approve all systems before they are accepted. Submit the request for formal inspection at least 15 days prior to the date the inspection is to take place. An experienced technician regularly employed by the pump installer shall be present during the inspection. Where pumps are engine driven, an experienced technician regularly employed by the engine manufacturer capable of demonstrating that all engine trouble alarms and operating features perform as required shall be present. Tests shall include 100 and 150 percent capacity flows and pressures, and no-flow pressures for conformance with manufacturer's characteristic curves. At this inspection repeat any or all of the required tests as directed. Correct defects in the work provided by the Contractor, and make additional tests until it has been demonstrated that the system complies with all contract requirements. Manufacturer's certified shop test characteristic curves for each pump being tested must be furnished by the Contractor at the time of the pump acceptance test. Furnish appliances, equipment, [water,] electricity, instruments, connecting devices, and personnel for the tests.

END OF SECTION

SECTION 22 10 00

PLUMBING SYSTEM

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Conditions:

1. Conform to General Conditions, Supplementary Conditions and Division 1 - General Requirements.

1.02 SCOPE

A. Section Includes:

1. Soil, waste and vent piping system and accessories inside building and to a point 5'-0" outside building.
2. Roof drains, piping and accessories inside building and to a point 5'-0" outside building.
3. Domestic hot and cold water piping and accessories inside building and to point 5'-0" outside building.

1.03 SUBMITTALS

A. Submittals: Meet the applicable requirements of Section 01 33 00 – SUBMITTAL PROCEDURES. Provide shop drawings, list of items applied and product data for:

1. Pipe and Fittings
2. Water heater
3. Hot Water Storage Tank
4. Roof Drains
5. Cleanouts
6. Trap Primers
7. Sewage Ejector
8. Submersible Pump
9. Oil Interceptor
10. Grease Interceptor
11. Hose Bibbs
12. Neutralization Tank
13. Booster Pump
14. Gas Vent
15. Water Hammer Arrestor
16. Washer Box
17. Sovent System
18. Instantaneous Water Heater
20. Expansion Tank
21. Thermostatic Mixing Valve

- B. Shop Drawings shall be for entire plumbing system. Provide coordinated layout drawings minimum 1/4" per foot, which show all piping, sprinkler heads, ductwork, equipment, conduit, cable trays, pull boxes, light fixtures, access panels, architectural, and structural systems. All trades to coordinate in preparation of drawings to establish final locations of work. Areas of extreme congestion shall be shown at 1/2" scale.

PART 2 - PRODUCTS

2.01 WATER PIPE AND FITTINGS

- A. Buried Water Pipe: Type "K" copper with wrought copper fittings, ASTM B-88, silver solder.
- B. Above Grade Water Piping: Type "L", hard drawn copper with wrought copper fittings, ASTM B-88, silver or 95-5 solder. Inside residential units, CPVC or PEX piping materials are allowable. Provide listed piping systems by ICBO, IAPMO, and National Sanitation Foundation NSF-61 and NSFCL-R listed for chlorinated domestic continuous recirculation systems. Install in accordance with manufacturer's recommendations. DZR Brass ASTM 1807

2.02 WATER HAMMER ARRESTORS

- A. Type: Factory fabricated, PDI certified unit with stainless steel construction and nitrogen charge. Sizes as recommended by manufacturer. J.R. Smith 5000, Zurn, Sioux Chief or Cash Acme.

2.03 WATER HEATER

- A. General: Electric, glass lined, UL labeled, diffuser dip tube, insulated casing, upper and lower thermostats with high limit control, anodes for corrosion protection, steel tank, two 4500 watt low-watt density direct immersion elements, automatic temperature control, brass drain valve, relief valve opening. As manufactured by A.O. Smith, Ruud, Republic, State.

2.04 BOOSTER PUMP

- A. General: Packaged unit fully piped, wired, tested and mounted on steel frame with control panel. Number of pumps and capacity as specified on the drawings. Bell & Gossett, Paco or Equal.
- B. System consist of two or more bronze fitted pumps with drip-proof motor, each with shut-off valves on suction and discharge, pressure gauges, combination pressure reducing nonslam check valves on discharge side and thermal protection on the discharge header. NEMA 1, UL listed control cabinet containing motor starters, control transformer, time delays, solid state current sensing relay, low system pressure cutout, H-O-A switches, minimum run timers, warning lights, automatic pump, alternators and programmable controllers.

2.05 SUBMERSIBLE PUMP

- A. General: Heavy duty sealed submersible effluent pump, cast iron body and impellers on supporting legs, stainless steel fasteners, motor and bearings in sealed housing, liquid level control for automatic operation, UL listed. Peabody Barnes, Paco, Hydromatic, Weil, Zoeller.

2.06 OIL INTERCEPTOR

- A. General: Steel body with acid resistant epoxy coating on inside and coal tar outside, integral storage compartment, removable sediment bucket and baffle, adjustable oil draw-off and vent connections on either side, internal air relief bypass, bronze cleanout plug, flow control fitting and one piece non-skid steel cover with lift ring and neoprene gasket. Jay R. Smith Series 8599 or equivalent by Josam, Zurn.

2.07 GREASE INTERCEPTOR

- A. General: Constructed of reinforced precast concrete in the capacity and configuration indicated on the drawings. It shall have two chambers with baffle, access manholes with traffic cast iron frame, gasketed cover and sampling box. Interior and exterior surfaces shall be coated with two coats of bituminous damp proof material. Unit shall be I.A.P.M.O. certified, UPC approved and meet the current City and County of Honolulu rules and regulations.

2.08 NEUTRALIZATION TANKS

- A. General: High-density polyethylene (polypropylene for temperature above 180 degree F) cylindrical tank with connecting fittings, flanged top and matching cover. Town & Country or Equal.
B. Furnish sufficient limestone for two fillings.

2.09 GAS VENT

- A. General: Double wall vent system consists of galvanized outer wall and aluminum inner wall. Accessories include roof flashing, vent top, adaptor and mounting supports.

2.10 SOVENT SYSTEM

- A. General: Engineering single stack drainage systems are allowed as indicated on plans. Deviations from plans even if allowable by Sovent Manufacturer are not allowed unless the modification is required for compliance with manufacturer's guidelines. Where drawings are more conservative than manufacturer's guidelines, deviation from the drawings are not allowed. Install in accordance with plans and manufacturer's recommendations. Provide factory review of all shop drawings prior to submittal. Only cast-iron sovent fittings manufactured by US Manufacturer's shall be provided. All aerators and deaerators manufactured by Conine Mfg. Co. Inc. or approved equal.

2.11 INSTANTANEOUS WATER HEATER

- A. General: Tankless type electric resistance heater, automatic adjustable thermostat control, high temperature cutoff rated for 150 PSI pressure, UL listed. Eemax, Stiebel Eltron or Equal.

2.12 WASHER BOX

- A. General: Constructed of high impact Polystyrene with hammer arrester $\frac{1}{4}$ turn brass ball valves, 2" drain opening and mounting brackets. Oatey, Sioux Chief, Guy Gray.

2.13 ICE MACHINE BOX

- A. General: Constructed of high impact polystyrene with hammer arrester $\frac{1}{4}$ turn brass ball valves, copper sweat, 6"x6"x3" box and mounting brackets. Oatey, Sioux Chief, Guy Gray.

2.14 HOSE BIBBS

- A. General: Shall be brass, key type, with integral wall flange and screwdriver stop. Finish: chrome-plated. Provide non-removable type backflow preventer on outlet, listed approved by the City and County of Honolulu, Watts , Chicago Faucets, Arrowhead.

2.15 DRAINAGE, WASTE AND VENT PIPE AND FITTINGS - UNDERGROUND

- A. Type: Cast iron no-hub pipe and fittings with MG or Anaco Husky SD 4000 heavy duty couplings may be used. ABS-DWV or PVC-DWV plastic, long pattern, solvent weld joints.

2.16 DRAINAGE, WASTE AND VENT PIPE AND FITTINGS - ABOVEGROUND

- A. Type: Galvanized, schedule 40, long pattern recessed C.I. screw fittings. DWV copper, long pattern cast brass fittings - 50/50 solder. Cast iron, no-hub, long pattern, ring clamp joints.

2.17 PIPE AND FITTINGS - EXTERIOR DOWNSPOUTS

- A. Type: Galvanized, Schedule 40, long pattern recessed cast iron screwed fittings.

2.18 ROOF DRAINS

- A. Requirements: See Plumbing Fixture Schedule on drawings. Furnish all roof drains with flashing collars and deck clamps.

2.19 DOWNSPOUT BOOTS

- A. Type: J.R. Smith, Zurn, Josam or Wade equal to J.R. Smith Model 1785, 1786 or 1787-18 as applicable.

2.20 FORCED MAIN PIPING

- A. Ductile iron Class 53 with mechanical coupling for aboveground pipe. PVC pipe schedule 80, solvent weld joints for underground pipe.

2.21 CLEANOUTS

- A. General: J.R. Smith, Zurn, Josam or Wade equal to J.R. Smith models listed.
1. Grade Cleanout - GCO - 4283 - brass tapered thread plug.
 2. Floor Cleanout - FCO - 4023 - brass tapered thread plug.
 3. Floor Cleanout - FCO - 4143 - use in tile floors.
 4. Wall Cleanout - WCO - 4472 - bronze plug, chrome cover
 5. Floor Cleanout - FCO - 4023-Y - with carpet marker.

2.22 FLASHING AND COUNTERFLASHING

- A. Requirements: 3 lb. lead soldered joints and seams, 24 x 24 base pad and counterflashed into pipe.

2.23 TRAP PRIMERS

- A. Type: J.R. Smith, Josam or Zurn equal to J.R. Smith Model S-2699. PPP Model PR 500 SS with distribution unit.

2.24 DIESEL ENGINE EXHAUST

- A. General: Exhaust Pipe shall be black steel Schedule 40 with wall thimble and rain cap as required.

2.25 EXPANSION TANK

- A. General: Steel construction per ASME Section VIII Division 1, pre-charge with removable heavy duty butyl bladder, 150 PSI working pressure, all wetted components shall be of FDA approved materials, designed for potable water application. Taco, Amtrol, Bell & Gossett.

2.26 THERMOSTATIC MIXING VALVE

- A. General: Constructed with all bronzed and stainless steel components with liquid-filled thermostatic piston and liner controller, check stops on inlets, removable strainer, positive shutoff of hot supply when cold supply is lost, volume control valve and bimetal thermometer. Provide stainless steel cabinet for outdoor installation. Bradley, Symmons, Leonard.

PART 3 - EXECUTION

3.01 LAYING OF PIPE

- A. Buried Pipe: Install with not less than one foot of cover, measured from top of pipe to approved finish floor. Install pipe in accordance with the manufacturer's recommendations. Construct water lines under other utilities where necessary to meet the minimum cover requirements.

3.02 WATER HAMMER

- A. General: Provide an approved mechanical device to absorb high pressure at each water connection to a plumbing fixture. Air chamber is not allowed.

3.03 FITTINGS

- A. Thrust Blocks: Poured concrete, Mix 1-2-4, against undisturbed soil with sufficient concrete and 3/4" anchor rods, if required, to resist the resultant forces.

3.04 COUPLINGS, BOLTS AND PIPE

- A. Existing Lines: Patch where protective coating has been damaged or removed by coating with applications of hot asphaltum and wrapping with protective wrapping material before installation in the trench.

3.05 OIL INTERCEPTOR

- A. Concrete Pit: Provide concrete pit with weep holes for buried oil interceptors, secure interceptor to the concrete pit.

3.06 CONTAMINATION

- A. Protection: Prevent contamination of the pipeline during construction from any operation or source.

3.07 WATER PIPING

- A. Thrust Blocks: Adequately anchor at all changes of direction. Pour concrete underground anchors in place, equivalent to 1/3 cubic foot per square inch of pipe area. Anchor, by tie rods and clamps, changes in direction in an approved manner. Not less than 3 feet coverage.

3.08 HOT WATER

- A. Temperature: Generate at 120 degrees F unless indicated otherwise on drawings.
- B. Water Heater: Provide temperature and pressure relief valve, check valve and expansion tank for a closed system.

3.09 CLEANING

- A. Method: Clean prior to testing by thoroughly flushing with water until all dirt and foreign materials have been removed. Maintain flushing operations for not less than one hour and until piping is clean. Not less than 80 psi flushing pressure. Inform Engineer two days in advance so he may witness cleaning.

3.10 STERILIZATION

- A. Method: Sterilize water lines with chlorine before acceptance of project by Owner. Apply amount of chlorine such as to provide a dosage of not less than 50 parts per million (PPM). After a contact period of not less than 24 hours, flush system with clean water until residual chlorine content is not greater than chlorine residual in the flushing water. Provide certifications of chlorinated PPM, contact period and chlorine PPM at flushing. Open all valves in lines being sterilized and close several times during contact period. Inform Engineer two days in advance so he may witness sterilization. Provide to Architect/Engineer written certification from an approved agency certifying that bacteriological examination shows no contamination in the system.

3.11 WATER SYSTEM TEST

- A. Procedure: Conduct for a period of not less than 8 hours at 150% operating pressure, 150 psig minimum. Inform Engineer two days in advance so he may witness testing.

3.12 RAINLEADERS

- A. Expansion: Provide swing or expansion joints. Install main vertical stacks with provisions for expansion.

3.13 HORIZONTAL DRAINAGE AND WASTE PIPING

- A. Grading: Provide a grade of 1/4" per foot where possible, but in no case less than 1/8" per foot (as allowed by code). Install main vertical soil and waste stacks with provisions for expansion and extend full size to roof line as vents.

3.14 BASE OF DRAINAGE AND WASTE STACKS

- A. Fittings: Provide supporting shoes and anchors.

3.15 DRAINAGE AND WASTE PIPING TESTS

- A. Requirements: Subject all work to hydrostatic test of 10 foot head of water. Obtain approval for all work or portions of work as tested, in writing, prior to covering or concealment in any manner. Notify Engineer at least 2 normal working days prior to testing any portion of work and do not conceal any work until so directed by the Engineer.

3.16 VENTS

- A. Flash and Counterflash: Install vents passing through roof with vandalproof roof flashing and counterflashing assemblies.

3.17 FLOOR DRAINS

- A. General: Provide above grade drains with seepage pan. Where installed in slabs with waterproof membrane, provide with clamping collar. Provide adaptors on drains suitable for anchoring to construction. Trap and vent all drains.
- B. Trap Primers: Install automatic trap primers at all locations as required by code.

3.18 CLEANOUTS

- A. Requirements: Provide every 50 feet and install at all locations required by code and to permit cleaning of all sewer piping. Provide cleanouts full size of pipe, but not larger than 4-inches. Close cleanout openings with brass screw plugs. Where cleanouts occur in floor, install a brass ferrule complete with a screwed brass cover, flush with floor. Install cleanout threads with graphite. Locate cleanouts to clear cabinet work and make them easily accessible.

3.19 WASTE PIPING TESTS

- A. Requirements: Subject all work to hydrostatic test of 10 foot head of water or as directed by local plumbing inspection authority. Obtain approval for all work or portions of work as tested, in writing, prior to covering or concealment in any manner. Notify Engineer at least two (2) normal working days prior to testing any portion of work and do not conceal any work until so directed by the Engineer.

END OF SECTION

SECTION 22 40 00

PLUMBING FIXTURES AND TRIM

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Conditions:

1. Conform to General Conditions, Supplementary Conditions and Division 1 - General Requirements.

1.02 SUMMARY

A. Section Includes:

1. Plumbing fixtures, trim and installation including installation and/or connection of fixtures provided by others.

1.03 SUBMITTALS

A. Submittals:

1. Meet the applicable requirements of Section 01 33 00 – SUBMITTAL PROCEDURES. Provide product data for all Plumbing Fixtures and accessories specified in this section or scheduled on the drawings.

B. Shop Drawings shall be for entire system. Provide coordinated layout drawings minimum 1/4" per foot, which show all piping, sprinkler heads, ductwork, equipment, conduit, cable trays, pull boxes, light fixtures, access panels, architectural, and structural systems. All trades to coordinate in preparation of drawings to establish final locations of work. Areas of extreme congestion shall be shown at 1/2" scale.

1.04 CLOSEOUT SUBMITTALS

- A. Submit under provisions of Section 01 77 00 – CLOSEOUT PROCEDURES.
- B. Operation and Maintenance Data: Submit operation and maintenance data including maintenance schedules, spare parts requirements, and procedures.

1.05 QUALITY ASSURANCE

- A. Single Source: Provide plumbing fixtures from a single manufacturer.

PART 2 - PRODUCTS

2.01 PLUMBING FIXTURES

- A. General: As scheduled on drawings, manufactured by American Standard, Eljer or Kohler for enameled cast-iron or china type, Just or Elkay for stainless steel units.

2.02 FIXTURE TRIM

- A. Type: As scheduled on drawings, manufactured by Chicago, T & S, Moen, American Standard, Crane, Speakman, Eljer, Kohler, Valley, Eastman, or CS & B.

2.03 WATER CLOSET SEATS

- A. Type: As scheduled on drawings, manufactured by Beneke, Church or Olsonite.

2.04 FIXTURE SUPPLIES

- A. General: Install for all required fixtures, equal to Eastman, 1/2" inlet and outlet, or similar loose key stop type as applicable to specific fixtures.

2.05 TRAPS

- A. General: Install for all fixtures. 17 gauge chrome plated brass.

2.06 DRAINS

- A. Type: Manufactured by J.R. Smith, Zurn, Wade or Josam, equal to J.R. Smith models scheduled.

2.07 FIXTURE SUPPORTS

- A. Type: Manufactured by J. R. Smith, Zurn, Wade or Josam, equal to J. R. Smith model numbers listed as standard. All supports shall be floor type.

2.08 FAUCETS

- A. General: Of one manufacturer and containing interchangeable operating units of both hand-closing and self-closing types as specified, closing with the pressure of the water.

2.09 VACUUM BREAKERS

- A. Type: Watts, Cash-Acme V-3, or equal.

2.10 PROTECTIVE PIPE COVERS

- A. Requirements: All ADA Lavatories and sinks shall have molded vinyl covers on all exposed piping and valves.

PART 3 - EXECUTION

3.01 EXPOSED PIPING, VALVES, HANGERS, ETC. AT FIXTURES

- A. Finish: Chromium plated.

3.02 SINK SIZE

- A. Coordination: Verify sink size with cabinet prior to ordering.

3.03 FIXTURES AND EQUIPMENT

- A. Rough-In And Connect: Connect fixtures and equipment furnished and installed by General Contractor, Owner, or others. It is the contractor's responsibility to obtain from supplier sufficient information to rough-in properly and connect all fixtures in accordance with manufacturer's recommendation. Furnish all traps, valves, tail pieces and other trim not furnished with equipment.

3.04 SHUT-OFF VALVES

- A. Fixture Groups: Provide shut-off valves on all water lines to fixture groups.

3.05 FIXTURES

- A. Locations: Locate in accordance with details and dimensions on architectural drawings and/or Architect's direction in field.

3.06 FIXTURES AND EQUIPMENT

- A. Installation: Support and fasten wall hung fixtures with concealed floor support type carriers. Align fixtures and equipment installed in batteries in accordance with architectural drawings. Fit fixtures on finished walls without noticeable warpage on either the wall or fixture and grout with G.E. silicone or similar approved material.

3.07 VACUUM BREAKERS

- A. Location: Install on water supply to all fixtures which have water connection located below rim. Install on all hose bibbs and hydrants.

3.08 WATER CONNECTIONS

- A. Stops: Install individual loose key stops on all fixtures. If water connections are concealed, install valves in lieu of stops.

3.09 FIXTURE CONNECTIONS

- A. Installation: In accordance with rough-in details of manufacturer.

END OF SECTION

SECTION 23 01 00

MAINTENANCE OF MECHANICAL SYSTEMS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- A. Conditions: Conform to General Conditions, Supplementary Conditions and Division 1 - General Requirements.

1.02 SUMMARY

- A. Section Includes: Provision of extended maintenance of mechanical systems specified in related sections within this specification.

1.03 SUBMITTALS

- A. Submittals: Submit under provisions of Section 01 33 00 – SUBMITTAL PROCEDURES.

1.04 CLOSEOUT SUBMITTALS

- A. Submit under provisions of Section 01 77 00 – CLOSEOUT PROCEDURES.
- B. Operation and Maintenance Data: Submit operation and maintenance data including maintenance schedules, spare parts requirements, and procedures.

1.05 QUALITY ASSURANCE

- A. Maintenance shall be performed by service company with no less than 10 years experience maintaining systems of similar size and complexity.

1.06 ONE YEAR GUARANTEE AND MAINTENANCE SERVICE CONTRACT:

- A. In addition to the Guaranty on materials and workmanship, the Installer shall submit seven (7) copies of the Maintenance Service Contract, countersigned by the Contractor that will validate the Guaranty.
- B. The Guarantee and maintenance service shall extend for a period of one year commencing after 30 consecutive days of trouble-free operation after the Project Acceptance Date or the air conditioning equipment acceptance date, if earlier than the Project Acceptance Date. It shall include all labor, materials, equipment and parts necessary to service the complete system, in accordance with the attached Schedule of Maintenance Service, so as to assure proper operation

and function of the system. All costs for the periodic maintenance, including emergency calls, shall be borne by the Contractor. This maintenance period and the Guaranty period shall run concurrently (same start and end dates). However, should the contractor default on maintenance service contract and must restart or complete the service, then the warranty period shall also be extended to match the revised maintenance service period.

- C. Trouble-free operation is defined as a non-disabling condition or a non-recurring failure or disruption and the following:
 - 1. The system shall be free of all discrepancies, contamination and debris which requires correction in excess to those described for the monthly service which is included in the Schedule of Maintenance.
 - 2. The system is maintaining operational conditions and other parameters as measured during acceptance tests.
- D. The installer shall include a listing of the following items along with the Maintenance Service Contract:
 - 1. Name of the servicing contractor.
 - 2. Air conditioning system acceptance date.
 - 3. Service contract expiration date.
 - 4. Service Inspection schedule for the maintenance period.
 - 5. Itemized listing of the equipment covered under the service contract, including a description of the equipment identified, its model and serial number(s) and manufacturer's name(s).
- E. The Maintenance Service Contract shall be submitted along with the Operations and Maintenance Manual on/or before the Project Acceptance Date.
 - 1. Distribution of submittal:
 - a. 1 copy: Contractor
 - b. 1 copy: DAGS, Inspection Branch Engineer Files
 - c. 2 copies: User (District Office and School)
 - d. 2 copies: User's Facility Maintenance Agency
 - e. 1 copy: DAGS, Quality Control Branch

1.07 OPERATIONAL AND MAINTENANCE MANUAL:

- A. Submit three (3) hard bound copies of the Operating and Maintenance Manual on all equipment and the system as a whole. The manual shall identify project name and number, contractor, consultant, date, and all equipment provided. It shall include the equipment manufacturer's name, model and serial number, tag no., capacity, quantity of units, their location and area (room) served and shall each include the manufacturer's operation and maintenance manuals including control and wiring diagrams and source of service and replacement parts. When standard manufacturers brochures are used, adequately indicate (highlight, arrow, etc.) the project related information and delete (X or cross-out) the non-applicable information.
- B. Distribution of Submittals:
 - 1. 1 Copy: User
 - 2. 2 Copies: User=s Facility Maintenance Agency

1.08 SCHEDULE OF MAINTENANCE SERVICE

- A. All services performed by the Contractor shall include applicable items listed but shall not be limited to the following maintenance tasks.

1.09 AIR HANDLING UNIT/FAN COIL UNIT

A. Monthly Service:

1. Clean and clear all drip pans and flush all related condensate drain lines with nitrogen. (Contractor may be liable for water damage due to clogged drains). Install pan tablets if necessary to control algae.
2. Change all disposable air filters at least once a month, using filters similar to existing.
3. Wash permanent type filters with an approved detergent and spray coat with an approved filter treatment solution. Replace deteriorated permanent type filters which cannot be cleaned.
4. Lubricate and oil all fan and motor bearings and connections of dampers and vanes.
5. Check all drives for wear; adjust belt tension. Replace belt as required.
6. Operate equipment to check for proper operation, unusual noise and vibration; adjust or repair all equipment and controls as required; clean-up all equipment. Check UVC light element and fixtures.
7. Check time clock for proper operation and time settings.
8. Certify performance of monthly services and that all discrepancies are reported and corrected.

B. Quarterly Service:

1. Clean cooling coils of dirt accumulation using water, steam or chemical coil cleaner solution (acidic or alkaline not allowed), unless equipped with UVC lights.

C. Annual Service:

1. Adjust alignment of bearings and sheaves; lubricate fan and motor bearings. Replace worn or noisy bearings or sheaves.
2. Check water pressure and temperature differential across cooling coils and log readings. Clean water strainers, check vents and drains on chilled water coils.
3. Remove and wash supply and return air grilles, registers and diffusers and fresh air intake grilles and dampers and repair or replace deteriorated bird screens.
4. Clean and adjust water valve, clean strainer (chilled water) and clean all fan wheels and interior and exterior of equipment housings.
5. Secure all loose housing, seal leaks and touch-up paint after cleaning all rust.
6. Check and calibrate all electric and/or electronic temperature controls.
7. Replace UVC light elements with new elements.
8. Certify performance of annual service and correct and report all discrepancies.

1.10 COOLING TOWER

A. Monthly Service:

1. Check and adjust water make-up float valve and bleed rate.
2. Check general condition of tower interior and water distribution pattern.
3. Check and lubricate motor and fan bearings.
4. Check all drives for wear; adjust belt tension. Replace belts or sheaves as required.
5. Remove foreign material from inside the tower.
6. Check for leaks, patch, correct or repair as required..
7. Certify performance of monthly maintenance service, correct and report all discrepancies.

- B. Semi-Annual Service:
1. Drain, clean and flush tower; coordinate with water treatment service.
 2. Clean condenser suction screen, drift eliminators and spray nozzles.
 3. Certify semi-annual cleaning of towers and correct and report all discrepancies.

1.11 VENTILATION FANS (Exhaust and Supply)

- A. Quarterly Service:
1. Check motor-controlled and back-draft dampers for proper operation; lubricate linkage for free movement.
 2. Lubricate fan motors and bearings.
 3. Check belt wear and tension; adjust or replace as needed.
 4. Check sheaves for wear, replace as needed.
 5. Check fan collar, bearings and shaft for wear, repair or replace as needed.
 6. Replace air filters where installed; remove and wash intake grille.
 7. Certify performance of quarterly fan maintenance service and correct and report all discrepancies.
- B. Semi-Annual Service:
1. Check and clean fan wheels and housings of dust, dirt, and grease.
 2. Remove and wash all intake grilles and dampers and repair or replace deteriorated bird screens.
 3. Certify performance of semi-annual fan maintenance service and correct and report all discrepancies.

1.12 PUMPS

- A. Quarterly Service:
1. Lubricate and check pump and motor bearings for abnormal temperature and unusual noise or vibration and repair as needed.
 2. Check packing glands and seals for excessive leakage. Adjust, tighten or replace as required.
 3. Certify performance of quarterly service and correct and report all discrepancies.
- B. Semi-Annual Service
1. Remove and clean strainer for all condenser pumps after tower cleaning.
 2. Check and blow down strainer to chilled water pumps. Remove and clean strainer if excessive debris is noted.
 3. Check condition of insulation, reinsulate as necessary.
 4. Log suction and discharge pressures.
 5. Clean and remove all dust and foreign matter. Clean all rust spots and scratches and touch up paint with matching color.
 6. Check motor coupling for alignment; mounting bolts are secure.
 7. Certify performance of semi-annual service and correct and report all discrepancies.

1.13 TEMPERATURE CONTROLS

- A. Quarterly Service
1. Check control devices for proper operation, sticking stems, and calibration; repair/replace weak or broken springs and all other parts.
 2. Check automatic dampers for tightness in closing, bent blades and defective linkage; lubricate connections for free movement and repair as required.
 3. Adjust thermostat to maintain 75 degrees F room temperature.
 4. Certify performance of quarterly maintenance service and that all discrepancies are reported and corrected.

1.14 PACKAGED WATER CHILLER, RECIPROCATING COMPRESSOR, AIR-COOLED/ WATER-COOLED CONDENSER

- A. Monthly Service
1. Check and record entering and leaving water temperatures and pressures of chilled water and water-cooled condenser in "maintenance log book".
 2. Check and record refrigerant compressor suction and discharge and oil pressures.
 3. Visual check for water, refrigerant and oil leakage; correct or repair as required. Check vibration isolator mounts.
 4. Check compressor, fan, and motor bearings for abnormal temperature and unusual noise; lubricate and/or replace as required.
 5. Adjust chilled water temperature setting for seasonal change.
 6. Check refrigerant sight glass; change filter/drier if moisture indicated (DX system). Check compressor oil level and add oil as required.
 7. Check air-cooled condenser belt and tension, adjust, or replace as required.
 8. Adjust alignment of bearings and sheaves for fans, motors, and compressors, and replace worn or noisy bearings or sheaves.
 9. Note and run system operation through complete operating cycle and adjust for proper operation. Certify performance of monthly maintenance service and correct and report all discrepancies.
- B. Quarterly Service
1. Check chiller response at various cooling load conditions for proper operation and calibration of capacity control system.
 2. Check operation of freezestat and oil failure switch; record settings.
 3. Test adjust "make-up" water and expansion tank.
 4. Certify performance of quarterly maintenance service and correct and report all discrepancies.
 5. Clean condenser coils with water, steam or chemical coil cleaning solution (air-cooled).
- C. Semi-Annual Service:
1. Remove heads of condenser and internally brush tubes at the same time cooling tower is cleaned (water-cooled).
- D. Annual Service:
1. Test compressor crankcase oil and replace if contaminated or submit oil test results; clean or replace strainer and oil filter.

2. Megger (electrical test to measure wire insulation resistance, i.e. condition) chiller/compressor motor; check starter relay and control contacts and electrical connections for tightness and clean as required.
3. Test operate control switches, compressor unloading and safeties; calibrate and record settings. Adjust as required.
4. Submit and certify performance of annual maintenance service. Correct and report in writing to Manager-in-Charge all discrepancies.

1.15 PACKAGE OR SPLIT DX AIR-COOLED AIR CONDITIONER

- A. Monthly Service:
 1. Perform the tasks of Item A, Air Handling Unit/Fan Coil Unit.
 2. Check compressor oil level and refrigerant sight glass; add oil as needed and change filter/drier if moisture indicated.
 3. Check refrigerant system for leaks, unusual noise and vibration and record suction, discharge and oil pressures in maintenance log book and correct and report all deficiencies.
- B. Quarterly Service
 1. Clean condenser coils of dirt accumulation using water, steam or chemical coil cleaner solution.
- C. Annual Service
 1. Perform the tasks of Item A, Air Handling Unit/Fan Coil Unit.
 2. Check compressor coupling alignment; lubricate or replace noisy bearings.
 3. Test compressor crankcase oil and replace if contaminated or submit oil test results. Clean or replace strainer and oil filter (open compressor).
 4. Test and check system response at various cooling load conditions for proper operation, record settings, adjust as required. Recalibrate all safeties, capacity, and temperature controls to proper settings.
 5. Check and clean all unit housing (inside and outside and components), seal leaks and remove rust from exterior components and touch-up paint.
 6. Megger (electrical test to measure wire insulation resistance, i.e. condition) compressor motor and submit report and recommendation; check starter, relays, and control contacts and electrical connections for tightness and clean as required.

1.16 WINDOW AND DUCT-LESS SPLIT DX AIR CONDITIONERS (3-1/2 Tons or Less)

- A. Quarterly Service
 1. Clean evaporator and condenser coils with spray coil cleaner; wash unit to remove dirt, oil and debris from fan assembly and chassis.
 2. Clean condensate pan and flush drain line.
 3. Lubricate compressor and fan motor bearings.
 4. Check system refrigerant charge.
 5. Furnish and install new filter.
 6. Run and check cooling operation and controls through complete cycle; record temperature and setting when compressor cuts in.
 7. Certify performance of quarterly maintenance service and correct and report all discrepancies.

1.17 STANDBY AND LEAD-LAG EQUIPMENT (Pumps, Chillers, Cooling Towers, etc.) AND TIME CLOCKS

- A. The Contractor shall be responsible for the operational change-over of all standby and lead-lag equipment.
- B. Monthly - clean contacts, replace if necessary; check and adjust time settings as directed or required.
- C. Certify that all discrepancies are reported and corrected.

1.18 VALVES AND CONDENSER WATER LINES, EQUIPMENT AND SUPPORTS

- A. The Contractor shall exercise all equipment shut-off valves annually for proper operation and tightness.
- B. Wirebrush, prime and paint rust from pipe, equipment and support surface to prevent further rusting.
- C. Certify that all discrepancies are reported and corrected.

1.19 CLEANING OF MECHANICAL EQUIPMENT ROOMS OR ENCLOSURES

- A. Monthly:
 1. Vacuum or wipe clean all equipment surfaces and all related appurtenance.
 2. Vacuum clean or sweep complete floor and platform areas. DO NOT wet floor and platform area where there is no waterproofing.
 3. Wet wash complete floor area with tap water where allowed. Remove all used, deteriorated, replaced, discarded parts and related debris.
CAUTION: DO NOT splash water onto the electrical and mechanical equipment
 4. Notify Manager-in-Charge of any dangerous conditions, improper storage of furniture, materials and supplies which impacts your work within rooms and enclosures, including vandalism.
- B. Work Schedule
 1. All maintenance work shall be performed between the hours of 7:30 a.m. and 4:00 p.m., on normal working days, Monday through Friday, excluding State Holidays.
- C. Trouble Calls
 1. Emergency service and repairs required between regular service calls shall be rendered with 24 hours after the Contractor is notified, non-work days excluded.
 2. The Contractor shall call DAGS Central Services Division the next working day after being notified of the problem and report the status of repairs.

1.20 MAINTENANCE REPORT/CHECKLIST

- A. The Contractor shall prepare and maintain a maintenance service report/checklist which shall include the following:

1. Date maintenance service was performed.
2. The name of the mechanic who performed said maintenance.
3. The type and cost (labor, materials, parts and equipment) of repair work performed on the unit, if any.
4. Documents and other data pertaining to the maintenance performed.

5. It will be the responsibility of the Contractor to maintain the report/checklist by recording the above noted data after each scheduled maintenance and emergency repairs, and have the checklist available for inspection at the building site. The report shall be sufficiently detail to properly reflect the past maintenance history of the equipment.

Reports shall be certified by a representative of the facility being served and shall be submitted to DAGS Central Services Division monthly at the completion of the service/trouble call.

1.21 CLEANUP AND WORK PRACTICES

- A. The Contractor shall keep the job site free of debris, litter, discarded parts, etc. and shall clean all oil drippings during the daily progress of work. The Contractor shall remove all tools, parts and equipment from the service areas upon completion of the work.
- B. The Contractor shall exercise caution during the progress of his maintenance and repair work to prevent damage to the ceilings, roofing and other building structure. The Contractor shall restore all damages, caused by his negligence, to its original condition at his own expense.

1.22 OPERATIONAL ACCEPTANCE TESTS

- A. Accomplish performance tests in accordance with the attached Operational Performance Tests Form provided by the Maintenance Contractor.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

NOT USED.

END OF SECTION

SECTION 23 05 48

NOISE AND VIBRATION CONTROL

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- A. Conditions: Conform to General Conditions, Supplementary Conditions and Division 1 - General Requirements.

1.02 SUMMARY

- A. Extent of vibration control work required by this section is indicated on drawings and schedules, and/or specified in other Division 23 sections.
- B. Unless other noted on the equipment schedule, all Division 23 mechanical equipment shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce uniform deflection. Deflections shall be as noted on the schedules.
- C. Vibration control products furnished as integral part of factory-fabricated equipment are specified as part of equipment assembly in other Division 23 sections.
- D. Refer to other Division 23 sections for equipment foundations, hangers, sealants, gaskets, and other work related to vibration control work.
- E. Refer to other Division 23 sections for requirements of electrical connections to equipment isolated on vibration control products.
- F. Refer to other Division 23 sections for requirements of duct connections to air handling equipment isolated on vibration control products.

1.03 SUBMITTALS

- A. Submittals: Submit under provision of Section 01 33 00 - SUBMITTAL
- B. Product Data: Submit manufacturer's technical product data and installation instructions for each type of vibration control product. Submit schedule showing size, type, deflection, and location for each product furnished.
- C. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weights, required clearances, and method of assembly of components. Detail bases, and show location of equipment anchoring points, coordinated with equipment manufacturer's shop drawings.

- D. Maintenance Data: Submit maintenance data for each type of vibration control product. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 1.

1.04 CLOSEOUT SUBMITTALS

- A. Submit under provisions of Section 01 77 00 - CLOSEOUT PROCEDURES.
- B. Operation and Maintenance Data: Submit operation and maintenance data including maintenance schedules, spare parts requirements, and procedures.

1.05 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of vibration control products, of type, size, and capacity required, whose products have been in satisfactory use in similar service for not less than 5 years.
1. Except as otherwise indicated, obtain vibration control products from single manufacturer.
 2. Engage manufacturer to provide technical supervision of installation of vibration control products.

PART 2-PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. All vibration isolators shall be of the seismic restraint type. Ceiling mounted equipment shall have seismic bracing. Outdoor isolators shall have hot dipped galvanized or neoprene coated finish on all bolts, nuts, screws, washers and other mounting hardware.
- B. Manufacturer: Subject to compliance with requirements, provide vibration control products of one of the following:
1. Amber/Booth Co.
 2. Flex-Hose
 3. Kinetics
 4. Mason Industries, Inc.
 5. Vibro-Acoustics

2.02 VIBRATION CONTROL MATERIALS AND SUPPORTS UNITS

- A. Neoprene Pads: Neoprene pads molded in natural rubber, 180 lbs load rating, 2"x2" square by $\frac{3}{4}$ " thick, single layer. (Mason Industries, Inc. Type Super W or equal)
- B. Neoprene Isolators: Double deflection neoprene mountings shall have a minimum static deflection of 0.35". All metal surfaces shall be neoprene covered to avoid corrosion and have friction pads both top and bottom so they need not be bolted to the floor. Bolt holes shall be provided for these areas where bolting is required. On equipment such as small vent sets and close coupled pumps, steel rails shall be used above the mountings to compensate for the overhang. (Mountings: Mason

Industries, Inc Type ND or equal) (Rails: Mason Industries, Inc. Type DNR or equal).

- C. Spring Isolators: Spring type isolators shall be free standing and laterally stable without any housing and complete with 1/4" neoprene acoustical friction pads between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly, bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflections, compressed spring height and solid spring height. (Mason Industries, Inc. Type SLF or equal).
- D. Restrained Spring Isolators: Equipment with operating weight different from the installed weight such as chillers, boilers, etc. and equipment exposed to the wind such as cooling towers shall be mounted on spring mountings, but a housing shall be used that includes vertical limit stops to prevent spring extension when weight is removed. The housing shall serve as blocking during erection and cooling tower mounts shall be located between the supporting steel and roof or the grillage and dunnage as shown on the drawings. The installed and operating heights shall be the same. A minimum clearance of 1/2" shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Limit stops shall be out of contact during normal operations. Mountings used outdoor shall be hot dipped galvanized and PVC coating on the spring. (Mason Industries, Inc. Type SLR or equal)
- E. Spring Hangers (Fans, Piping): Vibration hangers shall contain a steel spring and 0.3" deflection neoprene element in series. The neoprene element shall be molded with a rod isolation bushing that passes through the hanger box. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 degree arc before contacting the hole and short circuiting the spring. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include a scale drawing of the hanger showing the 30' capability. (Mason Industries, Inc. Type 30N or equal)
- F. Precompressed Spring Hangers: Vibration hangers shall be as described in Type D hangers, but they shall be precompressed to the rated deflection so as to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. (Mason Industries, Inc. Type PC30N or equal)
- G. Spring Hangers (Ductwork): Vibration hangers shall contain a steel spring located in a neoprene cup manufactured with a grommet to prevent short circuiting of the hanger rod. The cup shall contain a steel washer designed to properly distribute the load on the neoprene and prevent its extrusion. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30' arc before contacting the hole and short circuiting the spring. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Hangers shall be provided with an eye bolt on the spring end and provision to attach the housing to the flat iron duct straps. Submittals shall include a scale drawing of the hanger showing the 30' capability. (Mason Industries, Inc. Type W30 or equal)

- H. Steel Bases: Vibration isolator manufacturer shall furnish integral structural steel bases. Bases shall be rectangular in shape for all equipment other than centrifugal refrigeration machines and pump bases which may be >T= or >L= shaped. Pump bases for split case pumps shall include supports for suction and discharge base ells. All perimeter members shall be beams with a minimum depth equal to 1/10th of the longest dimension of the base. Beam depth need not exceed 14" provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Height saving brackets shall be employed in all mounting locations to provide a base clearance of one inch. (Mason Industries, Inc. Type WF or equal)
- I. Rail Bases: Vibration isolator manufacturer shall provide steel members welded to height saving brackets to cradle machines having legs or bases that do not require a complete supplementary base. Members shall be sufficiently rigid to prevent strains in the equipment. (Mason Industries, Inc. Type ICS or equal)
- J. Concrete Inertia Bases: Vibration isolator manufacturer shall furnish rectangular structural beam or channel concrete forms for floating foundations. Bases for split case pumps shall be large enough to provide support for suction and discharge base ells. The base depth need not exceed 12" unless specifically recommended by the base manufacturer for mass or rigidity. In general, bases shall be a minimum of 1/12th of the longest dimension of the base, but not less than 6". Forms shall include minimum concrete reinforcement consisting of half-inch bars or angles welded in plate on 6" centers running both ways in a layer 1-1/2" above the bottom, or additional steel as is required by the structural conditions. Forms shall be furnished with drilled steel members with sleeves welded below the holes to receive equipment anchor bolts where the anchor bolts fall in concrete locations. Height saving brackets shall be employed in all mounting locations to maintain a 1" clearance below the base. (Mason Industries, Inc. Type K or equal)
- K. Flexible Spherical Connectors: Rubber expansion connectors shall be used on all equipment as indicated on the drawings or on the equipment schedule. They shall be manufactured of peroxide cured EPDM throughout with kevlar tire cord reinforcement. The raised face rubber flanges must encase solid steel rings to prevent pull out. Flexible cable wire is not acceptable. Straight connectors shall have two spheres. Connectors up to and including 1-1/2" diameter may have threaded ends. Connectors 2" and larger shall be manufactured with floating galvanized flanges recessed to lock the connector's raised face neoprene flanges. Connectors shall be installed on the equipment side of the shut-off valves. Connectors shall be rated a minimum of 150 psi at 250 degrees F.
- 1. Submittals shall include two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies. (Mason Industries, Inc. Safeflex Type SFDEJ or equal)
- L. Flexible Metallic Hoses: Flexible hoses shall have stainless steel braid and carbon steel fittings. 3" and larger sizes shall be flanged. Smaller sizes may have male nipples. Minimum length shall be as recommended by the manufacturer. Hoses shall be installed on the equipment side of the shut-off valves. (Mason Industries, Inc. Type BSS or equal)

- M. Acoustical Floor Ceiling and Wall Seal: Where piping passes through equipment walls, floors or ceilings, the vibration isolator manufacturer shall provide a split seal consisting of two bolted pipe halves with 3/4" or thicker neoprene sponge bonded to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Concrete may be packed around the seal to make it integral with the floor, wall or ceiling if the seal is not already in place around the pipe prior to the construction of the building member. Seals shall project a minimum of 1" past either face of the wall. Where temperatures exceed 240 degrees F, 10# density fiberglass may be used in lieu of the sponge. (Mason Industries, Inc. Type SWS or equal)
- N. Pipe Anchors: Vibration isolator manufacturer shall provide an all directional acoustical pipe anchor, consisting of a telescopic arrangement of two sizes of steel tubing separated by a minimum half inch thickness of heavy duty neoprene and duck or neoprene isolation material. Vertical restraints shall be provided by similar material arranged to prevent vertical travel in either direction. Allowable loads on the isolation material shall not exceed 500 psi and the design shall be balanced for equal resistance in any direction. (Mason Industries, Inc. Type ADA or equal)
- O. Horizontal Thrust Restraints: Air handling equipment shall be protected against excessive displacement which might result from high air thrusts in relation to the equipment weight. The horizontal thrust restraint shall consist of a spring element in series with a neoprene pad as described in Type B mounting with the same deflection as specified for the mountings or hangers. The spring element shall be contained within a steel frame and designed so it can be preset for thrust at the factory and adjusted in the field to allow for a maximum of 1/4" movement at start and stop. The assembly shall be furnished with one rod and angle brackets for attachment to both the equipment and ductwork or the equipment and the structure. Horizontal restraints shall be attached at the centerline of thrust and symmetrically on either side of the unit. (Mason Industries, Inc. Type WB or equal)
- P. Roof Curb Isolation Bases: Curb mounted rooftop equipment shall be mounted on vibration isolation bases that fit over the roof curb and under the isolated equipment. The extruded aluminum top member shall overlap the bottom member to provide water runoff independent of the seal. The aluminum members shall house cadmium plated spring having a 1" minimum deflection with 50% additional travel to solid. Spring diameters shall be no less than 0.8 of the spring height at rated load. Wind resistance shall be provided by means of resilient snubbers in the corners with a minimum clearance of 1/4" so as not to interfere with the spring action except in high winds. The weather seal shall consist of continuous closed cell sponge materials both above and below the base and a waterproof flexible duct like EPDM connection joining the outside perimeter of the aluminum members. Foam or other contact sales are unacceptable at the spring cavity closure. Caulking shall be kept to a minimum. Submittals shall include spring deflections, spring diameters, compressed spring height and solid spring height as well as seal and wind resistance details. (Mason Industries, Inc. Type CMAB or equal)

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which vibration control units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 PERFORMANCE OF ISOLATORS

- A. General: Comply with minimum static deflections recommended by ASHRAE, for selection and application of vibration isolation materials and units as indicated.
- B. Manufacturer's Recommendations: Except as otherwise indicated, comply with manufacturer's recommendations for selection and application of vibration isolation materials and units.

3.03 APPLICATIONS

- A. General: Except as otherwise indicated, select vibration control products in accordance with ASHRAE Handbook, 2011 HVAC Applications Volume, Chapter 48 "Noise and Vibration Control," Table 47. Where more than one type of product is offered, selection is Installer's option.
- B. Piping: For piping connected to equipment mounted on vibration control products, install isolation hangers as indicated, and for first 3 points of support for pipe sizes 4" and less, for first 4 points of support for pipe sizes 5" through 8", and for first 6 points of support for pipe sizes 10" and over.
 - 1. Earthquake Restraint: Where indicated, install earthquake-restrained spring isolator units.
- C. Flexible Spherical Connectors: shall be installed on the equipment side of the shut-off valves horizontally and parallel to the equipment shafts wherever possible.
- D. Horizontal Pipe Isolation: The first three pipe hangers in the main lines near the mechanical equipment shall be as described in Type E hangers, Horizontal runs in all other locations throughout the building shall be isolated by hangers as described in Type D hangers. Floor supported piping shall rest on isolators as described in Type C mountings. Heat exchangers shall be considered part of the piping run. All Type E hangers or the first three Type C mounts as noted above will have the same static deflection as specified for the mountings under the connected equipment. (Note: If piping is connected to equipment located in basements and hangs from ceiling under occupied spaces, the first three hangers shall have 0.75" deflection for pipe sizes up to and including 3", 1.5" deflection for pipe sizes up to and including 6", and 2.5" deflection thereafter.) All other hangers and mounts will have a minimum steel spring deflection of 0.75". Hangers shall be located as close to the overhead supports as practical.
- E. Riser Isolation: Risers shall be suspended from or supported by Type E hangers or Type C mountings and the piping anchored or guided with Specification N anchors, all as indicated on the riser drawings. Steel spring deflection shall be a minimum 0.75" except in those expansion locations where additional deflection is required to limit deflection or load changes to plus or minus 25% of the initial stress.

- F. Duct Isolation: All discharge runs for a distance of 25' from the connected equipment shall be isolated from the building structure by means of Type F hangers. Spring deflections shall be a minimum of 0.75".

3.04 INSTALLATION

- A. General: Except as otherwise indicated, comply with manufacturer's instructions for installation and load application to vibration control materials and units. Adjust to ensure that units have equal deflection, do not bottom out under loading, and are not short-circuited by other contacts or bearing points. Remove space blocks and similar, devices intended for temporary support during installation.
- B. Install units between substrate and equipment as required for secure operation and to prevent displacement by normal forces, and as indicated.
- C. Adjust leveling devices as required to distribute loading uniformly onto isolators. Shim units as required where substrate is not level.
- D. Install inertia base frames on isolator units as indicated, so that minimum of 1" clearance below base will result when frame is filled with concrete and supported equipment has been installed and loaded for operation.
- E. For air handling equipment, install thrust restraints as indicated, and also wherever thrust exceeds 10% of equipment weight.
- F. Locate isolation hangers as near overhead support structure as possible.
- G. Weld riser isolator units in place as required to prevent displacement from loading and operations.
- H. Flexible Spherical Connectors: Install on equipment side of shutoff valves, horizontally and parallel to equipment shafts wherever possible.

3.05 ADJUSTING AND CLEANING

- A. Upon completion of vibration control work, prepare report showing measured equipment deflections for each major item of equipment as indicated.
- B. Clean each vibration control unit, and verify that each is working freely, and that there is no dirt or debris in immediate vicinity of unit that could possibly short-circuit unit isolation.

END OF SECTION

SECTION 23 05 93

TEST, ADJUST, AND BALANCE OF AIR AND WATER SYSTEMS

PART 1 - GENERAL

1.01 GENERAL CONDITIONS

- A. The General Conditions of the Contract for Construction and the Supplementary Conditions preceding this Section are a part of this Contract and shall govern each Section of the Work.
- B. Requirements specified in Division 1 Sections apply to all Section of the Project Manual, where applicable, with the same effect as if incorporated within each Section.

1.02 SUMMARY

- A. Upon completion of the installation and field testing, performance test and adjust the supply and exhaust air systems, and water systems to provide the air volume and water flow quantities indicated. Accomplish all work in accordance with the agenda and procedures specified and AABC 71679 and standards of the NEBB. Correct air and water system performance deficiencies disclosed by the test before balancing the systems.

1.03 REFERENCE STANDARDS

- A. National Environmental Balancing Bureau, NEBB.
- B. Associated Air Balance Council, AABC.

1.04 QUALIFICATIONS

- A. Agency Qualifications: The Contractor, shall obtain the services of a qualified testing organization to perform the testing and balancing work as herein specified. The Contractor shall submit the name of the proposed testing agency to the Architect for minimum 30 days prior to testing and balancing. The criteria for determining qualifications shall be membership in the AABC, or certification by the NEBB, and the agency shall have not less than 5 years experience on projects of similar scope and complexity.
- B. All balancing reports to be prepared under the supervision of members of AABC or NEBB.
- C. Agencies:
 1. TAB Engineers
 2. Air Balance Hawaii
 3. Pacific Test and Balance, Inc.

PART 2 - PRODUCTS

2.01 LEAK DETECTION CHEMICALS

- A. The following are acceptable leak detection chemicals:
 1. Gas and Chemicals, Inc., "Leak-Tee".
 2. Cosgille Scientific, Inc., "Sho Gas".
 3. Flamort Chemical Co., "Detect-A-Leak".
 4. Highside Chemicals, Inc., "Leak Finder Foam".

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine the areas and conditions where to be installed and notify the Architect of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected by the Contractor in a manner acceptable to the Architect.

3.02 SYSTEM CHANGES

- A. General: The Contractor shall make any necessary changes in sheaves, belts, and dampers, and add volume dampers, as required for correct balance at no additional cost to the Owner.

3.03 CLEAN-UP

- A. Do not allow debris to accumulate. Comply with the clean-up requirements specified in Section 01 77 00 – CLOSEOUT PROCEDURES.

3.04 TESTING - GENERAL

- A. Clean all piping and ducts before testing.
- B. Use calibrated test gauges with at least 4-1/2 inches diameter dial. Gauge rating shall not be more than three times test pressure.

3.05 BALANCING AGENDA

- A. Preliminary Report: Review plans, specifications and installation of any of the affected systems. Submit a written report to the Engineer indicating any deficiencies in the systems that would preclude the proper adjusting, balancing, and testing of the systems.

- B. Submittal: An agenda shall be submitted and approved by the Engineer prior to start of testing and balancing work. Include the following:
 - 1. A complete listing of all air and water flow and air terminal measurements to be performed.
 - 2. Specific test procedures and parameters for determining specified quantities; e.g. flow drafts, sound levels, etc., from the actual field measurements to establish compliance with contract requirements.
 - 3. Samples of forms showing applications of procedures and calculations to typical systems.
- C. Procedure Reporting: Provide specific test procedures for measuring air quantities at terminals. Specify type of instrument to be used, method of instrument application (by sketch), and factors for:
 - 1. Air terminal configuration
 - 2. Flow direction (supply or exhaust)
 - 3. Velocity corrections
 - 4. Effective are applicable to each size and type of air terminal
 - 5. Density corrections (unless applicable data are covered elsewhere)

3.06 PROCEDURES, GENERAL

- A. Requirements: Adjust systems and components thereof to perform as required by drawings and specifications.
- B. Test Duration: Operating tests of cooling towers, pumps, cooling coils, fans, and other equipment shall be of not less than 4 hours duration, after stabilized operating conditions have been established. Capacities shall be based on temperatures and air and water quantities measured during such tests.
- C. Instrumentation: Method of application of instrumentation shall be in accordance with the approved agenda. Furnish all personnel, instruments, and equipment for test specified herein.
 - 1. Accuracy of Instruments: Instruments used for measurements shall be accurate. Provide calibration histories for each instrument for examination. Calibrate each test instrument by an approved laboratory or by the manufacturer. The Engineer has the right to request instrument recalibration, or the use of other instruments and test methodology, where accuracy of readings is questionable.
 - 2. Application of Instruments: Comply with manufacturer's certified instructions.
 - 3. Permanently-Installed Instruments: Do not install permanently-installed equipment used for the tests, e.g. gages, thermometers, etc., until just prior to the tests to avoid damage and changes in calibration.
 - 4. Filters: Install new air filters after the test run and before the start of testing and balancing.
 - 5. Strainers: Blow down all water strainers before the start of testing and balancing.

3.07 AIR SYSTEM PROCEDURE

- A. Adjustments: Adjust air handling to provide the required design and air quantity to, or through, each component. Conduct adjusting and balancing of systems during periods of the year approximating maximum seasonal operation.
- B. Equalizers: Adjust equalizing devices to provide uniform velocity across the inlets (duct side for supply of terminals) prior to measuring flow rates.
- C. Balance: Use flow adjusting (volume control) devices to balance air quantities only; i.e. proportion flow between various terminals comprising system, and only to the extent that their adjustments do not create objectionable air motion or sound. Make final measurements of air quantity, after the air terminal has been adjusted to provide the optimum air patterns of diffusion.
- D. Fan Adjustment: Total air system quantities shall be varied by adjustment of fan speeds.
- E. Air Measurement:
 1. Pitot Tube: Except as specifically indicated herein, make pitot tube traverses of each duct to measure air flow therein. Pitot tubes, associated instruments, traverses, and techniques shall conform with the ASHRAE Handbook Fundamentals.
 2. Pitot Tube Traverse: Pitot-tube traverse may be omitted if the duct serves only a single room or space and its design volume is less than 2000 CFM. In lieu of Pitot-tube traverse, determine air flow in the duct by totalling volume of individual terminals served, measured as described herein.
 3. Measurements of Air Quantity: Where duct's design velocity and air quantity are both less than 1000 (FPM/CFM), air quantity may be determined by measurements at terminals served.
 4. Test Holes: Test holes shall be in a straight duct, as far as possible down stream from elbows, bends, takeoffs, and other turbulence generating devices, to optimize reliability of flow measurements.
 5. Air Terminal Balancing: Measurement of flow rates by means of velocity meters applied to individual terminals, with or without cones or other adapters, shall be used only for balancing. Measurement of air quantities at each type of air terminal (inlet and outlet) shall be determined by the method approved in the balancing agenda.
- F. Air Balancing:
 1. Balance with outside and return air dampers fixed in minimum outside air positions. Obtain value of minimum outside air from drawings.
 2. Balance with filter pressure drop at midpoint between clean and dirty filters. Artificially create required pressure drop, if necessary, by blanking off coils.
 3. Balance with doors and windows in their normal, closed position.
 4. Balance air to the following tolerances:
 - a. Each outlet: +/- 10 percent.
 - b. Each room with multiple outlets: 0 percent to +10 percent.
 - c. Positive system: Exhaust rate to -5% of design, supply rate to +5% of design.
 - d. Negative system: Exhaust rate to +5% of design, supply rate to -5% of design.

5. Balance main exhaust systems to maintain interior building pressure at 0.05" water greater than outdoor pressure. This may require different exhaust or return air quantities than scheduled.
6. Adjust throw patterns of supply air outlets to result in uniform, draft-free room air distribution.
7. System design static pressures are approximations. Make changes in sheaves and belts as required for specific air balance. Final adjustment of sheaves to result in sheave with additional possible adjustment in both directions.
8. Inspect all rooms for room temperatures, drafts, and noise. Make adjustments to correct any problems.
9. Operate each room thermostat to verify correct system response to raising and lowering thermostat set points.

3.08 WATER SYSTEM PROCEDURE

- A. Adjustment: Adjust chilled water system to provide required quantity to, or through, each component.
- B. Metering: Measure water quantities and pressures with calibrated meters. Use venturi tubes, orifices, or other metering fittings and pressure gages. Adjust systems to provide the approved pressure drops through the heat transfer equipment (coils, etc.), prior to the capacity testing. Where flow metering fittings are not installed determine flow balance by measuring temperature differential across the heat transfer equipment. Perform measurement of temperature differential with the air system, adjusted as described herein, in operation.
- C. Automatic Controls: Position automatic control valves for full flow through the heat transfer equipment of the system during tests.
- D. Flow: Flow through bypass circuits at three-way valves shall be adjusted to balance that through the supply circuit.
- E. Distribution: Adjust distribution by means of balancing devices (cocks, valves, and fittings). Do not use service valves for adjustment.
- F. Special Procedures: When the pump capacity (as designed) is less than total flow requirements of individual heat transfer units of system served, full flow may be simulated by the temporary restriction of flow to portions of the system. In such a case, delineate specific procedures in the agenda.

3.09 CERTIFIED REPORTS

- A. Submittal: Submit three copies of the reports described herein, covering air and water system performance and air motion (FPM), to the Engineer prior to final tests and inspection.
- B. Instrument Records: Include types, serial numbers, and dates of calibration of all instruments.
- C. Reports: Reports shall identify conspicuous items not conforming to contract requirements.

3.10 AIR SYSTEM DATA

A. Report: The certified report shall include for each air handling system the data listed below.

1. Equipment (fan or factory fabricated air handling unit):
 - a. Installation Data:
 - (1) Manufacturer and model size
 - (2) Arrangement, discharge, and class
 - (3) Motor HP, voltage, phase, cycles, and full load amps
 - (4) Location and local identification data
 - b. Design Data:
 - (1) Data listed in schedules on drawings and specifications.
 - c. Fan Recorded (Test) Data:
 - (1) CFM
 - (2) Static pressure (suction, discharge, and total)
 - (3) RPM
 - (4) Motor operating amps
 - (5) Motor operating BHP
 - (6) Fan Curve
 - d. Duct Systems:
 - (1) Duct Air Quantities (Maximum and Minimum) - Main, Submains, Branches, Outside Air, Total Air, and Exhaust:
 - (2) Duct size(s)
 - (3) Number of pitot-tube (pressure) measurements
 - (4) Sum of velocity measurement, excluding pressure measurements
 - (5) Average velocity
 - (6) Recorded (test) CFM
 - (7) Design CFM
 - e. Individual Air Terminals:
 - (1) Terminal identification (supply or exhaust, location and number designation)
 - (2) Type size, manufacturer, and catalog identification
 - (3) Design and recorded quantities - CFM
 - (4) Deflector vane or diffusion cone settings
 - (5) Applicable factor for application, velocity, area, etc.
 - (6) Design and recorded velocities - FPM (state "core," "inlet," etc., as applicable)

3.11 WATER SYSTEM DATA

- A. Report: Include data listed below.
 - 1. Air Handling Units:
 - a. Design Data:
 - (1) Load in BTU per hour
 - (2) CFM
 - (3) Entering and leaving water temperature
 - (4) Entering and leaving air conditions (D.B. and W.B.)
 - (5) CFM
 - (6) Water pressure drop
 - b. Recorded Data:
 - (1) Type of equipment and identification (location or number designation)
 - (2) Entering and leaving air conditions (D.B. and W.B.)
 - (3) GPM (if metered)
 - (4) Temperature rise or drop
 - 2. Pumps:
 - a. Installation Data:
 - (1) Manufacturer and model
 - (2) Size
 - (3) Type drive
 - (4) Motor HP, voltage, phase, and full load amps
 - b. Design Data:
 - (1) GPM
 - (2) Head
 - (3) RPM
 - (4) BHP and amps
 - c. Recorded Data:
 - (1) Discharge pressures (full-flow and no-flow)
 - (2) Suction pressures (full-flow and no-flow)
 - (3) Operating head
 - (4) Operating GPM (from pump curves if metering is not provided)
 - (5) No-load amps (where possible)
 - 3. Pressure: At return water inlet.
 - 4. Each Flow Balance Valve (Circuit setters):
 - a. Device type, model and size
 - b. Pressure differential
 - c. GPM

3.12 FINAL TESTS, INSPECTION, AND ACCEPTANCE

- A. Capacity and Performance Tests: Make tests to demonstrate that capacities and general performance of air and water systems comply with contract requirements.
- B. Retests: The testing agency shall recheck random selections of up to 10 percent of the data recorded in the balancing report in the presence of the Engineer. The balancing report will be automatically rejected if more than 20 percent of the rechecked readings deviate more than 10 percent of the recorded reading in the balancing report.

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HONOLULU, HAWAII

- C. Marking of Settings: Following final acceptance of the balancing report, the settings of all valves, splitters, dampers, and other adjustment devices shall be permanently marked by the balancing agency, so that adjustment can be restored if disturbed at any time.

END OF SECTION

SECTION 23 07 00

MECHANICAL INSULATION

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- A. Conditions:
 - 1. Conform to General Conditions, Supplementary Conditions and Division 1 - General Requirements.

1.02 SUMMARY

- A. Section Includes:
 - 1. Insulation of piping, ductwork, equipment and accessories.

1.03 SUBMITTALS

- A. Submit in accordance with Section 01 33 00 – SUBMITTAL PROCEDURES.
- B. Product Data: Submit manufacturer's product data and installation procedures for each type of product specified in this section.

1.04 CLOSEOUT SUBMITTALS

- A. Submit under provisions of Section 01 77 00 – CLOSEOUT PROCEDURES.

1.05 QUALITY ASSURANCE

- A. Qualifications: Furnish and install insulation by specialty subcontractor normally engaged in performance of this work using Pittsburg Corning, Owens Corning, Schuller Manville, Knauf, CertainTeed, IMCOA, Armstrong or equal to items specified.
- B. Fire and Smoke Requirements: Flame spread rating of 25 and developed smoke rating of 50 for all materials used in plenum areas. In non- plenum areas, smoke developed rating per local code requirements and NFPA maximum 150 allowed.

PART 2 - PRODUCTS

2.01 CLOSED CELL POLYOLEFIN PIPE INSULATION:

- A. General: Flexible closed cell polyolefin insulation, 1.5 lbs/cu. ft. density, self sealing, water vapor transmission rate of 0.0 perm-in.
- B. Manufacturers: IMCOA Imcolock

2.02 FLEXIBLE ELASTOMERIC CELLULAR PIPE INSULATION

- A. General: Preformed flexible elastomeric insulation, self sealing.
- B. Manufacturers: Armstrong AP Armaflex, John Manville Rubatex

2.03 GLASS FIBER PIPE INSULATION

- A. General: Semi-rigid fibrous glass material, factory applied all service jacket with self-sealing adhesive, ASJ-SSL, 4 lbs/cu. ft. density ASTM C 547, MIL-I-22344.
- B. Manufacturers: Owens Corning Model ASJ/SSL-II, John Manville Model Micro-Lok HP, CertainTeed, Knauf

2.04 CELLULAR GLASS PIPE COVERING

- A. General: Cellular glass with sealed cells construction, water resistant, incombustible, ASTM C 552.
- B. Manufacturer: Pittsburgh Corning Model Foamglas.

2.05 RIGID GLASS FIBER

- A. General: Rigid, inorganic glass fiber bonded by a thermosetting resin, noncombustible, 6 lbs/cu. ft. density, ASTM C 612.
- B. Manufacturers: Manville, Knauf, Owens Corning, Certain Teed.

2.06 RIGID BLOCK

- A. General: High temperature pipe and block insulation composed of hydrous calcium silicate. ASTM C 533, Type 1.
- B. Manufacturers: Manville Thermo-12 Blue.

2.07 FLEXIBLE GLASS FIBER DUCT WRAP

- A. General: Blanket type, noncombustible glass fibers insulation with factory applied vapor barrier jacket. ASTM C 553, Type 1.
- B. Manufacturers: Manville Microlite, Owens Corning All-Service, Knauf, Certain Teed.

2.08 INSULATING CEMENT

- A. General: Calcium Silicate, Asbestos Free, ASTM C-449. SS-C-160, Type 3, Grade F

2.09 ADHESIVES AND SEALANTS

- A. General: Materials shall be suitable for the materials, insulations, jackets and application desired.
- B. Manufacturers: Foster, Childers, Armaflex.

2.10 TAPE

- A. General: Pressure sensitive lap of facing material. Type suitable for its application.
- B. Manufacturers: Venture Tape, Ideal Tape, Avery Dennison Fasson.

2.11 JACKETS

- A. Laminated: Kraft paper, aluminum foil NFPA 90A approved and 0.02 permeability, exterior layer ASTM C665 no mold growth, tri-directional fiberglass reinforcing, flame resistant, high intensity white, all service jacket (ASJ).
- B. Metal: 0.016" aluminum Metal adhesive jacketing equal to 3M venture tape with same thickness of metal, may be substituted for metal jacket.

2.12 COATINGS

- A. General: Weatherproofing breathing type durable coating and fire- resistive. UL classified and tested according to ASTM E-84. NFPA Standard 90-A. Childers VI-CRYL, CP-10/11.

2.13 FIRE BARRIER DUCT WRAP

- A. General: UL Listed, 2-hour fire resistive enclosure protection for zero clearance to combustible construction, 2190F temperature rating, 1-1/2" thick, 6 pcf density flexible blanket fully encapsulated in glass fiber reinforced aluminum//polypropylene scrim. FireMaster FastWrap XL or pre-approved equal.

PART 3 - APPLICATION

3.01 GENERAL

- A. Pipe Insulation: Insulation thickness is based on insulation having a thermal resistance of 4.0 to 4.6 per inch of thickness at a mean temperature of 75 degrees F. Insulation thickness shall be increased or decreased for materials having R values less than 4.0 per inch or greater than 4.6 per inch.

- B. High Temperature Piping: On piping systems where operating temperatures exceed 400 degrees F, provide calcium silicate with 6 oz. canvas jacket, 1-1/2" thick through 4" pipe, 2" thick over 4" pipe.

3.02 DOMESTIC SYSTEMS

- A. Hot Water, Tempered, and Recirculating: Pre-Formed Glass Fiber

Temp. Range F	1-1/2" & Less	2"to 4"
100 to 140	1"	1-1/2"
141 to 180	1-1/2"	2"

- B. Cold Water piping on Roof: Insulate with 1" fiberglass for piping exposed to sunlight on the roof.

3.03 COOLING SYSTEMS

- A. Refrigeration: Closed cell piping meeting all flame spread and smoke developed ratings for air plenums.

Temp Range F	1-1/4"& Less	1-1/2" & Larger"
Below 40	1"	1-1/2"

- B. AC Condensate: Imcolock for all indoor piping, 3/4" thick. Uninsulated PVC SCH. 80 acceptable for use in conditioned spaces.

3.04 SUPPLY AND RETURN AIR DUCTWORK, EXPOSED

- A. Ductwork shall be lined. Refer to section 23 30 00 – AIR DISTRIBUTION SYSTEM

3.06 GREASE EXHAUST DUCT CONCEALED

- A. Method: Provide 2 layers of fire barrier duct wrap on kitchen grease duct which penetrate a rated assembly. Provide access to the manufacturer's duct access door system. Install per manufacturer's instructions.

PART 4 - INSTALLATION

4.01 APPLICATOR

- A. Qualification: Applied by mechanics specializing in this type work. Apply covering when building is thoroughly dry to prevent shrinkage.

4.02 EXISTING INSULATION

- A. General: Repair and/or replace damaged or removed covering on existing equipment and piping where damaged by work under this contract.

4.03 EXPOSED PIPING AND EQUIPMENT

- A. General: Finish exposed piping and equipment insulation with white pigmented lagging adhesive (not required on AP jacket finish). Equipment, piping, valves, etc., in boiler rooms, mechanical rooms and fan rooms are considered exposed whether in a plenum or not. Piping within 8'-0" of Floor: Provide field applied 6 oz. canvas jacket. Finish with white pigmented lagging adhesive.

4.04 VALVES, FITTINGS, STRAINERS AND ACCESSORIES

- A. Application: Apply insulation to all fittings, valves, strainlers and accessories equal to adjacent thickness and finish with 4 oz. canvas jacket or preformed PVC fitting covers. Pipe insulation shall have ends thoroughly coated with Type II vapor barrier coating not more than 6 inch directions. Use removable covers for valve handles.
- B. Accessories: At penetrations such as thermometers, the void in the insulation shall be filled with vapor barrier coating and the penetration shall be sealed with a brush coat of the same coating.
- C. Unions: Unions are not to be insulated. The insulation shall be tapered to the union at a 45-degree angle. The insulation and jacket shall terminate and shall be sealed with two coats of vapor barrier coating for cold pipes or adhesive for hot pipes, with glass tape embedded between coats.
- D. Flexible Connections: At pumps and other equipment shall be insulated with unicellular plastic insulation.

4.05 EQUIPMENT CONNECTIONS

- A. General: Insulate all risers, branches and connections to equipment.

4.06 RAINLEADERS

- A. Insulation Not Required: Underground, in tunnels, in crawl spaces, and in unexcavated areas.

4.07 REINFORCEMENT

- A. Location: Provide hex mesh wire reinforcing where finishing cement is applied over rigid board.

4.08 COLD WATER

- A. Buried: Do not insulate direct burial cold water.

4.09 BURIED LINES

- A. Extra Protection: Double insulation thickness for all buried lines.

4.10 METAL JACKETS

- A. General: Apply metal jackets with seam joints by inserting flat edge into sealing joint (on horizontal line at 4 o'clock position to shed water). Attach end joint strips with integral mastic at end joints and band (2" wide metal 18" OC).
- B. In lieu of metal jackets, provide 3M VentureClad Insulation Jacketing Tape embossed aluminum, submit to owner and engineer for review prior to installation.
- C. If piping is located inside weather resistant enclosures, metal jackets are not required. Any new enclosures installed should match the manufacturer and type of existing enclosures used on site. Acceptable enclosures include SLIMDUCT by INABA DENKO, Mitsubishi Line-Hide, RectorSeal Fortress Line Set Covers, or Diversitech SpeediChannel Line Set Cover. Submit to owner and engineer for review prior to installation.

4.11 OUTDOOR PIPING

- A. Jackets: Provide metal jackets with waterproof joints and seams on all outdoor insulated piping, pumps, and accessories.

4.12 OUTDOOR DUCTWORK

- A. Requirements: Insulate supply and return ductwork exposed to the weather as noted for exposed supply ductwork with fibrated solvent asphalt waterproof jacket.

4.13 PROTECTIVE SADDLE

- A. General: Insulate under pipe hangers (full thickness) and provide 18 gauge galvanized protective saddles covering lower half of insulation. Protective saddle length equal to pipe size with 6"minimum length. Use high density insulation insert on pipe 2" and larger.

4.14 UN-INSULATED AREAS

- A. General: Do not insulate over equipment data or ASME labels for warm equipment. Completely insulate all cold equipment and piping with operating temperatures under 70 degrees F, including ducts, tubing and piping from rooms cooled below 70 degrees, condensate drains and traps and waste piping receiving and carrying condensate, fittings, unions, refrigerant lines, chilled water make-up lines, and valves (except stems and operators).
- B. Insulate domestic water mains within ventilated areas (mechanically or passively), including but not limited to storage and mechanical rooms, parking garages and attic spaces.

END OF SECTION

SECTION 23 08 00

COMMISSIONING OF MECHANICAL SYSTEMS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- A. Conditions: Conform to General Conditions, Supplementary Conditions and Division 1 - General Requirements.

1.02 SCOPE

- A. Section Includes: Commissioning requirements and documentation required for all HVAC systems.

1.03 SUBMITTALS

- A. Submittals: Meet the applicable requirements of Section 01 3300 – SUBMITTAL PROCEDURES. Provide list of items applied and product data for:
 1. Commissioning Tools and Equipment
 2. Commissioning Documentation

1.04 COMMISSIONING HVAC SYSTEMS

- A. General Requirements: This specification covers the commissioning of HVAC systems which are a part of this project. The purpose of commissioning is to bring the project HVAC system to a state of dynamic operation in accordance with the contract plans and specifications by verifying the operation of individual components, subsystems, and systems.

- 1. Tools and Equipment: The Contractor shall furnish all special tools and equipment required during the commissioning process. A list of all tools and equipment to be used during commissioning shall be submitted for approval.

- B. Commissioning Documentation: The Contractor shall maintain the commissioning documentation in ring binders. The commissioning documentation shall be organized by system and subsystem when practicable. All pages shall be numbered and a table of contents page shall be provided. The commissioning documentation shall include, but not be limited to, the following:

- 1. Approved Test and Balance Report for the building (project) being commissioned.
 - 2. All approved shop drawings of HVAC equipment to be commissioned. Shop drawings shall be full size sheets folded as required to fit in binders.
 - 3. All pre-commissioning checklists initialed by indicated personnel organized by system and subsystem.
 - 4. All functional performance test checklists signed by indicated personnel organized by system and subsystem.

5. Three copies of the Operation and Maintenance Manuals specified on other sections of these specifications shall be included with the Commissioning Documentation. The manuals shall be incorporated in the Commissioning Documentation prior to the commencement of the training required in this and other sections of the specifications. Preparation of Operation and Maintenance Manuals shall be as specified in other sections of these specifications.
6. HVAC Shop Drawings and As Built Drawings and Specifications shall be assembled after completion of HVAC pre-commissioning phase and prepared as indicated above. Changes as a result of subsequent HVAC Commissioning procedures will be incorporated (as required) at the conclusion of final HVAC Commissioning.
7. The Contractor shall be responsible for maintaining the commissioning documentation until final acceptance of the project. All checklists included in this section of the specifications shall become part of the commissioning documentation. The commissioning documentation shall be kept current by the contractor and shall be available for inspection at all times. At the time of acceptance of the project, the Contractor shall **furnish 3 copies of the commissioning documentation** to the Owner's representative.

C. Commissioning Schedule:

1. Phase 1 - Preliminary Commissioning: **All HVAC shop drawings, including but not limited to equipment, controls, test and balance reports, operation and maintenance manuals**, shall be submitted and approved by the Owner's representative. In addition, all pre-commissioning checklists shall be completed (initialed by all parties).
2. Phase 2 - Functional Performance Testing shall be performed as indicated on the Functional Performance Test Checklists. Functional Performance Testing shall not begin until Phase 1 of the commissioning process is complete.

Functional Performance Test Notification: The Contractor shall notify the Owner's representative 2 weeks before functional performance testing is to begin.
3. Phase 3 - HVAC Training shall be conducted as indicated in the specifications for each item of equipment.

D. System Performance Criteria: All HVAC related equipment commissioned in this section of the specifications will be evaluated based on the sequences of operation/control and the equipment schedules. Sequences of equipment operation and control and design performance data shall be as specified for the equipment item in other sections of these specifications and on the contract drawings.

E. Pre-Commissioning Checklists:

1. Pre-commissioning checklists shall be completed prior to the commencement of functional performance testing. The indicated initial is required in each location for all items, except where an "X" is shown indicating an initial is not required. See initials legend below for required initials. The pre-commissioning checklist will not be accepted as complete until all items have been initialed signifying this portion of the project is ready for Functional Performance Testing. The Owner's representative shall be the last person to initial each checklist item. The Contractor shall submit for approval a **list of all Contractor and subcontractor representatives** responsible for the completion of the pre-commissioning checklist phase of the project. This list of representatives shall be submitted 2 weeks prior to the installation of any HVAC equipment. Representatives may be replaced only after written approval from the Owner's representative.

Initials Legend:

- A - General Contractor's representative
- B - Mechanical Contractor's representative
- C - Electrical Contractor's representative
- D - Owner's representative
- E - Balancing Contractor's representative
- F - Controls Contractor's representative

2. Blank pre-commissioning checklists are in Appendix 1 located at the end of this section of the specifications.

F. Functional Performance Test Checklist:

1. Functional performance testing shall be performed by a commissioning team consisting of the individuals indicated on the Functional Performance Test Checklists. The Contractor shall **submit in writing a list of all Contractor and subcontractor representatives** responsible for the completion of the functional performance testing phase of the project. This list of representatives shall be submitted 2 weeks prior to commencement of functional performance testing of HVAC equipment. All representatives shall remain on the commissioning team throughout functional performance testing. Substitutions will not be permitted. Functional performance test checklists shall be completed in the presence of all commissioning team personnel at the time of the functional performance test.
 - a. Upon failure of completion of a functional performance test checklist, the Contractor shall provide a written report to the Owner's representative listing the deficiencies causing the failure and remedies to correct all deficiencies. After the Contractor has corrected all deficiencies, the entire functional performance test checklist for the item of equipment shall be repeated. If possible, corrections can be accomplished during the functional performance testing of equipment in other non-related systems. In any case, no system will be accepted until all equipment items in the system have complete functional performance test checklists thereby demonstrating satisfactory performance.
 - b. Failure to complete 3 functional performance test checklists constitutes failure of phase 2 of the HVAC commissioning process, however functional performance testing shall be continued to identify all failures. The Contractor shall provide a **written report** to the Owner's representative listing the deficiencies causing all failures and remedies to correct all deficiencies. After correction of all deficiencies, phase 2 of the HVAC commissioning process shall be repeated in its entirety. The Contractor shall give the

- Owner's representative 2 weeks notice before repeat functional performance testing is scheduled.
2. Blank functional performance test checklists are in Appendix 2 located at the end of this section of the specifications.
- G. Quality Control: The Contractor shall establish and maintain quality control for operations under this section to assure compliance with contract requirements and maintain records of his quality control for all the activities listed hereinbefore. **A complete quality control report** shall be made of each of the activities outlined in this section of the specifications listing attendees, items discussed, deficiencies noted and corrective actions taken. The quality control reports for this section shall be made in duplicate so that one copy can be transmitted through quality control channels and the other made a part of the commissioning documentation.

PART 2 - PRODUCTS

NONE

PART 3 - EXECUTION

SEE APPENDIX 1 AND APPENDIX 2

BENJAMIN WOO ARCHITECTS
PROJECT NO. 1709

LILIA WAIKIKI
HONOLULU, HAWAII

APPENDIX 1

COMMISSIONING HVAC SYSTEMS

1. PRE-COMMISSIONING CHECKLIST - DUCTWORK

For Outside Air Unit: OAU-1, all stair pressurization systems, all exhausts systems and all ducted FCU systems.

CHECKLIST ITEM	A	B	C	D	E	F
Installation						
a. Ductwork complete.			X			X
b. As-built shop drawings submitted.						
c. Duct pressure and leakage test complete.			X			X
d. Fire dampers installed as required.			X		X	X
e. Smoke dampers installed as required.			X		X	X
f. Access doors and panels installed.			X		X	X
g. Verify open/closed status of dampers.			X		X	
h. Verify smoke dampers operation.			X		X	
Test and Balance						
Test and Balance operation complete.			X			X

2. PRE-COMMISSIONING CHECKLIST - VARIABLE VOLUME OUTSIDE AIR UNIT

For Packaged Air Conditioning Unit: OAU-1.

CHECKLIST ITEM	A	B	C	D	E	F
Installation						
a. Unit in place with recommended service/air clearances.			X		X	X
b. Refrigerant pipe leak tested.			X		X	X
c. Vibration isolation devices installed.			X		X	X
d. Access doors are operable and sealed.			X		X	X
e. Casing undamaged.			X		X	X
f. Insulation undamaged.			X		X	X
g. Condensate drainage is unobstructed.			X		X	X
h. Fan belt adjusted.			X			X
Electrical						
a. Power available to unit disconnect.					X	X
b. Power available to unit control panel.					X	
c. Proper motor rotation verified.						X
Coils						
a. Refrigerant piping properly connected.			X		X	X
b. Refrigerant piping pressure tested.			X		X	X
Controls						
a. Unit safety/protection devices			X		X	
b. Control system and interlocks installed.			X		X	
c. Control system and interlocks operational.			X		X	
d. Control valves/actuators properly installed.			X		X	
e. Control valves/actuators operable.			X		X	
f. Dampers/actuators properly installed.			X		X	
g. Dampers/actuators operable.			X		X	
h. Duct static pressure sensor installed.			X		X	
i. Static pressure sensor calibrated.			X		X	
j. Fan air volume controller operable.			X		X	
k. Air handler control system operational.			X		X	

CHECKLIST ITEM	A	B	C	D	E	F
Test and Balance (T & B)						
a. Construction filters removed and replaced.			X			X
b. T & B simulate 1/2 loaded filters.			X			X
c. T & B results $\forall 10\%$ CFM shown on drawings.			X			X
d. Test and Balance Report submitted.			X			X

3. PRE-COMMISSIONING CHECKLIST - DX AIR COOLED CONDENSING UNIT

For Condensing Units: Refer to ACCUs on equipment schedule sheets.

CHECKLIST ITEM	A	B	C	D	E	F
Installation						
a. Condensing Unit in place with recommended service/air clearances.			X		X	X
b. Condensing Unit piped.			X		X	X
c. Refrigerant pipe leak tested.			X		X	X
Electrical						
a. Power available to unit disconnect.					X	X
b. Power available to unit control panel.						X
Controls						
a. Unit safety/protection devices tested.			X		X	
b. Control system and interlocks installed.			X		X	
c. Control system and interlocks operational.			X		X	

4. PRE-COMMISSIONING CHECKLIST - FAN COIL UNIT

For Fan Coil Units: Refer to FCUs on equipment schedule sheets.

CHECKLIST ITEM	A	B	C	D	E	F
Installation						
a. Vibration isolation devices installed.			X		X	X
b. Access doors are operable and sealed.			X		X	X
c. Casing undamaged.			X		X	X
d. Insulation undamaged.			X		X	X
e. Condensate drainage is unobstructed.			X		X	X
f. Fan belt adjusted.			X		X	X
Electrical						
a. Power available to unit disconnect.					X	X
b. Power available to unit control panel.					X	X
c. Power motor rotation verified.					X	X
Coils						
a. Refrigerant piping properly connected.			X		X	X
b. Refrigerant piping pressure tested.			X		X	X
Controls						
a. Control valves/actuators properly installed.			X		X	
b. Control valves/actuators operable.			X		X	
Test and Balance (T & B)						
a. T & B results $\pm 10\%$ CFM shown on drawings.			X			X
b. Test and Balance Report submitted.			X			X

5. PRE-COMMISSIONING CHECKLIST - EXHAUST FAN

For Exhaust Fans: Refer to EFs on equipment schedule sheets.

CHECKLIST ITEM	A	B	C	D	E	F
Installation						
a. Fan belt adjusted.			X			X
Electrical					X	
a. Power available to fan disconnect.					X	
b. Power motor rotation verified.						X
Controls						
a. Control interlocks properly installed.			X		X	
b. Control interlocks operable.			X		X	
c. Dampers/actuators properly installed.			X		X	
d. Dampers/actuators operable.			X		X	
Test and Balance (T & B)						
a. T & B results $\pm 10\%$ CFM shown on drawings.			X			X
b. Test and Balance Report submitted.			X			X

6. PRE-COMMISSIONING CHECKLIST - HVAC SYSTEM CONTROLS

For HVAC Systems.

CHECKLIST ITEM	A	B	C	D	E	F
Installation						
a. Layout of control panel matches drawing.			X		X	
b. Framed instructions mounted in or near control panel/			X		X	
c. Components properly labeled (on inside and outside of panel).			X		X	
d. Control components piped and/pr wired to labeled terminal strip(s).			X		X	
e. EMCS connection made to labeled terminal strip(s) as shown on drawings.			X		X	
f. Control wiring and tubing labeled at all terminations, splices, and junctions.			X		X	
g. Shielded wiring used on electronic sensors.			X		X	
Main Power						
a. 110 volt AC power available to panel.			X		X	

BENJAMIN WOO ARCHITECTS
PROJECT NO. 1709

LILIA WAIKIKI
HONOLULU, HAWAII

APPENDIX 2

FUNCTIONAL PERFORMANCE TEST CHECKLISTS

1. FUNCTIONAL PERFORMANCE TEST CHECKLIST - OUTSIDE AIR UNIT

For Packaged Air conditioning Unit: OAU-1

1. Functional Performance Test: Contractor shall verify operation of packaged air conditioning unit as per specification including the following:

- a. Verify activation of unit using control system command.

ON	AUTO	OFF
----	------	-----

- b. The following sequence of control shall be verified during start-up:

- 1) All dampers in normal position.
- 2) All valves in normal position.
- 3) System safeties allow start if safety conditions are met.
- 4) VAV fan controller shall "soft-start" fan.

- c. Normal operation.

- 1) Outside air damper at minimum position.
- 2) Fan VAV controller receiving signal from duct static pressure sensor and modulating fan to maintain supply duct static pressure setpoint.

- d. System shut down

- 1) All dampers in normal position.
- 2) All valves in normal position.
- 3) Fan de-energizes.

- e. Verify unit shut down during fire event initiated by smoke/heat sensors.

BENJAMIN WOO ARCHITECTS
PROJECT NO. 1709

LILIA WAIKIKI
HONOLULU, HAWAII

1. FUNCTIONAL PERFORMANCE TEST CHECKLIST - OUTSIDE AIR UNIT (Continued)

For Packaged Air conditioning Unit: OAU-1

2. Verify unit amperage each phase and voltage phase to phase and phase to ground.

AMPERAGE
VOLTAGE
VOLTAGE
VOLTAGE TO GROUND

- 3. Record the following information:**

- #### 4. Check and report unusual vibration, noise, etc.

- ## 5. Results:

- a. Contractor shall record and submit results obtained in items 1, 2, 3, and 4 above to the Owner's Representative.
 - b. If specified equipment performance is not verified, Contractor shall report remedial action required and re-schedule Functional Performance Test.

6. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

DATE:

General Contractor's Representative

Mechanical Contractor's Representative

Electrical Contractor's Representative

Balancing Contractor's Representative

Controls Contractor's Representative

Owner's Representative

BENJAMIN WOO ARCHITECTS
PROJECT NO. 1709

LILIA WAIKIKI
HONOLULU, HAWAII

2. FUNCTIONAL PERFORMANCE TEST CHECKLIST - AIR COOLED CONDENSING UNIT

For Condensing Units: Refer to ACCUs on equipment schedule sheet.

1. Functional Performance Test: Contractor shall demonstrate operation of refrigeration system as per specifications including the following: Start fan coil unit to provide load for condensing unit. Activate controls system start sequence as follows:
 - a. Start Fan Coil Unit. Verify control system energizes condensing unit start sequence.
 - b. Shut-off fan coil unit to verify condensing unit de-energizes.
 - c. Re-start fan coil unit 1 minute after condensing unit shut down. Verify condensing unit restart sequence.
 2. Verify condensing unit amperage each phase and voltage phase to phase and phase to ground.

AMPERAGE
VOLTAGE
VOLTAGE
VOLTAGE TO GROUND

- 3. Record the following information:**

AMBIENT TEMPERATURE degrees F.

4. Check and report unusual vibration, noise, etc.

- ## 5. Results:

- a. Contractor shall record and submit results obtained in items 1, 2, 3, and 4 above to the Owner's Representative.
 - b. If specified equipment performance is not verified, Contractor shall report remedial action required and re-schedule Functional Performance Test.

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PROJECT NO. 1709

LILIA WAIKIKI
HONOLULU, HAWAII

2. FUNCTIONAL PERFORMANCE TEST CHECKLIST - AIR COOLED CONDENSING UNIT
(Continued)

For Condensing Units: ""

6. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

DATE:

General Contractor's Representative

Mechanical Contractor's Representative

Electrical Contractor's Representative

Balancing Contractor's Representative

Controls Contractor's Representative

Owner's Representative

3. FUNCTIONAL PERFORMANCE TEST CHECKLIST - FAN COIL UNITS

For Fan Coil Units: Refer to all FCUs on equipment schedule sheets.

1. Functional Performance Test: Contractor shall demonstrate operation of selected fan coils as per specifications including the following:

- a. Verify fan coil unit response to room temperature setpoint adjustment. Changes to be cooling setpoint to cooling setpoint minus 10 degrees and return to cooling setpoint.
- b. Check blower fan cfm.
- c. Check inlet air temperature.
- d. Check outlet air temperature.

2. Results:

- a. Contractor shall record and submit results obtained in item 1 above to the Owner's Representative.
- b. If specified equipment performance is not verified, Contractor shall report remedial action required and re-schedule Functional Performance Test.

3. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

DATE:

General Contractor's Representative

Mechanical Contractor's Representative

Electrical Contractor's Representative

Balancing Contractor's Representative

Controls Contractor's Representative

Owner's Representative

4. FUNCTIONAL PERFORMANCE TEST CHECKLIST - EXHAUST FANS

For Exhaust Fans: Refer to all EFs on equipment schedule sheets.

1. Functional Performance Test: Contractor shall demonstrate operation of selected exhaust fans as per specifications including the following:

- a. Verify activation of exhaust fan using control system command.

ON	AUTO	OFF
----	------	-----

- b. Check exhaust fan cfm.
 - c. Check and report unusual vibration, noise, etc.

2. Results:

- a. Contractor shall record and submit results obtained in item 1 above to the Owner's Representative.
 - b. If specified equipment performance is not verified, Contractor shall report remedial action required and re-schedule Functional Performance Test.
3. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

DATE:

General Contractor's Representative

Mechanical Contractor's Representative

Electrical Contractor's Representative

Balancing Contractor's Representative

Controls Contractor's Representative

Owner's Representative

5. FUNCTIONAL PERFORMANCE TEST CHECKLIST - HVAC CONTROLS

1. Functional Performance Test: Contractor shall verify operation of HVAC controls by performing the following tests:
 - a. Verify that controller is maintaining the setpoint by manually measuring the controlled variable with a thermometer, sling psychrometer, inclined manometer, etc.
 - b. Verify sensor/controller combination by manually measuring the controlled medium. Take readings from control panel display and compare readings taken manually. Record all readings.

SENSOR

MANUAL MEASUREMENT

PANEL READING VALUE

- c. Verify system stability by changing the controller setpoint as follows:

- 1) Air Temperature - 10 degrees F
- 2) Static Pressure - 10 percent of setpoint
- 3) Relative Humidity - 10% (RH)

The control system shall be observed for 10 minutes after the change in setpoint. Instability or excessive hunting will be unacceptable.

- d. Verify interlock with other HVAC controls.
- e. Verify interlock with fire alarm control panel.
- f. Verify interlock with EMCS.

2. Results:

- a. Contractor shall record and submit results obtained in item 1 above to the Owner's Representative.
- b. If specified equipment performance is not verified, Contractor shall report remedial action required and re-schedule Functional Performance Test.

BENJAMIN WOO ARCHITECTS
PROJECT NO. 1709

LILIA WAIKIKI
HONOLULU, HAWAII

5. FUNCTIONAL PERFORMANCE TEST CHECKLIST - HVAC CONTROLS (Continued)

3. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

DATE:

General Contractor's Representative

Mechanical Contractor's Representative

Electrical Contractor's Representative

Balancing Contractor's Representative

Controls Contractor's Representative

Owner's Representative

SECTION 23 09 00

ENERGY MANAGEMENT AND CONTROL SYSTEMS (EMCS)

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- A. Conditions: Conform to General Conditions, Supplementary Conditions and Division 1 - General Requirements.

1.02 SECTION INCLUDES

- A. The EMCS systems shall be supplied and installed completely under the BAS/ATC Contract. Control components shall be mounted and wired by the EMCS Contractor.
- B. The engineering, installation, calibration, software programming and checkout necessary for complete and fully operational EMCS systems, as specified hereafter, shall be provided by the EMCS Contractor. Included are:
 1. Central processing unit
 2. Software
 3. Control Equipment
 4. Control Wiring and Power Wiring for Control Devices
 5. Automatic dampers
 6. Damper actuators
 7. Sequence of operations
 8. Point lists

1.03 SUBMITTALS

- A. Meet the applicable requirements of Section 01010 – PROJECT GENERAL REQUIREMENTS. The following data/information shall be submitted for approval:
 1. Complete sequence of operation.
 2. Control system CAD generated drawings including all pertinent data to provide a functional operating system.
 3. Valve and damper schedules showing size, configuration, capacity and location of all equipment.
 4. Data sheets for all hardware and software control components
 5. A description of the installation materials including conduit, wire, flex, etc.
 6. Thermostat/sensor locations.
 7. Computer panel locations.
 8. Provide as part of the submittal five copies of all data and control drawings.

1.04 CLOSEOUT SUBMITTALS

- A. Submit under provisions of Section 01010 – PROJECT GENERAL REQUIREMENTS.
- B. Operation and Maintenance Data: Submit operation and maintenance data including maintenance schedules, spare parts requirements, and procedures.

1.05 QUALITY ASSURANCE

- A. The BAS/ATC Contractor shall have a local office within a 50 mile radius of the job site, staffed with factory trained engineers fully capable of providing instruction, routine maintenance and 24-hour emergency maintenance service on all system components. The BAS/ATC Contractor shall have a three year experience record in the design and installation of computerized building systems similar in scope and performance to that specified herein, and shall be prepared to provide evidence of this history as condition of acceptance and approval prior to Bidding.

1.06 AGENCY LISTINGS

- A. UL 916 Energy Management Systems.
- B. FCC-Part 15 Subparagraph J. Class A. Emissions requirements.

1.07 GENERAL INSTRUCTIONS

- A. The BAS/ATC systems as specified herein shall be provided in their entirety by the BAS/ATC Contractor. The BAS/ATC Contractor shall base his Bid on the system as specified, the sequence of operations and the points list. System shall be web browser based and accessible to users via internet.
- B. As part of his Bid, the BAS/ATC Contractor shall submit for review by the engineer a written description of his proposed BAS/ATC systems, including block diagrams showing all major components and panels, printers and other processing devices and required cabling between each. Include environmental and space requirements for panels, CPU's and other major devices.
 - 1. Include manufacturer's literature for each type of panel, controller or device that may be shown on the Riser Diagram.
 - 2. Riser Diagram shall show, schematically, the entire building system with all major components identified.
 - 3. System points list.
- C. In general, the proposal shall be based on a completely electronic system, including valve and damper actuators, and a full DDC/VAV system, wherein all VAV terminals are centrally controlled by the BAS/ATC system.

PART 2 - PRODUCTS

2.01 ASBESTOS PROHIBITION

- A. No asbestos containing materials or equipment shall be used under this section. The Contractor shall ensure that all materials and equipment incorporated in the project are asbestos-free.

2.02 MANUFACTURERS

- A. Trane, Carrier, Alerton, Johnson Controls, Automated Logic are the only approved systems for this section.

2.03 OPERATOR INTERFACE

- A. Local Interface. Furnish one PC based workstation as shown on the system drawings in manager's office or as indicated on plans.
 - 1. Hardware:
 - a. Operator workstation and custom programming workstation shall consist of the following: Personal Computer: Furnish Windows 7 or 10 PC to be used as DDC system workstation in general manager's office. The CPU shall be a minimum of an Intel Pentium core I5 processor and operate at a minimum equal to a currently marketed DELL mini tower professional workstation, with a 24" LED monitor.
 - 2. Workstation Software:
 - a. Multiple Users: The system shall accommodate simultaneous multiple user operation. Access the system data should be limited only by operator password. Multiple users shall have access to all valid system data. An operator shall be able to log onto any workstation on the system and have access to all valid data.
 - b. Operating System: Furnish a concurrent multi-tasking operating system. The operating system shall accommodate processes and threads as well as prioritizing applications based on their input output priority level (IOPL). The operating system shall also support the use of other common software applications that operate Microsoft Windows. Examples include Microsoft Office applications Excel, Word, etc. Acceptable operating systems are Windows 7, and Windows 10.
 - c. System Graphics: The Operator Workstation software shall be graphically oriented. The system shall allow display of up to 10 graphic screens at once for comparison and monitoring of system status. Provide a method for the operator to easily move between graphic displays and change the size and location of graphic displays on the screen. The system graphics shall be able to be modified while on line. An operator with the proper password level shall be able to add, delete, or change dynamic points on a graphic. Dynamic points shall include analog and binary values, dynamic text, static text, and animation files. Graphics shall have the ability to show animation by shifting image files based on the status of the point.
 - d. Standard Graphics: Provide graphics for each major piece of equipment in the building. This includes each Chiller, condenser water pumps, chilled water pumps, and Cooling Tower fans. These standard graphics shall show all points as specified in the points list.
 - e. Graphics Library: Furnish a complete library of common HVAC equipment such as

- chillers, air handlers, terminals, and unit ventilators. This library shall also include symbols for other equipment including fans, pumps, valves, piping, and ductwork. The library shall be furnished in a file format compatible with the PC Paint program.
- f. Photo Quality Input: The system shall be able to accommodate high resolution digitized photographs. These shall be scanned in from photographs or 35mm slides. The owner shall be able to edit the photo quality graphics using the furnished PC Paint Program.
 - g. Workstation Applications: The workstation shall serve as the primary area of the system for operator interface and offline storage of system information. The workstation shall also serve as the bridge to other building systems. Provide the following applications at the workstation.
 - h. Automatic System Database Save and Restore: Workstation shall store on the hard disk a copy of the current database of each building controllers. This database shall be updated whenever a change is made in any panel in the system. The storage of this data shall be automatic and not require operator intervention. In the event of a database loss in a building management panel, the first workstation to detect the loss shall automatically restore the database for that panel.
 - i. Manual Database Save and Restore: A system operator with the proper password clearance shall be able to save the database from any system panel. The operator shall also be able to clear a panel database and manually initiate a download of a specified database to any panel in the system.
 - j. System Configuration: The workstation software shall provide a simple to use graphical method of configuring the system. As elements are located on the site they shall be displayed on a graphical representation of the system. This shall be flexible to allow for future system changes or additions.
 - k. On Line Help: Provide a context sensitive on line help 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.
 - l. Security: Operator shall be required to log on to the system with a user name and password in order to view, edit, add or delete data.
 - m. System Diagnostics: The system shall automatically monitor the operation of all workstations, printers, modems, LAN connections, building management panels and controllers. The failure of any device shall be annunciated to the operator.
 - n. Alarm Processing: Any object in the system shall be configurable to alarm in an out of normal state. The operator shall be able to configure the alarm limits, states, and reactions for each object in the system.
 - o. Binary Alarms: Each binary object shall be set to alarm based on the operator specified state. Provide the capability to automatically and manually disable alarming.
 - p. Analog Alarms.: Each analog object shall have both high and low alarm limits as well as high and low "early warning" limits. Provide separate sets of limits for both occupied and unoccupied (on/off) conditions. Alarming must be able to be automatically or manually disabled.
 - q. Alarm Reactions: The operator shall be able to determine what action if any are to be taken, by object, during an alarm. Actions shall include logging, printing, starting programs, displaying messages, providing audible annunciation or displaying specific system graphics. Each of these actions shall be configurable by workstation and time of day. The system shall provide 20 levels of alarm priority. An object in alarm that has not been acknowledged within an operator specified time period shall be moved to a higher level of priority and follow the actions for that level.
 - r. Trend Logs: Each object in the system shall automatically be trend logged. This trend

- shall be stored for a minimum of 24 hours. The operator shall be able to view this trend on demand.
- s. Event Log: Provide a central point in the system that the operator can use for viewing all system alarms and change of states. Events shall be listed chronologically. An operator with the proper security level may acknowledge and clear alarms. All that have not been cleared by the operator shall be archived to the hard disk on the workstation.
 - t. Point Status and Control: Provide a method for the operator to view, and edit if applicable, the status of any object and property in the system. These statuses shall be available by menu on graphics or through custom programs.
 - u. Clock Synchronization: The real time clocks in all building control panels and workstations shall be synchronized on command of an operator. The system shall also be able to automatically sequence all system clocks, daily from any operator designated device in the system. The system shall automatically adjust for daylight savings and standard time if applicable.

2.04 NETWORK CONTROLLERS

- A. General: Provide an adequate number of Building Management Panels to provide the performance specified above. Each of these panels shall meet the following requirements.
 - 1. The Building Automation System shall be composed of stand-alone, microprocessor based Network Controllers to manage the global strategies described in Application software section.
 - 2. The Network Controller shall have ample memory to support its operating system, database, and programming requirements.
 - 3. The multi-tasking operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.
 - 4. Data shall automatically be shared between Network Controllers when they are networked together.
 - 5. The database and custom programming routines of remote Network Controllers shall be editable from a single operator station.
 - 6. The Network Controller shall continually check the status of all processor and memory circuits. If a failure is detected, the controller shall:
 - a. Assume a predetermined failure mode.
 - b. Emit an alarm.
 - c. Display card failure identification.
- B. Communications: System shall be web browser based and accessible to users via internet.
- C. Serviceability: The Network Controller should be designed in a modular fashion so that the enclosure may be roughed in prior to the installation of the electronics. Provide diagnostic LEDs for power, communications, and alarms. The controller shall have provisions for expansion and future controller architectures. All wiring connections shall be made to field serviceable terminal strips or to a termination card connected by a ribbon cable.

- D. Memory: The Network Controller shall maintain all BIOS and programming information in the event of a power loss for at least 7 days. If a battery backup is used, the batteries must be replaced at the end of the warranty period. The system BIOS shall be easily upgradable from the PC workstation without the need for going out to the panel. System manufacture shall provide current version software and firmware at the end of the warranty period.

2.05 INPUT/OUTPUT INTERFACE

- A. Hardwired inputs and outputs may tie into the system through System Application, Custom Application, or Application Specific Controllers. Slave devices are also acceptable. Any critical points requiring immediate reaction shall be tied directly into the controller hosting the control software algorithm for the critical function.
- B. Binary inputs shall allow the monitoring of on/off signals from remote devices. The binary inputs shall provide a wetting current of 12MA at 12VDC to be compatible with commonly available control devices. All status points shown on the point list shall be positive proof differential pressure or current sensing binary switches.
- C. Analog inputs shall allow the monitoring of low voltage, current, or resistance signals and shall have a minimum resolution of 0.1% of the sensing range. Analog inputs shall be compatible with, and field configurable to commonly available sensing devices.
- D. Binary outputs shall provide a continuous low voltage signal for on/off control of remote devices. Where specified in the sequence of operations or indicated on the points list, binary outputs shall have 3-position (on/off/auto) override switches, status lights, and shall be selectable for either normally open or normally closed position.
- E. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0 to 10 VDC or a 4 to 20 milliampere signal as required to provide proper control of the output device. Systems that utilize a pulse width modulating output (PWM) shall include a position feedback AI for each output.
- F. System architecture shall allow for point expansion in one of the following ways:
 1. The addition of input/output cards to an existing System Application Controller.
 2. A slave controller may be used to expand point capacity.
 3. 100% expansion capacity for all point types in all DDC panels.

2.06 AUXILIARY CONTROL DEVICES

A. TEMPERATURE SENSORS

- 1. Temperature sensors shall be Resistance Temperature Detector (RTD) or Thermistor as dictated by the requirements of this specification.
- 2. Duct sensors shall be rigid or averaging as specified in the sequence of operations. Averaging sensors shall be a minimum of 5 feet in length.
- 3. Immersion sensors shall be provided with a separable stainless steel well.
- 4. Space sensors shall be equipped with setpoint adjustment and/or override switch as specified on the plans or in the sequence of operations.
- 5. Accuracies shall be ± 1 degrees F for standard applications. Where high accuracy is required, accuracies shall be ± 0.2 degrees F.

- B. DIFFERENTIAL PRESSURE SWITCHES
 - 1. Differential Pressure Switches shall be furnished as indicated for status purposes in air and water applications. Provide single pole double throw switch with fully adjustable differential pressure settings.
- C. STATIC PRESSURE SENSORS
 - 1. Static pressure sensors shall be differential pressure type. The sensor range shall be closely matched to the system static pressure, -0.5 to 0.5 inches, -1 to 1 inches, 0 to 2.5 inches.
 - 2. Sensor accuracy shall be plus or minus 5% of the sensing range.
- D. HIGH LIMIT THERMOSTATS
 - 1. High limit thermostats shall be manual reset type set at 120 degrees F.
- E. LOW LIMIT THERMOSTATS
 - 1. Safety low limit thermostats shall be vapor pressure type with a 20 foot minimum element. Element shall respond to the lowest temperature sensed by any one foot section.
 - 2. Low limit shall be manual reset only.

2.07 NETWORK CONTROLLER SOFTWARE

- A. SYSTEM SECURITY
 - 1. User access shall be secured using individual security passwords and user names.
 - 2. Passwords shall restrict the user to only the objects, applications, and system functions as assigned by the system manager.
 - 3. User logon/logoff attempts shall be recorded.
 - 4. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user definable.

2.08 SYSTEM SOFTWARE

- A. Furnish the following applications software for building and energy management. All software applications shall reside and run in the system controllers. Editing of applications shall occur at the operator workstation. System shall be web browser based and accessible to users via internet.
 - 1. Scheduling: Provide the capability to schedule each object or group of objects in the system. Each schedule shall consist of the following:
 - a. Weekly Schedule: Provide separate schedules for each day of the week. Each of these schedules should include the capability for start, stop, optimal start, optimal stop, and night economizer. Each schedule may consist of up to 10 events. When a group of objects are scheduled together provide the capability to adjust the start and stop times for each member.
 - b. Exception Schedules: Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed it will be discarded and replaced by the standard schedule for that day of the week.
 - c. Holiday Schedules: Provide the capability for the operator to define up to 99 special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.

2. Optimal Start/Stop: The scheduling application outlined above shall support an optimal start/stop algorithm. This shall calculate the thermal characteristics of a zone and start the equipment prior to occupancy to achieve the desired space temperature at the specified occupancy time. The algorithm shall calculate separate sets of heating and cooling rates for zones that have been unoccupied for less than and greater than 24 hours. Provide the ability to modify the start/stop algorithm based on outdoor air temperature. Provide an early start limit in minutes to prevent the system from starting too early.
3. System Coordination: Provide a standard application for the proper coordination of equipment. This application shall provide the operator with a method of grouping together equipment based on function and location. This group may then be used for scheduling, and other applications.
4. Alarm Reporting: The operator shall be able to determine the action to be taken in the event of an alarm. Alarms shall be routed to the appropriate workstations based on time and other conditions. An alarm shall be able to start programs, print, be logged in the event log, printed, generate custom messages and display graphics.

2.09 LOCAL CONTROLLER

- A. The local controller shall be mounted in a locking enclosure with the following characteristics:
 1. Enclosure shall be available in standard ambient, extended ambient and weatherproof enclosures.
 2. Enclosure shall include 120/240 selectable transformers.
 3. Enclosure must have access for wire and conduit to enter the cabinet. All control wiring and system communications must be electrically terminated inside the cabinet.
 4. Enclosure shall include a duplex receptacle inside the cabinet.
- B. The local controller shall be configurable using modular Input/Output points to allow for system customization and expansion.
- C. The local controller shall receive signals from industry standard sensors and input devices and directly control actuators and control devices. The controller shall have the capability to monitor and control the following types of inputs and outputs:
 1. Analog Inputs
 - a. Current: 0 to 20 mA
 - b. Voltage: 0 to 10 VDC
 - c. Thermistor
 - d. Resistance RTD
 2. Binary Inputs
 - a. Isolated dry contact closure
 - b. Pulse
 3. Analog Outputs
 - a. Current: 0 to 20 mA
 - b. Voltage: 0 to 10 VDC
 4. Binary Outputs
 - a. 24 VAC, Triac
- D. Output points must be available with manual software and hardware overrides with feedback indication that an output is presently overridden.

- E. Each controller must have a real time clock which shall remain active during power failure for up to seven (7) days under normal operating conditions. When the controller is used with a higher level system, the time clock shall be automatically synchronized with the system controller.
- F. The local controller must provide backup of all memory for a period of seven (7) days under normal operating conditions if commercial power to the controller is interrupted.
- G. The controller operating system and programming must be stored in EEPROM.
- H. Each controller must have an On/Off Switch inside the cabinet.
- I. Each controller shall monitor all Analog Inputs and Analog Outputs and perform 12 bit A-to-D and D-to-A conversion.
- J. Each controller shall be capable of executing Direct Digital Control (DDC) loops and Custom Control Routines.
- K. DDC loops shall be programmable to operate at user-defined intervals with a maximum frequency of one second.
- L. The local controller shall include an RS232 port for connection to a personal computer for upload, download and editing of data.
- M. The local controller must contain the following diagnostic information:
 1. LEDs indicating the status of the main board, communications Transmit and Receive, and Binary Output on/off.
 2. Information regarding the failure of any analog or the change of state of any binary point. The controller must then capture an image of all points at the value or state at the time of the event/alarm. This data must be able to be viewed from a set of screens which are labeled with the alarm point, date and time of occurrence and cause of failure.
 3. Input/Output fail.
 4. Memory fail.
- N. The local controller shall include an operator interface allowing the user to monitor point status, view alarms, and control output points. At a minimum the interface shall be:
 1. Factory installed on the unit, with an option for remote mounting at least 250 feet from the controller.
 2. Capable of accepting up to eight (8) user defined, alpha-numeric passcodes providing discrete, user defined levels of security.
 3. Able to display the current state of any input/output point connected to the controller.
 4. Able to modify the current state of any output point connected to the controller, given the appropriate security level.
 5. Capable of displaying controller status, faults, and diagnostics including:
 - a. Communications errors.
 - b. Controller software versions.
 - c. Input/output point alarms.
 - d. Controller operating mode.

2.10 LOCAL CONTROLLER EDIT SOFTWARE

- A. BAS/ATC contractor shall provide edit software to be used on a laptop service tool for set-up, programming and editing of the local controller database.
 1. Edit Software shall run on the Windows 7 or 10.
 2. Edit software shall facilitate off-line, fill-in-the-blank programming of the Local Controller.
 3. Edit software shall provide operating and programming error messages and diagnostics.
 4. Edit software shall facilitate database save and restore.
- B. Access to the local controller via the edit software must include a minimum of three levels of security.
- C. A service tool using edit software, and connected to one local controller shall have full access to all local controllers on the same communications link.

PART 3 - EXECUTION

3.01 INSTALLATION REQUIREMENTS

- A. All electrical work performed in the installation of the BAS/ATC system as described in this specification shall be per the National Electrical Code (NEC) and per applicable state and local codes. Where exposed, conduit shall be run parallel to building lines properly supported and sized at a maximum of 40% fill. In no case shall field installed conduit smaller than the 2" trade size be allowed. Where conductors are concealed (tenant spaces), cable rated for use in return air plenums shall be used.

3.02 OWNER TRAINING

- A. The BAS/ATC contractor shall provide 3 copies of an operator's manual describing all operating and routine maintenance service procedures to be used with the temperature control and Building Automation System supplied. This contractor shall instruct the owner's designated representatives in these procedures during the startup and test periods. The duration of the instruction period shall be no less than 12 hours, during normal working hours.

3.03 CALIBRATION AND ADJUSTMENTS

- A. After completion of the installation, perform final calibrations and adjustments of the equipment provided under this contract and supply services incidental to the proper performance of the ATC and BAS system under warranty below.

3.04 ACCEPTANCE PROCEDURE

- A. Upon completion of the calibration, contractor shall startup the system and perform all necessary testing and run diagnostic tests to ensure proper operation. Contractor shall be responsible for generating all software and entering all database necessary to perform the sequence of control and specified software routines. An acceptance test in the presence of the owner's representative or engineer shall be performed.

3.05 WARRANTY

- A. All BAS/ATC devices and installation shall be warranted to be free from defects in workmanship and material for a period of one year from the date of job acceptance by the State. Any equipment, software, or labor found to be defective during this period shall be repaired or replaced without expense to the State. Factory authorized warranty service shall be available within 50 miles of the jobsite.

END OF SECTION

SECTION 23 09 13

TEMPERATURE CONTROLS AND INSTRUMENTATION

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- A. Conditions: Conform to General Conditions, Supplementary Conditions and Division 1 - General Requirements.

1.02 SCOPE OF WORK

- A. Section Includes: Instrumentation and electric/electronic temperature controls for air conditioning, ventilation, exhaust, domestic water, and chiller systems. EMCS shall be specified in SECTION 23 09 00.
- B. The principal items of work included in this section are:
 1. Electric and electronic controls for all items indicated on the drawings and described hereinafter including sensors, switches, relays, thermostats, control panels for instruments.
 2. Variable frequency drive for duct static pressure control.
 3. Adjustment and validation of control system. Instruction of Owner's representative on maintenance and operation of control equipment.
 4. Composite electronic and electric diagrams showing interlocks between equipment furnished under this and other sections and controls furnished herein.

1.03 SUBMITTALS

- A. Submittals: Submit under provision of Section 01 3300 – SUBMITTAL PROCEDURES.
- B. Product Data: Submit manufacturer's product data and installation procedures for each type of product specified in this section.
- C. Installation: Provide submittal to include control components, control diagrams and operational sequences.
- D. Completion: Provide certificate stating that control systems have been tested and adjusted for proper operation.
- E. Coordination: It is the responsibility of the control subcontractor to read and conform to all sections of this specification, to coordinate all equipment supplied by others with his work, to provide control equipment as specified in other sections of this document and to install

1.04 CLOSEOUT SUBMITTALS

- A. Submit under provisions of Section 01 77 00 – CLOSEOUT PROCEDURES.
- B. Operation and Maintenance Data: Submit operation and maintenance data including maintenance schedules, spare parts requirements, and procedures.

1.05 QUALITY ASSURANCE

- A. Single Source: Provide control system from a single manufacturer.
- B. Control system manufacturer shall have had a complete engineering, sales, installation and service operation within the area for a period of not less than five years prior to bid date of this project.
- C. The Temperature Control System shall be by Trane, Carrier, Johnson Controls, Honeywell, Allerton, or approved equal.

PART 2 - PRODUCTS

2.01 CONTROL PANELS

- A. General: Fully enclosed to contain relays, terminal strips, manual switches, time clocks, etc., all with identification.
 - 1. Air conditioning control panels shall be located near electrical panels.
- B. All controllers, relays, switches, etc., for equipment located within equipment rooms shall be mounted in enclosed control panels with hinged locking doors. All control devices, including indicators, for equipment located in exposed areas subject to outside weather conditions, shall be mounted inside weatherproof enclosures. Location of each panel is to be convenient for adjustment service. Nameplates shall be provided beneath each panel mounted control device describing the function of the device.

2.02 ROOM TYPE INSTRUMENTS

- A. Room thermostats, humidistats, and transmitters shall be of the miniature type with adjustable sensitivity. A robust cover with tamper-proof screws shall be provided on all room type instruments, except as indicated elsewhere. Thermostat cover shall have concealed setpoint adjustment and no thermometer.

2.03 DAMPER OPERATORS

- A. All damper operators shall be fully proportioning unless otherwise specified. Damper motor operators shall have metal bodies. The operators shall have ample power to overcome friction of damper linkage and air pressure acting on the damper blades. The damper operator mounting arrangement shall be outside the airstream wherever possible. The operators shall have external adjustable stops to limit the stroke. The operator linkage arrangement shall be such as to permit normally open or normally closed positions of the damper as indicated. Provide control power or electric line power to damper operators as required.

2.04 THERMOSTATS

- A. Electric Room Thermostats: shall be line or low voltage two position devices as indicated on the plans. Standard manufacturing configurations of single or multi-stage as well as heating/cooling arrangements shall be furnished as required to provide an operable system. Operating differential shall not be more than 1-1/2 degrees F. Housing shall be corrosion-resisting metal. Thermostats shall not be equipped with thermometers. Select type of thermostat to match the equipment it controls.
- B. Equipment Room Ventilation Thermostats: shall be wide differential type with coiled elements exposed.

2.05 AUTOMATIC CONTROL VALVES

- A. All automatic control valves shall be fully proportioning with modulating plugs for equal percentage of linear flow characteristics. The valves shall be sized by the control manufacturer and be provided with actuators of sufficient power for the duty intended. Valve body and actuator selection shall be sufficient to handle system pressure and shall close against the differential pressures liable to be encountered on the project.
- B. Small Valves – 1/2" through 1"
Valves shall be constructed with a cast brass body and screwed ends. Trim shall consist of a removable cage providing valve plug guiding throughout the entire travel range. A stainless steel stem shall be provided. Bonnet, cage, and the stem and plug assembly shall be removable for servicing. Actuator shall be cast aluminum with spring return piston operated by synthetic rubber diaphragm. Body rating shall be 400 psi at 150 degrees F.
- C. Valves – 1-1/2" through 2"
Valves shall be constructed with a cast brass body and screwed ends. For special duty, valves may be selected by the control manufacturer to have either bronze or cast iron bodies with screwed or flanged ends. Valves shall have either piston or diaphragm actuators as required.
- D. Valves – 2-1/2" and above
Valves shall be constructed with a cast iron body and have flanged connections. Actuators shall be of he synthetic rubber, spring return, diaphragm type sized for the duty.

2.06 DAMPERS

- A. Modulating Dampers: shall be furnished by the Temperature Control Contractor and shall be of the multiple opposed-blade type. All damper frames are to be constructed of #13 gauge galvanized sheet metal and shall have flanges for duct mounting. All blade-to-blade linkage on each section shall be concealed within the damper frame. In no case shall the section linkage be exposed to the air stream. Damper blades shall not exceed 6" in width. All blades are to be corrugated type construction, fabricated from two sheets of #22 gauge galvanized sheet steel, spot welded together. Blades are to be suitable for high velocity performance. Replaceable synthetic elastomer seals are to be provided with dampers to be used for outside, return or exhaust air and for zone mixing dampers. Seals are to be along each blade edge. Seals shall provide a tight closing, low leakage damper of less than 1% at 3" static pressure. Bearing shall be oil impregnated sintered bronze or bearing grade nylon.
- B. Fire and Smoke Dampers: shall meet UL 555 requirements.

2.07 DUCT SMOKE DETECTOR

- A. The duct smoke detector shall operate on photoelectric principle rated for air velocities 100 – 4000 fpm. Each detector shall be supplied with properly sized air sampling tubes. The detector head shall be a plug-in unit. The unit shall have a lamp on the housing to indicate when the unit has been activated by fire or smoke.

2.08 CONTROL POWER

- A. Method: Provide transformers to supply power for control equipment operating at less than normal lighting circuit voltage. Do not use spare circuits in electric panels. Do not connect control wiring to lighting circuits. Transformers and line voltage controllers serving individual heating unit may be fed from the fan motor leads. Each transformer shall have a capacity to simultaneously operate all apparatus connected to it. Provide relays of open contact, mercury tube, or electronic type, with dust-proof enclosures and capacities adequate for loads controlled. Provide manual transfer switches with operating levers and index plates showing switch position and names of units controlled. Complete electric wiring shall be furnished and installed for temperature controls, including wiring to transformer primaries. All wires shall be color-coded or numbered for identification. Use plenum rated cable for all wiring in ceilings or plenums and not in conduit. Wiring may be run without conduit except in areas where susceptible to damage, which shall be run in EMT.

2.09 NAMEPLATES

- A. General: Provide labels for controllers and control panels; black plastic with white lettering. Provide controllers with Engineer-approved tag indicating set points.

2.10 TIME CLOCKS

- A. General: Vertex energy manager model EM3 with indoor temperature sensor and outdoor temperature/wind sensor. Programming of clock and operating instructions to Owner provided by Vertrex factory-authorized personnel.
- B. Provide a 7-day dial, four single pole, single throw switches, timeclock, or timeclocks as required. Provide minimum 14 on-off trippers, manual on-off lever, 7" dial subdivided in 1/2 hour increments. Provide heavy duty industrial type synchronous motor, sealed in mechanism, lubricated for life. UL listed. Dayton, Tork.
- C. Operation during power failure: Provide, by same manufacturer, spring wound carryover to keep timer running during failures. Carryover shall have 10 hour reserve, rewinds automatically when power is resumed. Mechanicsm shall pulse continuously to reduce failure to inactivity.

2.11 CO SENSOR

- A. General: Microprocessor base carbon monoxide gas monitoring system consists of solid state or electrochemical sensor with digital signal for integration with a controller. Controller shall have both audible and visual LED alarm and able to schedule operation of exhaust fans. Manufacturer Shall be MSA Z Guard or equal.

PART 3 - EXECUTION

3.01 SUBMITTALS

- A. The following shall be submitted for approval:
 1. Data sheets for all control systems and components.
 2. Valve, humidifier, damper, and well and tap schedules showing size, configuration, capacity and location of all equipment.
 3. Control system drawings containing pertinent data to provide a functional operating system, including a sequence of operation. Detailed shop drawings may be submitted in as-built form upon project completion.

3.02 INSPECTION OF CONDITIONS

- A. Examine related work and surfaces before starting work of this section. Report to Architect, in writing, conditions which will prevent proper provision of this work. Beginning work of this section without reporting unsuitable conditions to Architect constitutes acceptance of conditions by Contractor. Perform any required removal, repair or replacement of this work caused by unsuitable conditions at no additional cost to Owner.

3.03 WIRING

- A. Electric wiring and wiring connections required for the installation of the temperature control system, as herein specified, shall be provided by the temperature control contractor unless specifically shown on the drawings or called for in the specifications to be by the Electrical Contractor. All wiring shall comply with the requirements of local and national electrical codes.

3.04 BYPASS TIMERS

- A. Location: Mount in fully-recessed wall box with locking flush cover.

3.05 INSTRUCTION AND ADJUSTMENT

- A. Upon completion of the project, the Temperature Control Contractor shall adjust and validate all thermostats, controllers, valves, damper operators, relays, etc., provided under this section.
- B. Instruction manuals shall be furnished covering the function and operation of the control system on the project for use by the owner's operating personnel. An instruction period lasting not less than four hours shall be provided to completely familiarize operating personnel with the temperature control systems on the project.

3.06 WARRANTY

- A. Upon completion of the project as defined either by acceptance of the building by the owner or by beneficial use of the equipment by the owner, a warranty period of one year shall commence. The warranty shall consist of a commitment by the Automatic Temperature Control Contractor to provide, at no cost to the owner, parts and labor as required to repair or replace such parts of the temperature control system that prove inoperative due to defective materials or installation practices. This warranty expressly excludes routine service such as filter cartridge replacement, compressor lubrication or instrument calibration.

3.07 DUCT SMOKE DETECTOR

- A. In systems over 2000 CFM listed smoke detector shall be installed to detect the presence of smoke and automatically stop the fans; in the supply air duct downstream of the filters, and in the return system on each floor at a point of entry into the common return.
- B. The smoke detector in the return air duct may be omitted in systems less than 15,000 CFM.
- C. The detectors in the supply and return air stream may be omitted provided that the system is less than 15,000 CFM and the space is protected by an area smoke detection system.

PART 4 – SEQUENCE OF OPERATION - CONTROL CONTRACTOR TO EDIT SECTION

4.01 AIR HANDLING UNIT CONTROL

- A. The air-handling unit shall be controlled (ON/OFF) from the timeclocks.
 - 1. A temperature controller with sensor in the supply air shall modulate the cooling coil valve to maintain a constant supply air temperature of 55 degrees F (adjustable). The cooling coil valve shall be interlocked to close with the respective air-handling unit.
 - 2. A duct smoke detectors shall be provided in the supply and return air duct to stop the fan on detection of products of combustion.
 - 3. Each air-handling unit shall be provided with inlet vane control. Duct static pressure sensors shall be provided as shown on the drawings. The lower static pressure signal shall be used to modulate the inlet vane dampers to maintain a constant duct static pressure. The inlet vane shall be interlocked to close with the respective air-handling unit.

4.02 FAN COIL UNIT CONTROL

- A. A room thermostat (with ON/OFF switch as indicated) shall modulate the cooling coil valve to maintain the desired room temperature. The cooling coil valve shall close on fan shut down.

4.03 STAIRWAY VENTILATION FAN CONTROL

- A. The stairway supply fan shall be interlocked to start when the building fire alarm system is in alarm. A static pressure controller in the stairway shall modulate the exhaust damper on the roof to maintain the desired positive static pressure in the stairway.

4.04 CHILLER PLANT CONTROL

- A. The central chiller and heating plant shall be controlled and monitored by the EMCS system.
- B. The chilled water and hot water generating equipment shall be interlocked and controlled so as to maximize “free” heating (heat recovery) and cooling. Interlocking wiring shall be in strict accordance with manufacturers’ recommendations.
- C. The cooling tower fans shall be controlled by the EMCS to maintain the coldest possible condenser water temperature permitted by the prevailing outdoor conditions. This shall be accomplished by monitoring the outdoor air dry and wetbulb temperatures. The cooling tower fans shall be interlocked to stop when the condenser pumps are not running. A differential pressure controller in the common chilled water supply and return lines shall modulate a chilled water bypass valve to maintain a constant pressure across the chilled water supply and return lines.

END OF SECTION

SECTION 23 11 23

SYNTHETIC NATURAL GAS SYSTEM

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Conditions:

1. Conform to General Conditions, Supplementary Conditions and Division 1 - General Requirements.

1.02 SCOPE

- A. This section includes synthetic natural gas and piped distribution. Comply with requirements and recommendations of NFPA 54 National Fuel Gas and City and County Codes.

1.03 SUBMITTALS

- A. Submittals: Meet the applicable requirements of Section 01 33 00 – SUBMITTAL PROCEDURES. Provide list of items applied, shop drawings, and product data for:
1. Pipe and Fittings
 2. Valves

- B. Shop Drawings shall be for entire system. Provide coordinated layout drawings minimum 1/4" per foot, which show all piping, sprinkler heads, ductwork, equipment, conduit, cable trays, pull boxes, light fixtures, access panels, architectural, and structural systems. All trades to coordinate in preparation of drawings to establish final locations of work. Areas of extreme congestion shall be shown at 1/2" scale.

PART 2 - PRODUCTS

2.01 PIPE AND FITTINGS

- A. Galvanize steel, schedule 40, ATSM A53 with malleable iron screwed fittings.
- B. High density polyethylene pipe, ASTM D2513.
- C. Corrugated stainless steel tubing (CSST) with exterior PVC covering, as approved for use by local codes.

2.02 VALVES

- A. Gate Valve: Bronze, class 125, threaded. Equal to Nibco model T-111
- B. Solenoid Valve: Aluminum body, NBR seals and disc, stainless steel core and springs, 120 volt. ASCO series 8042 or approved equal.

PART 3 - EXECUTION

3.01 PIPING

- A. Install piping, fittings and accessories in accordance with manufacturer's recommendations and conform to local codes.
- B. Cap all outlets gastight with threaded plug.

3.02 VENT

- A. Support at building wall and terminate 9 feet above grade with weatherproof vent cap minimum 3 feet from building opening.

3.03 VALVES

- A. Provide shut-off valve within 3 feet of connection to each equipment or appliance and pressure regulator. Refer to Section 15050 – BASIC MATERIALS AND METHODS.
- B. Provide solenoid valve on appliances under exhaust hood with fire alarm protection system.

3.04 TEST

- A. In accordance with NFPA 54 and AGA recommendations.

END OF SECTION

SECTION 23 13 00

FUEL OIL PUMPING SYSTEMS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Conditions:

1. Conform to General Conditions, Supplementary Conditions and Division 1 - General Requirements.

1.02 SCOPE

- A. This section includes fuel oil storage and piped distribution. Comply with requirements and recommendations of NFPA 31.

1.03 SUBMITTALS

- A. Submittals: Meet the applicable requirements of Section 01 33 00 – SUBMITTAL PROCEDURES. Provide list of items applied, shop drawings, and product data for:

1. Pipe and Fittings
2. Fuel Oil Tank
3. Fill Box
4. Fuel Pump

- B. Shop Drawings shall be for entire fuel system. Provide coordinated layout drawings minimum 1/4" per foot, which show all piping, sprinkler heads, ductwork, equipment, conduit, cable trays, pull boxes, light fixtures, access panels, architectural, and structural systems. All trades to coordinate in preparation of drawings to establish final locations of work. Areas of extreme congestion shall be shown at 1/2" scale.

PART 2 - PRODUCTS

2.01 PIPE AND FITTINGS

- A. Schedule 40, black steel with malleable iron screwed fittings. Install in accordance with manufacturers' recommendations.

2.02 GATE VALVES

- A. Equal to Nibco Model T-111.

2.03 FUEL OIL TANK

- A. UL listed Single Double wall vented fiberglass reinforced plastic (FRP). Owens Corning, Xerexes, & Lifetime.

2.04 FUEL LEVEL GAUGE

- A. Remote hydrostatic type, wall mounted gauge calibrated in gallons indicating full at maximum tank capacity. Hersey Levelometer Small Model.

2.05 FILL BOX

- A. Water tight, flush, locking type with tank settling adjustment. Provide wrench. Emco A-0571.

PART 3 - EXECUTION

3.01 PIPING

- A. Grade to tank. Provide swing joints (2 - 90E elbows and 12" of pipe between) at each connection to tank.

3.02 VENT

- A. Support at building wall and terminate 9 feet above grade with weatherproof vent cap minimum 3 feet from building opening.

3.03 VALVES

- A. Provide at connections to equipment.

3.04 FUEL LEVEL GAUGE

- A. Install buried gauge tubing in steel pipe conduit.

3.05 FILL BOX AND MANHOLE MARKER

- A. Install on concrete and flush with grade.

3.06 FUEL STORAGE TANKS

- A. Install tank(s) with vent, filter, oil lines and concrete hold down pad. Surround tank with minimum of 6" clean sand. Vent pipe sloped toward the tank. See detail on drawings.

- B. Install as indicated on drawings and in accordance with manufacturer's recommendations.
Provide final asphalt coating in field, touch up immediately prior to backfilling.

3.07 TEST

- A. In accordance with NFPA 30.

END OF SECTION

SECTION 23 20 00

CONDENSER WATER SYSTEMS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- A. Conform to General Conditions, Supplementary Conditions and Division 1 - General Requirements.

1.02 SUMMARY

- A. Section Includes:
 1. Condenser water system and accessories.

1.03 SUBMITTALS

- A. Submit in accordance with Section 01 33 00 – SUBMITTAL PROCEDURES
- B. Product Data: Submit manufacturer's product data and installation procedures for each type of product specified in this section.
- C. Shop Drawings shall be for entire condenser water system. Provide coordinated layout drawings minimum 1/4" per foot, which show all piping, sprinkler heads, ductwork, equipment, conduit, cable trays, pull boxes, light fixtures, access panels, architectural, and structural systems. All trades to coordinate in preparation of drawings to establish final locations of work. Areas of extreme congestion shall be shown at 1/2" scale.

1.04 CLOSEOUT SUBMITTALS

- A. Submit under provisions of Section 01 77 00 – CLOSEOUT PROCEDURES.
- B. Operation and Maintenance Data: Submit operation and maintenance data including maintenance schedules, spare parts requirements, and procedures.

1.05 QUALITY ASSURANCE

- A. Single Source: Provide pumps and accessories from a single manufacturer.
- B. Chemical and service supplier to be specialist in water treatment, active in field for a minimum of 10 years. Full time service personnel to be located within the State of Hawaii. Equipment and chemicals to be Nalco, Dearborn, or Calgon.

PART 2 - PRODUCTS

2.01 CONDENSER WATER PIPING, ABOVE GROUND

- A. Steel Pipe: ASTM A53, Schedule 40, galvanized, Open Loop (Cooling Tower to Heat Exchangers)
 - 1. Fittings: ASTM A234, galvanized wrought steel welding type.
 - 2. Joints: Threaded or ANSI/AWS D1.1 welded.
 - 3. Mechanical Grooved Couplings and Fittings: Ductile iron; housing, rust inhibiting no-lead paint, heat treated steel bolts and nuts, grade E EPDM sealing gaskets. Victaulic, Tyco Grinnell, Anvil International.
- B. Steel Pipe: ASTM A53, Schedule 40, Closed Loop (Heat Exchangers to Retail Spaces)
 - 2. Fittings: ASTM A234, wrought steel welding type.
 - 2. Joints: Threaded or ANSI/AWS D1.1 welded.
 - 3. Mechanical Grooved Couplings and Fittings: Ductile iron; housing, rust inhibiting no-lead paint, heat treated steel bolts and nuts, grade E EPDM sealing gaskets. Victaulic, Tyco Grinnell, Anvil International.
- B. Expansion Joints:
 - 1. Mason Industries Safeflex SFDEJ.
- C. Alignment Guides: Mason Industries.
- D. Pump Connectors: Mason Industries Safeflex SFDEJ.

2.02 CONDENSATE PIPING

- A. Condensate piping shall be Type L, ASTM B 88 hard drawn copper tubing or DWV copper, ASTM B 306 with wrought copper fittings, silver solder joint or PVC, ASTM D 1785 (Schedule 80), solvent joint.

2.03 WATER TREATMENT

- A. Condenser Water System:
 - 1. The condensing water treatment systems shall be fully automatic in operation, and shall be Dearborn Chemical Company's system 5H502 or approved equal, including a Flo-Thru Probe with condensing water sensing, piping from the condensing water pump discharge and suction lines, control panel to control system automatic solenoid bleed valve, sense and indicate alarm for low solution tank levels, along with control wiring from the control panel in the equipment room with necessary controls to start and stop the treatment agitators and pumps.
 - 2. Chemical storage tanks shall be PVC lined, 50-gallons, with supporting legs, sight glass, stainless steel dissolving basket, and motor driven agitator. Provide stainless steel strainer between the tank and pump.
 - 3. Pump unit for condensing water treatment system shall be duplex with a minimum capacity of 1.0 GPH at 150 psi pressure each. Pumps shall have suction valves; check

and gate valve on the discharge. Pumps shall be adjustable from 0-100% while in operation. All metal in contact with the solution shall be stainless steel.

2.04 END SUCTION CENTRIFUGAL PUMPS

- A. Frame-mounted, single stage, end-suction centrifugal, flexible coupled drive and cast iron or steel base. Pumps with the selected impeller size near the maximum possible impeller size will not be accepted. Pumps shall not overload the motor anywhere on their performance curve.
- B. For capacities and pump heads, see Mechanical Equipment Schedule on the drawings.

2.05 AIR SEPARATOR

- A. Air separator fitting shall be Model No. R-8 "Rolairtrol", as manufactured by Bell & Gossett Company, constructed of black steel, 125 psi working pressure in accordance with ASME Code for Unfired Pressure Vessels. Separator shall have flanged inlet and outlet connections, size as shown on plans, blowdown, and air vent connections, perforated stainless steel collector tube. Units shall be supported from the floor on a stand fabricated from welded steel 3 inch by 3 inch by 1/4 inch angles.

2.06 EXPANSION TANK AND ACCESSORIES

- A. Furnish and install where shown on the plans, a pre-charged steel expansion tank with replaceable heavy duty Butyl rubber bladder. Tank shall have floor mounting skirt and lifting rings. The tank shall have NPT system connection, charging valve connection and drain connection. Tank construction shall be in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code and stamped 125 psi working pressure.
- B. Provide a backflow preventer, pressure reducing valve with valved bypass and pressure gauges in the cold water makeup to the chilled water system. Tank and fittings shall be as manufactured by Bell & Gossett, Taco or equal.

2.07 SUCTION DIFFUSER

- A. Angle pattern flow straightening fitting of cast iron construction. Fitting equipped with a combination diffuser-strainer-orifice cylinder with removable end cap.

2.08 CENTRIFUGAL SEPARATOR

- A. Completely-assembled package unit consists of a separator, pump, suction strainer, solids collection vessel, isolation valves, flow control orifice and electrical control. 125psi working pressure. Unit as manufactured by Lakos or equal.

2.09 PLATE HEAT EXCHANGER

- A. Corrugated alloy plates gasketed and compressed together in a carbon steel frame. Plates shall be 304 stainless steel with NBR clip on seals and inlined connection material. 150 psi operating pressure. Unit as manufactured by Alfa Laval Thermal or equal.

2.10 STRAINERS

- A. Furnish and install "Y"- type strainers ahead of the chilled water and condensing water pumps. Strainer baskets shall be bronze with not larger than 1/16-inch perforations. Provide 3/4-inch valved flushing lines from the bottom of each strainer.

PART 3 - EXECUTION

3.01 ACCESS

- A. Coordination: Install equipment with associated piping to permit access to doors and service areas as required for ease of maintenance.

3.02 LOCATION AND SIZE

- A. Coordination: Equipment scheduled on drawings are selected and configured to fit in mechanical spaces available. Insure that substitute equipment will fit without change in function or quality and without additional cost.

3.03 CAPACITIES

- A. Substitutions: Scheduled capacities reflect calculations based on manufacturer's recommended procedures using listed accessories and design parameters. Insure that substitute equipment will provide similar operating characteristics and capacities.

3.04 INSTALLATION

- A. Coordination: Install equipment in accordance with manufacturer's recommendations. Bring conflicts between such recommendations and drawings to immediate attention of Architect/Engineer.
- B. Condenser Water Piping: Install piping to assure complete drainage of system with hose bibbs at low points. Install automatic air vents to all high points of system with copper tube discharge to sewer.
- C. Expansion Joints: Install with two alignment guides on each side of the joint. The first guide must be not more than 4 pipe diameters from the joint with the second not more than 14 pipe diameters away from the first guide.

- D. Anchors: Install so as not to injure construction, either in installing or by weight or by expansion of pipe.
- E. Expansion Bends, Ells and Loops: Cold sprung open by an amount not to exceed 50% of total expansion, based on installation temperature. All bends, ell and loops expansion type.
- F. Isolation Valves: Provide isolation valves on all equipment.

3.05 VALVE INDEX/PIPING CLEANING/TESTING

- A. Valve Index:
 - 1. Install brass tags on all new valves with numbers and letters stamped or engraved thereon designating service of each valve. The letter indication shall be as designated by the Owner.
 - 2. Furnish and mount where directed a chart indicating location, index number and purpose of all air conditioning valves. Chart shall have metal frame and glass cover.
- B. Cleaning:
 - 1. All equipment, piping, ducts and lines shall be thoroughly cleaned in an approved manner, before leaving the work.
 - 2. After the condensing water piping has been pressure tested and before the system has been put into operation, this contractor shall flush the system.
 - 3. Fill the condensing water systems and operate for 8 hours; clean the strainers and refill the system and operate for 8 hours. If at this time the system is not clean, repeat the procedure.
- C. Testing and Adjusting:
 - 1. Test all piping to 150 pounds pressure and make tight. Caulking will not be permitted. Pressure shall be held for 4 hours with not more than a 1-pound loss.
 - 2. The contractor shall obtain the services of an independent test and balance agency approved by the engineer, that specializes in and whose business is limited to the testing and balancing of air conditioning systems. The agency selected shall have a record of experience of at least one year in testing and balancing of air conditioning systems.
 - 3. Testing and balancing shall be performed in complete accordance with all the forms in the Test and Balance Analysis Report as published by the Associated Air Balance Council.
 - 4. Instruments used for testing and balancing of air and hydronic systems must have been calibrated within a period of six months prior to balancing. All final test analysis reports shall include a letter of certification listing instrumentation used and last date of calibration.
 - 5. Three copies of the complete test reports shall be submitted to the engineer prior to final acceptance of the project.
 - 6. Name of the Test and Balance Agency shall be submitted for approval by the engineer within 15 days after receipt of construction contract by air conditioning contractor.
 - 7. Testing and balancing shall include all air handling systems, and condensing water systems.

3.06 START-UP AND TESTING

- A. Requirements: Performed by factory authorized personnel at completion of project. Test and adjust to conform to project requirements. Submit written report to Engineer.

END OF SECTION

SECTION 23 30 00

AIR DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- A. Conditions:
 - 1. Conform to General Conditions, Supplementary Conditions and Division 1 - General Requirements.

1.02 SUMMARY

- A. Section includes supply, return and exhaust ductwork, accessories and terminal units.

1.03 SUBMITTALS

- A. Submit in accordance with SECTION 01 33 00 – SUBMITTALS PROCEDURES.
- B. Product Data: Submit manufacturer's product data and installation procedures for each type of product specified in this section.
- C. Shop Drawings: Shall be for entire air distribution system. Provide coordinated layout drawings minimum 1/4" per foot, which show all piping, sprinkler heads, air systems, equipment, conduit, cable trays, pull boxes, light fixtures, access panels, architectural, and structural systems. All trades to coordinate in preparation of drawings to establish final locations of work. Areas of extreme congestion shall be shown at 1/2" scale.

1.04 CLOSEOUT SUBMITTALS

- A. Submit in accordance with Section 01 77 00 – CLOSEOUT PROCEDURES.
- B. Operation and Maintenance Data: Submit operation and maintenance data including maintenance schedules, spare parts requirements, and procedures.

1.05 QUALITY ASSURANCE

- A. Single Source: Provide ductwork accessories from a single manufacturer.

PART 2 - PRODUCTS

2.01 DUCTWORK

- A. Standards: Comply with most stringent requirements and recommendations of Uniform Mechanical Code and SMACNA (Sheet Metal and Air Conditioning Contractors National Association) Duct Construction Standards for fabrication, construction and sealant of duct, fittings, and accessories. Duct construction pressure classification for each system shall be based on the system operating pressure stated on the equipment schedule. Variable volume systems shall have 2" w. g. pressure class construction for ductwork upstream of the VAV boxes.
- B. Application:
 1. Galvanized steel sheet, ASTM A653 (for general ductwork)
 2. Carbon steel sheet, ASTM A568, min. 16 gauge (for kitchen grease ductwork)
 3. Stainless steel sheet, ASTM A 167, AISI Type 302/304, min. 18 gauge (for exposed kitchen exhaust ductwork)
 4. Aluminum sheet, ASTM B209, Alloy 3303, Temper H14 (for ductwork use in shower exhaust, dishwasher exhaust and where indicated on plans)
- C. Construction: Casings, ductwork, and fitting configuration as indicated on drawings. Indicated dimensions are net inside. Allow for thickness of duct lining where indicated.
- D. Seams and Joints: Seal per SMACNA seal class 'B'. Seal transverse joints per seal class 'D'. Welded watertight for kitchen exhaust ductwork.

2.02 HIGH AND MEDIUM VELOCITY/PRESSURE DUCTWORK

- A. Standards: Comply with most stringent requirements and recommendations of Uniform Mechanical Code and SMACNA High Pressure Duct Construction Standards for fabrication, construction and sealant of duct, fittings and accessories. Ductwork may be factory fabricated. United Sheet Metal, Metco, Allied.
- B. Application: Galvanized sheet steel, ASTM A653 for all ductwork.
- C. Construction: Casings, ductwork, and fitting configuration as indicated on drawings. Indicated dimensions are net inside. Allow for thickness of duct lining where indicated.
- D. Construction: Ductwork and fitting configuration as indicated on drawings.

2.03 ACOUSTICAL FAN PLENUMS, FACTORY FABRICATED

- A. General: Provide pre-engineered panel plenum casings as indicated by Koppers, Rink, IAC, Gale, Baldwin-Ehret-Hill, or United Sheet Metal.
- B. Plenum Walls: 4" nominal thickness, fabricated with an 18 gauge galvanized steel outer sheet, 22 gauge galvanized perforated steel inner sheet, fully framed and stiffened with 16 gauge galvanized steel channels spot welded or riveted to inner and outer sheets and packed with four PCF density acoustical glass fiber without paper face covering. (Thickness of glass fiber 1/3"

greater than stud thickness.) Vertical edges of all panels shall be pre-drilled both sides. No span shall exceed 24 inches. Wall panels noted as septum on drawings shall have 20 gauge galvanized perforated steel exterior sheets both sides, with 18 gauge galvanized steel airtight membrane. Walls shall be 4" thick, 2" on either side of membrane. Entire standard plenum wall shall be self-supporting up to a 10-foot span and shall withstand an internal positive pressure of 12 inches of water in the supply section and an internal negative pressure of 4 inches of water in the return section.

- C. Panel Connectors: Furnished in standard lengths for field cutting to finished dimensions. Floor channels, wall caps, and roof angles shall be furnished full pre-drilled and corner sections shall be furnished preassembled for each installation.
- D. Access Doors: 24" x 60" or 36" x 84" opening, as shown on drawing, furnished and installed in panel frames with two wedge-type latches, single air seals, bull hinges and open against the air pressure.
- E. Transmission Loss: Panels shall have the following transmission loss characteristics as tested by Riverbank Labs in accordance with ASTM E90-70:

1. Hz	125	250	500	1000	2000	4000
2. B	21	28	39	48	56	58
- F. Absorption Coefficients: Panels shall have the following minimum absorption coefficients as tested by Riverbank Labs in accordance with ASTM C423-65, mounting No. 4:

1. Hz	125	250	500	1000	2000	4000	NRC
2. Abs. Coeff.	.60	.99	.99	.99	.99	.99	.99
- G. Openings and Penetrations: All openings or panel penetrations greater than 6" shall be cut and framed at the factory. Openings or penetrations less than 6", i.e. pipe and conduit holes, etc., are to be located and cut by the installer. All blank-off panels and safing between equipment and casing to be provided by installer.
- H. Panel Manufacturer: Furnish complete, coordinated erection drawings and installation instructions to include a bill of materials, and panel shipment to be piece-marked to match the drawings and material list and furnish installer with sufficient mastic sealant and self-drilling sheet metal screws for complete installation. Caulk all connections and bottoms of floor channels with a butyl rubber elastomer base compound.

2.04 OPTIONAL JOINT SYSTEM

- A. Transverse Joints: Transverse duct joints may be made with the Ductmate System at Contractor's option. The Ductmate companion angle shall be constructed of 20 gauge galvanized steel with an integral polymer mastic seal. Corner pieces shall be constructed of 12 gauge steel.

2.05 FLEXIBLE DUCT

- A. Requirements: UL 181, Class 1 complete with aluminum flexible interior liner, R-4.2; 1" insulation and exterior vapor barrier. Clevaflex, United Sheet Metal, Gensco, Casco, Thermaflex, or Johns-Manville, equal to Thermaflex models as follows:
1. Low Velocity: M-KE
 2. Medium/High Velocity: M-KC

2.06 ACOUSTICAL TREATMENT (DUCT LINING)

- A. Indoor Ductwork: Fiberglass, 1.5" (R-5 min) thickness and 1.5 lbs. density, minimum NRC of 0.6 in accordance with requirements of NFPA Standards 90-A and 90-B and suitable for operating velocities to 4000 FPM. Acrylic coated with EPA-registered anti-microbial agents to preclude microbiological growth and allow duct cleaning. Johns Manville Linacoustic RC , Owens Corning QuietR or KNAUF EM. Provide on all ductwork, except where indicated.
- B. Outdoor Ductwork: Fiberglass, 2" (R-8 min) thickness and 3.0 lbs. density, minimum NRC of 0.8 in accordance with requirements of NFPA Standard 90-A and suitable for operating velocities to 4000FPM. Acrylic coated with biocide to preclude microbiological growth and allow duct cleaning. Johns Manville Permacote Linacoustic R300, Owens Corning Quiet R, KNAUF EM or CertainTeed ToughGuard 2. Provide on all ductwork, except where indicated.

2.09 FIRE DAMPERS

- A. Requirements: Dynamic type constructed and tested in accordance with ANSI Z233.1 (UL555) and with UL label for rating as required by Building Code, 160 degrees - 165 degrees F fusible link, blades mounted out of the airstream. Provide three additional spare fusible links of each type installed.

2.10 COMBINATION SMOKE/FIRE DAMPERS

- A. Requirements: Constructed and tested in accordance with ANSI Z233.1 (UL555 and UL555S) and with UL label rating as required by Building Code, 165 degrees and Class II leakage rating. Provide a sleeve mounted smoke detector, electric damper actuator with EFL (Electric Fuse Link) and resettable fire closure device or firestat. Damper shall be provided with 120V power. Connect to the fire alarm system to relay signal as required.

2.11 FLEXIBLE CONNECTIONS

- A. Requirements: Waterproof, air tight, heat resistant, neoprene-coated fabric, 32 ounce. Ventglas, Elgen, Duro Dyne.

2.12 ACCESSORIES

- A. Air Extractors: Adjustable blades, rotating shaft operator. Titus AG-45 with Young No. 1 operator.

- B. Backdraft Damper: Counterbalanced, aluminum blades, adjustable counterweights, felt edges. American Warming P-494 or equal by Wonder Metal.
- C. Manual Volume Damper: Single blade for ducts up to 12" high, opposed for over 12" high, locking nut and indicating device, SMACNA.
- D. Elbows: Standard radius or vaned square, SMACNA.
- E. Duct Access Door: Butt hinged, sash locks, SMACNA Fig.2-14.
- F. Remote Damper Operator: 3/8" concealed adjustable cover regulator, chrome-plated cover. Young Regulators or pre-approved equal.
- G. Sealant and Tapes: Non-combustible.
- H. Solder: ASTM B23, Grade 50B.

2.13 GRILLES, REGISTERS AND DIFFUSERS

- A. Requirements: As scheduled and indicated on drawings, with extruded aluminum construction, opposed blade damper and equalizing grid. Ceiling mounted units to mate with ceiling system. Provide plaster frames for units mounting in plaster walls or ceilings. Performance tests in accordance with ADC Standard 1062R2, Test Code, with ASHRAE Standard 36B. Sizes shown on drawings indicate duct connection with minimum 60% net free area. Titus, Metalaire, Price, Carnes, Krueger, Barber-Colman, Tuttle & Bailey.

2.14 LOUVERS

- A. Requirements: 4" deep blades, extruded aluminum or primed galvanized steel with 45 degree stormproof stationary blades and birdscreen. Airstream, Greenheck, Wonder Metal. Confirm louvers type, manufacturer, dimensions, free area and color with Engineer and Architect prior to installation.

2.15 LOUVERS

- A. Requirements: 2" deep blades, extruded aluminum with 45degree stormproof stationary blades and birdscreen. Airstream, Greenheck, Wonder Metal, Arrow United.

2.16 MANOMETER

- A. Type: Vertical for 3" to 10" water gauge; acrylic plastic body mounted on steel mounting panel; adjustable reflective chrome finish scales with locking screws; type "E" connectors; all tubing and mounting hardware. Scale indication 0 - ". Dwyer Model 3. Provide scale range and model number.

2.17 AIR FILTER GAUGE

- A. Type: Inclined for up to 3" water gauge; acrylic plastic body mounted on steel mounting panel; adjustable reflective chrome finish scales with locking screw. Scale indication .20-0 - 3.0". Dwyer Model No. 209-AF (inclined). Revise scale range and model number to suit application.

2.18 SOUND TRAPS

- A. Requirements: 22 gauge (18 gauge for 36-45 wide) galvanized steel outer casing, 26 gauge perforated steel inner surface and glass fiberfill. Units tested in accordance with ASTM E 477. IAC, Rink, EAP, Dyna Sonics, Acoustifoil, Gale.
- B. High Performance Duct Silencer: Duct silencer rated and certified with procedures certified in accordance with applicable portions of ASTM E 477. All dynamic insertion less performance data obtained in actual duct to room reverberant test facility with air flowing through the silencers. Performance, including pressure drop, dynamic insertion loss, self noise power levels, shall be equal to Type LFS Superior Low Frequency Quiet-Duct silencer by IAC.
1. Provide double layer gypsum board over 6" rigid fiberglass wrapping over all duct silencers (and ductwork between silencer and theatre walls) located outside of the theatre space.

2.19 AIR LOW METER

- A. Requirements; Single analog airflow output with integral probe mounted microprocessor base transmitter operating on 24 VAC supply voltage. Duct sensor probe shall be constructed of extruded 6063 aluminum tube with Kynar insulated internal wiring. Instrument cables shall be UL plenum-rated PVC jacket. EBTRON Model ELF or approved equal.

PART 3 - EXECUTION

3.01 DUCTWORK

- A. Install, Support and Seal: In accordance with respective duct standards SMACNA Low Pressure or High Pressure, ACGIH, UMC. Kitchen exhaust system shall be per NFPA 96 and local and fire department requirements.
- B. Drawings: Do not attempt to show all required offsets in ductwork. Make such offsets as necessary for installation of work without additional cost to Owner. 15 degree maximum angle of offset.
- C. Where Ducts Pass Through Partitions, Ceilings, or Floors: Provide 1" clearance and insulate from structure with insulation material. Provide flanged sheet metal closure.
- D. Isolate Joints: Between dissimilar metals with fiber gasket.

- E. Duct Lining: Interior surfaces of all sheet metal supply and return ducts shall be lined. Interior surfaces of ducts and plenums shall be insulated with 1.5" (R-5 min) thick 1-1/2 lb. density coated duct liner on indoor ductwork and 2" (R-8 min) thick 3 lb. density on outdoor ductwork. Insulation shall be attached to the surface with 100% coverage of an approved adhesive. Provide metal fasteners with 1" diameter washers at least 16" center to center and a maximum of 8" from any edge or side of duct. Apply a thick coating of approved sealing compound on the exposed end and at least 2" back from the edge of liner and all edges that might be eroded by air stream. At entrance to ducts, after the flexible joint, provide a metal clamp to hold the edge of the insulation in place.
- F. Outdoor Air Duct Lining: Interior surfaces of all sheet metal outside air ductwork on rooftop shall be lined with 2" thick 3.0 lb. density coated duct liner. All outside air ductwork at top of shaft for the first 15 linear feet shall be lined with 2" fiberglass duct liner. After first 15 linear feet of shaft, duct lining shall be in accordance with 1" thick 1-1/2 lb. density coated duct liner. Insulation shall be attached to the surface with 100% coverage of an approved adhesive. Provide metal fasteners with 1" diameter washers at least 16" center to center and a maximum of 8" from any edge or side of duct. Apply a thick coating of approved sealing compound on the exposed end and at least 2" back from the edge of liner and all edges that might be eroded by air stream. At entrance to ducts, after the flexible joint, provide a metal clamp to hold the edge of the insulation in place.
- G. Supply, Return and Plenum Duct Lining: Interior surfaces of all sheet metal supply, return and plenums within building shall be lined with 1" thick 1-1/2 lb. density coated duct liner. Insulation shall be attached to the surface with 100% coverage of an approved adhesive. Provide metal fasteners with 1" diameter washers at least 16" center to center and a maximum of 8" from any edge or side of duct. Apply a thick coating of approved sealing compound on the exposed end and at least 2" back from the edge of liner and all edges that might be eroded by air stream. At entrance to ducts, after the flexible joint, provide a metal clamp to hold the edge of the insulation in place.
- H. Flexible Duct: Install in full extended condition free of sags and kinks. Use minimum length required to make connection. Length shall not exceed 6 feet. Suspend on 36" centers. Use clamps and duct sealer.
- I. Access Doors: Provide duct access doors on operator side of automatic dampers, fire dampers, smoke dampers and heating coils. Provide duct access doors on downstream of grease exhaust duct elbows for cleaning. Provide access panels to dampers, motors and heating coils, where concealed. Access doors and panels shall be large enough to permit maintenance, adjustment, cleaning and resetting of the device. Provide telescoping or removable duct sections where access doors can not be of sufficient size. Provide 16" x 24" duct access doors beginning at the initial duct main and at 75 feet spacing for duct cleanout.
- J. Access Identification: Duct access doors, telescoping or removable duct sections shall be identified with letters no less than 2" high to indicate the location of the fire damper or smoke damper within.
- K. Concealed Dampers: Provide remote damper operator or access panels for concealed manual volume dampers.
- L. Flexible Connection: Install at inlet and discharge of fans not internally isolated. External connections shall be protected with metal shield.

3.02 UNDERGROUND DUCTWORK

- A. Requirements: Install with watertight joints in accordance with manufacturer's written instructions. Bed and backfill in accordance with manufacturer's written recommendations.

3.03 OPTIONAL DUCT JOINT SYSTEM

- A. General: The Ductmate angles shall be securely fastened to the duct walls using self-drilling screws, rivets or spot welding. Fastener spacing shall be as recommended by the manufacturer for the size of duct and the pressure class. The raw duct ends shall be properly seated in the integral mastic seal. A continuous strip of closed cell gasket tape, size 1/4" x 3/4", shall be installed between the mating flanges of the companion angles at each transverse joint, and the joint shall be made up using 3/8" diameter x 1" long plated bolts and nuts. Drive-on or snap-on cleats shall be used at spacings as recommended by the manufacturer.

3.04 EQUIPMENT

- A. Installation: In accordance with manufacturer's recommendations. Bring conflicts between such recommendations and drawings to immediate attention of Architect/Engineer.

3.05 AIR TERMINALS

- A. Mounting Frames: Select frame style for type of construction and module of ceiling or wall in which they are mounted.
- B. Flexible Duct Connections: Connection to air devices shall not have more than 15 degree offset.

3.06 LOUVERS

- A. Installation: As indicated.

3.07 SEAL AND CAULK

- A. Exposed Ductwork: In addition to requirements of SMACNA and ACGIH, seal all seams and joints of all exposed supply, exhaust and return air ductwork in finished rooms airtight with caulk. Wash exposed surfaces with vinegar solution and make suitable for painting.
- B. Ductwork Exposed to Weather: Seal all joints and seams watertight. Construct and install ductwork to prevent ponding of water.

3.08 MANOMETERS AND AIR FILTER GAUGES

- A. Installation: Install at locations shown on drawings and in accordance with manufacturer's written recommendations.

3.09 TESTS

- A. Upon completion of installation and prior to balancing, insulating and acceptance, subject ventilating system to such operating tests as may be required by Engineer to demonstrate satisfactory functional and operating efficiency.

END OF SECTION

SECTION 23 34 00

HVAC FANS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- A. Conditions: Conform to General Conditions, Supplementary Conditions and Division 1 - General Requirements.

1.02 SUMMARY

- A. Section Includes: Air handling, ventilation and exhaust equipment and accessories.

1.03 SUBMITTALS

- A. Submittals: Submit under provisions of SECTION 01 3300 – SUBMITTALS
- B. Product Data: Submit manufacturer's product data and installation procedures for each type of product specified in this section.
- C. Shop Drawings: Shall be for entire air distribution system. Provide coordinated layout drawings minimum $\frac{1}{4}$ " per foot, which show all piping, sprinkler heads, air systems, equipment, conduit, cable trays, pull boxes, light fixtures, access panels, architectural, and structural systems. All trades to coordinate in preparation of drawings to establish final locations of work. Areas of extreme congestion shall be shown at $\frac{1}{2}$ " scale.

1.04 CLOSEOUT SUBMITTALS

- A. Submit under provisions of Section 01 77 00 – CLOSEOUT PROCEDURES.
- B. Operation and Maintenance Data: Submit operation and maintenance data including maintenance schedules, spare parts requirements, and procedures.

1.05 QUALITY ASSURANCE

- A. Single Source: Provide air handling units from a single manufacturer. Fans shall be from a single manufacturer.

PART 2 - PRODUCTS

2.01 AIR HANDLING UNIT (OUTDOOR INSTALLATION)

- A. General: Packaged unit consisting of cabinet fan, coils, filters, mixing box, motor and accessories factory manufactured of weatherproof construction for roof mounting. All components by the same manufacturer with AMCA rating and UL approved. Aaon, Carrier, Mammoth, Trane, York.
- B. Fans: Double width-double inlet centrifugal type, airfoil for 24" fans and larger. Fan bearings rated at 200,000 hours average life.
- C. Coils: Copper tube, aluminum fin mechanically bonded and A.R.I. performance certified.
- D. Casings: Removable 18 gauge reinforced double wall steel panels with thermal breaks and R-13 foam insulation, baked enamel finish and gasketed panels with water tight seals for weather protection.
- E. Drain Pans: Stainless steel construction with foam insulation.
- F. Drives: Adjustable belt drives, Woods, Browning. Belt guard in accordance with OSHA requirements. Guard to have tachometer openings, internally mounted motor and drive.
- G. Isolation: Motor and fan on common base inside unit with spring isolators and flexible connections.
- H. Filter Section: Construction similar to fan casing, access doors both sides; disposable 2" pleated fabric media in chipboard frame, MERV 8 efficiency.
- I. Combination Filter Mixing Box: Construction similar to fan casing, access doors both sides; parallel opposed blade dampers, disposable 2" pleated fabric media in chipboard frame, 30%-35% ASHRAE 52-68 efficiency, Farr 30/30.
- J. Face and Bypass Dampers: Construction similar to fan casing, insulated bypass duct, opposed blade dampers.
- K. Corrosion Protection: Provide Ameron PSX 700 coating on the casing as described in Section 20 00 00 – Mechanical Basic Materials and Methods.
- L. Roof Curb: Provide roof curb with vibration isolation rails.

2.02 AXIAL VANE FAN

- A. General: Direct drive (arrangement 4) controllable pitch unit. Joy, Woods, American SF. Construction: Continuously welded 1/4" hot rolled steel housing with 3/4" end flanges and motor support ring, 3/4" motor support plate. Eight 3/16" stationary guide vanes welded to inside of housing. Cast aluminum rotor hub and airfoil blades. Maximum 0.10" blade tip clearance. 1/4" steel cross-braced supports.
- B. Blade control: Automatically variable blade pitch having stepless control across full pitch range during fan operation. Remote control blade operation by pneumatic actuator. Index markings for various pitch settings.
- C. Fan and Motor: Fan statically and dynamically balanced on fan/motor shaft and whirl-tested to 125% of operating speed. NEMA standard totally enclosed motor mounted inside fan housing.
- D. Accessories: Where indicated on drawings:
 1. Inlet Bell
 2. Inlet Bell Screen
 3. Discharge Cones
 4. Companion Flanges
 5. Backdraft Damper
- E. Performance and Sound: Provide data of tests in accordance with AMCA standards. Sound power levels shall not exceed those of equipment scheduled.

2.03 TUBULAR CENTRIFUGAL FAN

- A. General: Factory assembled unit consisting of housing, fan, motor and accessories. AMCA rated and UL approved. Trane, PennBarry, Carrier.
- B. Fan: Aluminum casting with radially projected air foil blades. Fan bearings rated at 200,000 hours average life.
- C. Housing: 14 gauge steel with stiffening rings and square mounting frame, baked enamel finish.
- D. Drives: Adjustable belt drive with motor out of air stream, Woods, Browning. Belt guard in accordance with OSHA requirements.
- E. Straightening Vanes: Radially projected aluminum air foil vanes.
- F. Inlet Control Vanes: Vortex type steel dampers and bronze bearings in steel housing with peripheral control mechanism out of air stream, control arm suitable for automatic operation.

2.04 MULTIZONE UNIT (ROOFTOP INSTALLATION)

- A. General: Packaged unit consisting of supply and return cabinet fans, coils, gas heater filters, mixing box, controls, zone dampers, motor and accessories. All components by the same manufacturer, AMCA rated and UL approved. Mammoth, Lennox.

- B. Fans: Double width-double inlet type, forward curved in blow through configuration. Fan bearings rated at 200,000 hours average life.
- C. Coils: Copper tube, aluminum fin mechanically bonded and A.R.I. performance certified hot.
- D. Casing: Removable 18 gauge reinforced double wall steel panels with R-13 foam insulation and baked enamel finish.
- E. Drain Pans: Stainless steel construction with foam insulation.
- F. Drives: Adjustable belt drives, Woods, Browning. Belt guard in accordance with OSHA requirements; guard to have tachometer openings.
- G. Heater Section: 16 gauge 300 stainless steel primary drum, 14 gauge high carbon steel secondary tubes, power firing type burner with primary combustion air blower and ignition spark transformer; F.M. gas train.
- H. Combination Filter Mixing Box: Construction similar to fan casing, access doors both sides; parallel opposed blade dampers; disposable 2" pleated fabric filter media in chipboard frame, MERV –8 efficiency.
- I. Discharge Plenum: Construction similar to fan casing; control dampers with flexible edge seals on hot and cold deck to match duct configurations on drawings.

2.05 SPLIT SYSTEM HEAT PUMP - INDOOR UNIT

- A. General: Factory assembled unit consisting of housing, fan, motor, coils, filters and accessories. Indoor and outdoor unit by the same manufacturer cataloged to mate with each other. Carrier, Trane.
- B. Fan Section: Galvanized steel enclosure, bonderized, insulated and with baked enamel finish. Resiliently mounted factory lubricated multispeed motor with internal overload protection. Slide out fan motor assembly for service.
- C. Combination Filter/Mixing Box: Construction similar to fan casing, access doors both sides, parallel opposed blade dampers, disposable 2" pleated fabric filter media in chipboard frame, MERV –8 efficiency.
- D. Cooling Coil: Constructed with aluminum plate fins mechanically bonded to nonferrous tubing with all joints brazed. Factory-installed refrigerant metering device and equipped with refrigerant line fittings which permit mechanical connections. Coil casing insulated and constructed of galvanized steel, bonderized and finished with baked enamel.
- E. Accessories: Cooling control kit, heater spacer plates and return air plenum.

2.06 UNIT VENTILATORS

- A. General: Packaged unit consisting of cabinet, fan, coils, filters, dampers, motor and accessories. All components by the same manufacturer with AMCA rating and UL approved. Trane, AAF.

- B. Cabinet: 16 gauge furniture quality steel with exposed edges rounded. Front panels retained by a minimum of three Allen wrench operated camlocks. Camlock heads surrounded by plastic inset to protect paint. Baked enamel finish over baked prime coat. Color selection by Architect from manufacturer's standard colors. Discharge grilles constructed of heavy steel bars welded in place as an integral part of the unit structure. Inlet grilles easily removable for easy filter access. Leveling legs at both ends of unit. Galvanized steel drain pan.
- C. Dampers: Dual blade type with continuous divider between blades to positively separate the outside air and return air compartments.
- D. Fan Board Assembly: Single, rigid assembly including the fans, fan housings, bearings, fan shaft and motor.
- E. Motor: Two speed permanent split capacitor type. Motor removable without removing the fan board.
- F. Hydronic Coils: Plate-fin type, heavy gauge aluminum fins with continuous fin collars, 5/8" x .020" wall copper tubes.
- G. Electric Coils: Resistance elements inserted in an extended surface fin-tube bundle. High temperature cutout with a continuous sensing element. Contractor to provide positive disconnect of electric power whenever fan motor power is interrupted.
- H. Filters: 1" thick throwaway type accessible without removal of the unit front panel.
- I. Outside Air Intake: Unit capable of 100% outside air. Extruded aluminum weather louver and wall box provided with unit.

2.07 FAN COIL UNITS

- A. General: Modular vertical concealed draw-through fan coil unit consists of cabinet, fan, coils, filters, motor and accessories. All components by the same manufacturer with AMCA rating and UL approved. IEC, Trane, Carrier, McQuay.
- B. Cabinet: 18 gauge galvanized steel with insulated interior surfaces. Insulation shall be ½", 4 pound per cubic foot, foil face, designed to inhibit biological growth. Unit shall be designed to have wallboard applied directly to the front surface. It shall have double deflection aluminum discharge grille and return grille for use as access panel.
- C. Fan: Direct drive, forward curved, double width fan.
- D. Motor: Three speed permanent split capacitor type, permanently lubricated with sleeve bearings.
- E. Coils: ½" copper tubes, aluminum fins, ASTM B-75, minimum three-row coil.
- F. Valves: Unit shall have 2-way motorized control valve with pressure taps, normally closed, powered open with AFR valve and shut off ball valves.
- G. Drain Pan: 18 gauge stainless steel with fire retardant closed cell elastomeric insulation. The drain shall be factory piped to the drain with removable insulated P-t trap.

- H. Filters: 1" thick MERV 8 throwaway type, accessible without removal of the unit front panel.
- I. Controls: Manual changeover digital thermostat with integral 3-speed fan switch.

2.08 FAN COIL UNITS

- A. General: Cooling unit consisting of cabinet fan, coils, filters, motor and accessories. All components by the same manufacturer with AMCA rating and UL approved. Trane, Aaon, Carrier, McQuay.
- B. Fans: Forward curved, centrifugal type, mounted on spring isolators. Fan shall be statically and dynamically balanced and AHRI standard 430 performance certified.
- C. Coils: Copper tube, aluminum fin mechanically bonded and A.R.I. performance certified.
- D. Casings: Removable double wall steel panels with internal thermal break, R-13 foam insulation and baked enamel finish. Access doors shall be of same construction.
- E. Drain Pans: Stainless steel construction with foam insulation.
- F. Drives: Adjustable belt drives, Woods, Browning. Belt guard in accordance with OSHA requirements. Guard to have tachometer openings.
- G. Filter Section: Construction similar to fan casing, access doors both sides; disposable 2" pleated fabric media in chipboard frame, MERV 8 efficiency.

2.09 EXHAUST FAN

- A. General: Centrifugal backward inclined fan in heavy gauge spun aluminum housing for roof or wall mount. Wheels shall be statically and dynamically balanced. Motor out of airstream and shall be mounted on vibration isolators. Direct drive units shall have variable speed switch. Belt drive units shall have adjustable sheaves. Heavy duty ball bearings selected for minimum 100,000 hours average life. Provide hinged sub-base and disconnect switch. Units used for grease exhaust shall be provided with grease trap and drain connection. AMCA rated capacities and UL listed. PennBarry, Greenheck, Cook.

2.10 EXHAUST FAN

- A. General: Centrifugal belt-driven, backward-inclined type. Wheel constructed of steel with non-stick Teflon coating, statically and dynamically balanced. The fan housing shall be constructed of 16-gauge galvanized, welded and leakproof with hinged base and grease trap. Motor and drive mounted on vibration isolators and out of the airstream. Heavy duty bearings selected for minimum 100,000 hours of average life. NEMA 3R disconnect switch, .AMCA rated and UL listed. Greenheck or approved equal.

2.11 CEILING EXHAUST FAN

- A. General: Centrifugal fan mounted in acoustically insulated galvanized steel housing suitable for ceiling installation, fan motor mounted on vibration isolators, aluminum backdraft damper at outlet duct collar, internal plug in type motor disconnect, variable speed controller and integral polystyrene grille on ceiling mount unit, Provide wall or roof cap with bird screen as indicated on drawings. Provide ceiling radiation damper on unit mounted in fire rated ceiling. AMCA rated and UL approved. PennBarry, Greenheck, Panasonic, Cook.

2.12 INLINE FAN

- A. General: Direct or belt driven centrifugal inline fan mounted in galvanized steel panel and duct collars. Permanently lubricated motor, variable speed switch on direct drive adjustable sheave for belt drive with motor cover, disconnect switch and backdraft damper. AMCA rated capacities and UL listed. PennBarry, Greenheck, Cook.

2.13 MIXED FLOW FAN

- A. General: Inline fan with mixed flow type wheel cone, spherical back plate and single thickness cambered blades. Wheels shall be statically and dynamically balanced. Housing shall be heavy gauge steel with inlet and outlet collars for duct connections. Unit shall have a universal mounting system that allows vertical or horizontal configuration. Bearings shall be heavy duty, grease lubricated, self-aligning ball or roller with extended lubrication lines. Unit shall be AMCA certified and UL listed. Greenheck, Cook, PennBarry.

2.14 WALL FAN

- A. General: Axial type sidewall fan, direct or belt drive, steel aluminum blades and hubs. Propellers shall be statically and dynamically balanced. Permanently lubricated heavy duty motor. Drive frame and panel assemblies shall be galvanized steel. Accessories include wall housing with OSHA guard and discharge damper with guard. Unit shall be AMCA certified and UL listed. Greenheck, Cook, PennBarry.

2.15 UTILITY FAN

- A. General: Backward inclined centrifugal fan in steel scroll and weatherproof housing with support frame for drive and motor rotatable discharge. Permanently lubricated motor with bearings life of 100,000 hours. Accessories include belt guard per OSHA standards, grease trap with drain connection for grease exhaust, polyester urethane coating on outdoor unit. AMCA rated and UL listed. Trane, Cook, McQuay, PennBarry, Greenheck,

2.16 DRYER BOOSTER FAN

- A. General: Inline backward inclined blades fan constructed of thermoplastic resin with mounting bracket and integrated automatic pressure sensing switch to activate the fan when dryer comes on. Provide galvanized lint trap when the dryer and booster fan is less than 15 feet. Manufacturer shall be Fantech or approved equal.

2.17 STAIRWAY PRESSURIZATION FAN

- A. General: VFD tubular in-line blower in welded and bolted construction. Permanently lubricated motor, heavy duty grease lubricated bearings. AMCA rated Capacity and UL listed. Adjustable sheave for belt drive with motor cover and belt guard, disconnect switch. Outdoor mounted unit shall have hot dipped galvanized and neoprene coated seismic restraint spring isolators and corrosion protection coating on the casing. Refer to Section 20 0000 – MECHANICAL BASIC MATERIALS AND METHODS. Greenheck, Cook, PennBarry, Acme.

2.18 FILTERS

- A. General: This paragraph applies to separately scheduled filters. For filters in packaged air handling units, see respective paragraphs.
- B. Final Filter: Pleated disposable glass fiber with 50%-55% ASHRAE 52-68 efficiency, UL listed. Farr HP 15.
- C. Holding Frames: Factory fabricated 16 gauge with gaskets and sealing fasteners.
- D. Retainer: Welded steel with corrosion resistant finish.
- E. Prefilter: Pleated fabric media in chipboard frame, 30%-35% ASHRAE 52-68 efficiency. Farr 30/30.

PART 3 - EXECUTION

3.01 ACCESS

- A. Coordination: Install equipment with associated ductwork and piping to permit access to doors and panels as required for periodic maintenance (e.g. filter servicing).

3.02 LOCATION AND SIZE

- A. Coordination: Equipment scheduled on drawings are selected and configured to fit in mechanical spaces available. Insure that substitute equipment will fit without change in function or quality and without additional cost. (See Section 15000, 2.3, Substitutions).

3.03 STATIC PRESSURES

- A. Substitutions: Scheduled static pressures reflect calculations based on manufacturer's recommended procedures using listed accessories and designed distribution system. Insure that substitute equipment will provide similar operating characteristics to include fan RPM and motor size to BHP ratio.

3.04 INSTALLATION

- A. Coordination: Install equipment in accordance with manufacturer's recommendations. Bring conflicts between such recommendations and drawings to immediate attention of Architect/Engineer.

3.05 FILTERS

- A. Quantity: Provide three complete sets of filters: One for use during construction, one initial operating set and one replacement set to be turned over to owner at time of occupancy.

3.06 UVC GERMICIDAL LAMPS

- A. Mount UVC lamps downstream of coil such that energy strikes all target surfaces of the coil, drain pan and the available line of sight airstream. Provide unit mounted on-off switch and transformer as required. Provide warning sign below switch to read "DANGER-UV LIGHT INSIDE-TURN OFF BEFORE SERVICING UNIT".

3.07 CORROSION PROTECTION

- A. Provide vinyl copolymer or phenolic corrosion protection coating in accordance with SECTION 20 00 00 – MECHANICAL BASIC MATERIALS AND METHODS.

END OF SECTION

SECTION 23 65 00

COOLING TOWERS

PART 1 - GENERAL

1.01 GENERAL PROVISIONS/CONDITIONS

- A. The General Conditions of the Contract for Construction and the Supplementary Conditions preceding this Section are part of this Contract and shall govern each Section of the Work.
- B. Requirements specified in Division 1 Sections apply to all Sections of the Project Manual, where applicable, with the same effect as if incorporated within each Section.

1.02 SECTION INCLUDES

- A. General:
 - 1. Provide cooling towers as indicated.

1.03 REFERENCE STANDARDS

- A. CTI. Cooling Tower Institute.
- B. Factory Mutual Research Corporation.

1.04 SUBMITTALS

- A. Submit complete manufacturer's data and drawings for cooling towers under provisions of Section 01 33 00 – SUBMITTAL PROCEDURES.
- B. Complete sound rating data.

PART 2 - PRODUCTS

2.01 COOLING TOWER - STAINLESS STEEL

- A. Induced draft, cross-flow cooling tower with horizontal air discharge. Construction of heavy gauge type 304 stainless steel angles and channels with stainless steel casing panels. Cold water basin and support structure shall be constructed of stainless steel. Five (5) year warranty.
- B. Brass make-up valves with large diameter plastic float.

- C. Large area, lift out, Type 304 stainless steel strainer with perforated openings sized smaller than water distribution nozzle orifices. Strainer with integral Type 304 stainless steel anti-vortexing hood to prevent air entrainment. Forced spray nozzles are not acceptable.
- D. Distribution weirs and plastic metering orifices for even distribution of water over the wet deck surface.
- E. Type 304 stainless steel flow balancing valves to distribute flow evenly between the distribution basins. Internal balanced flow piping is acceptable in lieu of balancing valves.
- F. Fan System: Two, totally enclosed, air over (TEAO) reversible, squirrel cage, ball bearing type motor designed specifically for cooling tower service. Motors shall be furnished with special moisture protection on the windings, shafts and bearings.
- G. Fill shall be formed from sheets of rigid PVC with ultra-violent inhibitors.
- H. Drift eliminators shall be formed PVC sheets minimum 25 mils thick bonded into a three-pass cellular construction. Drift eliminators shall be arranged in individual removable sections for access to the water distribution systems. The drift losses shall be less than 0.002 percent of the circulated water rate.
- I. Water Distribution System: A single inlet per cell shall deliver water to the distribution system by means of a header pipe with pipe laterals.
- J. All hardware such as nuts, bolts and anchors shall be stainless steel.
- K. Fans shall be multi-blade, axial flow, propeller-type with twisted air foil blades to provide high efficiency and low operating horsepower, designed to provide the required air flow through the cooling tower at maximum efficiency. Fan hub shall be furnished with a corrosion resistant finish. Fan guards of stainless steel shall be provided.
- L. Mechanical equipment system shall be provided with a vibration cutout switch to protect against damage due to excessive vibration. Switch unit, including one single pole, double throw (SPDT) contacts, sensitivity adjustment, and push button reset, shall be mounted in a weatherproof enclosure on the gear box.
- M. Maximum drift loss from the towers shall not exceed .002% of the circulating volume of water.
- N. All metal supports and accessories to be type 304 stainless steel.
- O. Extended lubrication lines.
- P. Baltimore Aircoil Company, Marley, Evapco or approved substitute.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine the areas and conditions where to be installed and notify the Architect of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected by the Contractor in a manner acceptable to the Architect.

3.02 CLEAN-UP

- A. Do not allow debris to accumulate. Comply with the clean-up requirements specified in Section 01 77 00.

3.03 GENERAL

- A. Install tower in accordance with manufacturer's recommendations.
- B. Install tower on structural steel beams as instructed by manufacturer.
- C. Elevate tower to maintain maximum positive suction head on condenser water pump.
- D. Install tower on vibration isolators. Refer to Section 15240.
- E. All piping to and from towers to be securely anchored. Piping supports shall be independent of tower.
- F. Provide flexible piping connectors to permit tower vertical movement when operating or when drained with no stress applied to connecting piping.
- G. Connect make-up water piping with flanged or union connections to tower.
- H. Provide factory representative for start-up and Owner instruction period.
- I. Provide a field performance test conducted in accordance with CTI standards. Submit test results prior to final acceptance.

3.04 PAINTING

- A. Paint all structural supports for the tower and piping.

END OF SECTION

SECTION 23 74 00

PACKAGED COOLING SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. Conditions:
1. Conform to General Conditions, Supplementary Conditions and Division I - General Requirements.

1.02 SUMMARY

- A. Section Includes:
1. Packaged roof-top air conditioner, split system with air cooled condensing unit and fan coil unit, packaged room air conditioner, piping, insulation and accessories.

1.03 SUBMITTALS

- A. Submit in accordance with Section 01 33 00 – SUBMITTAL PROCEDURES.
- B. Product Data:
1. Submit manufacturer's product data and installation procedures for each type of product specified in this section.
- C. Shop Drawings:
1. Shall be for entire air conditioning system. Provide coordinated layout drawings minimum 1/4" per foot, which show all piping, sprinkler heads, ductwork, equipment, conduit, cable trays, pull boxes, light fixtures, access panels, architectural, and structural systems. All trades to coordinate in preparation of drawings to establish final locations of work. Areas of extreme congestion shall be shown at 1/2" scale.

PART 2 - PRODUCTS

2.01 PACKAGED ROOFTOP AIR CONDITIONER

- A. General: Air-to-air single package unit with evaporator fan and coils, condenser fan and coils, compressor piping controls and accessories; Carrier, Trane, York, Aaon, Petra or approved equal. Units shall be constructed and designed for outdoor use. All components by the same manufacturer and UL approved.
- B. Casing: Constructed of removable double wall G90 galvanized steel panels with thermal break, R-13 foam insulation and weatherproof double sloped roof.

- C. Evaporator Fans: Variable speed direct drive backward curved plenum fan on vibration isolators.
- D. Condenser Fans: Vertical discharge direct drive axial fans with polyester coated steel wire guard.
- E. Refrigerant Coils: Aluminum fins mechanically bonded to copper tube.
- F. Compressor: Hermetic scroll type, vibration isolated and with overload protection using R-410a refrigerant.
- G. Refrigerant Circuits: Dual independent circuits with shut-off valves, sight glass, filter drier, solenoid valves and Hi/Lo refrigerant pressure protection switches.
- H. Drain Pan: Sloped stainless steel drain pan with insulation.
- I. Filters: Throw-away, 2-inch pleated fabric in chipboard frame, MERV 8 efficiency rating.
- J. Reheat Coil: Modulating hot gas reheat coil for humidity control.

2.02 AIR COOLED CONDENSING UNIT (SPLIT SYSTEM)

- A. General: Factory-assembled and tested air-cooled condensing unit consisting of casing, compressors, condensers, coils, condenser fans and motors with factory wiring, piping and controls. Unit shall be ARI performance certified, Energy Star and UL approved. Manufacturer shall be Carrier, Trane, McQuay, York, Aaon.
- B. Unit casings: Constructed of galvanized steel with removable access panels design for outdoor installation with weather protection for components and controls.
- C. Compressor: Hermetic scroll compressor mounted on rubber vibration isolators using R-410A refrigerant. Components to include filter dryer, crankcase heater, shut off valves, service port and, high and low pressure switches, internal thermal overload and pressure relief valve...
- D. Condenser coil: Provide copper tube, aluminum fins coil and A.R.I performance certified.
- E. Condenser fans and drives: Direct drive propeller type condenser fans with vinyl coated steel wire safety guard on fan opening. Totally enclosed fan motor and permanently lubricated bearings.
- F. Corrosion Protections: Provide corrosion protection for the casing and coil. Refer to Section 20 0000 – MECHANICAL BASIC MATERIALS AND METHODS for requirements.

2.03 AIR HANDLING UNIT (SPLIT SYSTEM)

- A. General: Packaged unit consisting of cabinet fan, coils, filter, motor and accessories. Unit shall be ARI certified and UL approved. All components by the same manufacturer as the air cooled condensing unit.
- B. Fans: Variable speed blower with ECM motor.

- C. Coils: Copper tube, aluminum fin mechanically bonded and factory installed thermostatic expansion valve.
- D. Casings: Removable steel panels with 1-inch insulation and baked enamel finish.
- E. Drain Pans: Heavy gauge steel or molded plastic with closed cell foam insulation.
- F. Filter Section; Design for easy access using cleanable polyester filter media.
- G. Controls: Programmable electronic wall thermostat.

2.04 SPLIT AC SYSTEM WITH VARIABLE REFRIGERANT FLOW

- A. General: Split system consists of outdoor air cooled condensing unit and multiple indoor fan coil units with variable speed inverter compressor and variable flow using R410A refrigerant. ETL listed. Factory charged and tested. Daikin, Mitsubishi or approved equivalent.
- B. Outdoor Condensing Unit:
 - 1. The outdoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigerant circuit of the condensing unit shall consist of single or multiple scroll compressors on isolation mounts with inverter driven variable speed drive, propeller fan, condenser coil, electronic expansion valve, solenoid valves, 4 way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports, liquid receivers and accumulators. Refrigerant shall be R-410A.
 - 2. Safety devices to be included on the condensing unit are high pressure switch, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
 - 3. The outdoor unit shall be completely weather proof and corrosion resistant. The unit shall be constructed from galvanized steel panel with acrylic or polyester powder coating and baked enamel finish.
 - 4. The condensing unit fan motor shall have multiple speed operation of the DC inverter type.
- C. Indoor Fan Coil Unit:
 - 1. Indoor unit shall be of the type as shown on plans and equipped with an electronic expansion valve and PID control to maintain room temperature.
 - 2. Unit cabinet shall have MERV 8 filter and drain pan with condensate pump as required.
 - 3. Unit shall be provided with a separate power supply.
 - 4. Unit shall have wall mount controller and remote sensor as required to perform input functions necessary to operate the system.
 - 5. Factory designed piping joints and headers.

2.05 REFRIGERANT AND CONDENSATE PIPING

- A. Refrigerant piping shall be Type ACR, ASTM B 280 copper tubing with wrought copper fittings and brazed joint.
- B. Condensate piping shall be Type L, ASTM B 88 hard drawn copper tubing or DWV copper, ASTM B 306 with wrought copper fittings, silver solder joint or PVC Sch. 80, ASTM D 1785, solvent joint.

- C. Refrigerant piping less than 1-1/2" size shall have 1/2" thick Diamondback Lineset "Twin-Tube" - single piece molded - closed cell foam insulation. Larger piping shall have 1" thick insulation. Condensate piping shall have 1/2" thick IMCOLOCK insulation. Outdoor piping shall have either an aluminum metal jacket with weatherproof joints over the insulation or JMF EZ-Pull Linesets.

2.06 PIPING ACCESSORIES

- A. Products of Alco, Sporlan, or Henry
1. Combination dryer strainer in the liquid line. Cartridge to be removable without disturbing the piping.
 2. Isolation valves on the dryer strainer.
 3. Site glass in liquid line.
 4. Thermal expansion valves with external equalizer line.
 5. Solenoid valve for pump down control.
 6. Shut-off valves on liquid and hot gas lines.
 7. Refrigerant charging valve.

PART 3 - EXECUTION

3.01 ACCESS

- A. Coordination: Install equipment with associated piping to permit access to doors and service areas as required for ease of maintenance.

3.02 CAPACITIES

- A. Substitutions: Scheduled capacities reflect calculations based on manufacturer' recommended procedures using listed accessories and design parameters. Insure that substitute equipment will provide similar operating characteristics and capacities.

3.03 INSTALLATION

- A. Coordination: Install equipment in accordance with manufacturer's recommendations. Bring conflicts between such recommendations and drawings to immediate attention of Architect/Engineer.
- B. Isolation Valves: Provide isolation valves on all equipment.
- C. Refrigerant piping: Install the pipe sizes as indicated on the plans. Pitch all refrigerant lines in the direction of refrigerant flow; 2-inch in 10 feet. Furnish and install all refrigerant piping in accordance with good industry practice. Verify that all piping sizes are in accordance with factory recommendations. Submit recommended pipe size changes to engineer before installation. Variable refrigerant flow system shall be installed with manufacturer designed piping joint and header connectors. Install piping so as not to interfere with access to unit.

Pass dry nitrogen through piping system during brazing process to totally eliminate formation of copper oxides.

3.04 INSULATION

- A. One inch thick for piping 1-inch and less. 1-1/2 inches thick for piping 1-1/4 inches to 2 inches.

3.05 FILTERS

- A. Quantity: Provide two complete sets of filters, one initial operating set and one replacement set to be turned over to owner at time of occupancy.

3.06 START-UP AND TESTING

- A. Requirements: Performed by factory authorized personnel at completion of project. Test and adjust to conform to project requirements. Submit written report to Engineer.

3.07 CORROSION PROTECTION

- A. Corrosion Protection: Provide corrosion protection coating on the condenser coil, evaporation coil with 50% or more outside air and unit casing for all units installed outdoor. Refer to Section 20 0000 – MECHANICAL BASIC MATERIALS AND METHODS for requirements.

END OF SECTION

SECTION 26 05 33
RACEWAYS, FITTINGS AND SUPPORTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Raceways and wire ways, conduit installation, and underground requirements.

1.02 APPLICABLE STANDARDS AND CODES

- A. EIA/TIA 569 Standards.
B. National American Standards Institute (ANSI)
C. National Electrical Manufacturer's Association (NEMA)
D. Nationally Recognized Testing Laboratory (NRTL)
E. National Electrical Code (NEC)
F. Uniform Building Code (UBC)
G. Underwriters Laboratory (UL)

1.03 SUBMITTALS

- A. Submit in accordance with Section 01 33 00 – Submittal Procedures.

PART 2 – PRODUCTS

2.01 RACEWAYS

- A. Conduit Materials:
1. Metallic conduit, and tubing shall be manufactured under the supervision of an UL, or another NRTL factory inspection and label service program. Each 10-foot length of conduit and tubing shall bear the UL or another NRTL label and manufacturer's name.
2. Rigid metallic conduit shall be rigid steel, heavy wall, mild steel, zinc-coated, with an inside and outside protective coating manufactured in accordance with ANSI C 80.1. Couplings, elbows, bends, condulets, bushings and other fittings shall be the same materials and finish as the rigid metallic conduit. Fittings, connectors, and couplings shall be threaded type, manufactured in accordance with ANSI C 80.1 and UL 6.
3. Electrical metallic tubing shall be steel tubing, zinc-coated with a protective enamel coating inside, manufactured in accordance with NEMA C 80.3. Fittings, couplings, and

connectors shall be gland compression type, set screw couplings and connectors not permitted. All parts shall be manufactured in accordance with NEMA C80.3 and UL 6A Electrical metallic tubing is designated hereinafter as EMT. Steel and rain tight fittings shall be approved and listed for the intended application.

4. Flexible steel conduit shall be of flexible interlocking strip construction with continuous zinc coating on strips, manufactured in accordance with UL 1. Connectors and couplings shall be required fittings of the type, which threads into convolutions of flexible conduit.
 5. Liquid-tight flexible metal conduit shall be galvanized heavy wall, flexible locked steel strip construction, UV rated, with smooth moisture and oil-proof, abrasion-resistant, extruded plastic jacket. Connectors shall be as required for installation with liquid-tight flexible conduit and shall be installed to provide a liquid-tight connection.
 6. Non-metallic conduit shall be rigid PVC electrical conduit extruded to schedule 40 dimensions of Type II. Grade 1 high impact, polyvinyl chloride, sweeps, couplings, reducers and terminating fittings shall be listed under the UL, or another NRTL, and shall bear the manufacturer's listed marking.
 7. Multi-cell raceway shall be 4 inch PVC, Type 40, UL or another NRTL listed for underground use with optical fiber and signal system cables. Raceway shall be furnished with 3-1/2 inch factory installed inner ducts with required internal spacers, and required couplers, sweeps, and end bells. Multicell raceway shall be Carlon Multigard, or approved equal.
 8. Metal Clad (MC) cable following NEC criteria can be used within residential units, and common area 20A power and lighting branch circuits jumpers. Common area home run circuits will remain in conduit, MC cable not allowed. Aluminum MC cable feeders will be allowed to feed residential units. Set screw or snap in connectors will be allowed for MC cable, provide manufacturer's recommended plastic bushings.
- B. Sleeves for Conduits: Sleeves shall be adjustable type, of 26 gage galvanized iron, Adjust-to-Crete Co. Adjust-to-Crete, or Jet Line Products Inc. Jet-Line, or equal, or of conduit material matching the provided raceway run.
- C. Where conduit enters a building through a concrete foundation below grade, or ground water level, or where it is necessary to seal around a conduit where it passes through a concrete floor or wall, provide O-Z/Gedney Type FSK Thru Wall and Floor Seal, or equal.
- D. Expansion Joints-Seismic Separations between building(s) and other locations as required:
1. Provide Thomas & Betts XJG-TB, O-Z/Gedney. Type AX with bonding strap and clamps, or equal. At exterior locations, provide Thomas & Betts XJG-TB, O-Z/Gedney type EX, or equal. Provide O-Z/Gedney type AXDX, or equal combination deflection/expansion fittings at all seismic separations. Provide manufacturer's internal and external bonding jumpers at all locations. Liquid-tight metal conduit or flexible metal conduit shall not be approved at expansion joints, separations between buildings or seismic separations.
 2. Provide expansion fittings at intervals not exceeding 100 feet in conduits exposed to direct sunlight. Fittings may be installed in the conduit run or where conduit attaches to junction or pull boxes. OZ/Gedney type AX, TX or EXE series, or equivalent by Thomas and Betts or approved equal.
- E. Conduit Seal Fittings:
1. Provide conduit seal fittings where required by the NEC. Conduit seals shall be of rigid galvanized steel. Seals in horizontal conduit installations shall be Appleton Type ESU, Crouse Hinds Type EYS, or equal. Seals in vertical conduit installations shall be Appleton Type SF, Crouse Hinds Type EYD, or equal, with continuous drain. When installing

- conduit seals make provision for percent fill space reduction in accordance with NEC.
2. Install sealing compound after wire has been installed. Ensure drain is not blocked in vertical seals when installing compound. Where conduit seals are installed in hazardous area applications, there shall be no conduit coupling, fitting, etc., between seal and boundary of hazardous area.
- F. Surface Steel Raceway: The surface steel raceway system for branch circuit wiring, data network, voice, video, and other low voltage wiring shall be as manufactured by the Wiremold Company, Hubbell, or Mono-Systems, Inc. or equal. The raceway system may be supplied pre-wired in accordance with all sections of these specifications and requirements herein, and shall be UL or another NRTL listed. Computer data installation shall be as required by other sections of this Division.
1. If furnished pre-wired, the system must be listed in accordance with UL or another NRTL for "Multiple Outlet Assemblies" and so labeled on interior of the assembly. The pre-wired installation must contain no extra wire splices in the raceway as compared to a contractor assembled installation assembled from components. The pre-wired steel raceway shall be Hi-Pot tested at the factory to prevent any potential bare wire or short circuit defects.
 2. The raceway base, cover, and device bracket shall be manufactured of steel and finished in ivory, gray enamel or custom colors suitable for field painting to match adjacent finishes.
 3. The raceway shall be a 2-piece design with a metal base and snap-on metal cover, except for the Wiremold V700 system, Hubbell V750 series and Mono-Systems Inc. S145-700 series. Which shall be a one-piece design. The base and cover sections shall be a minimum of 0.040 inch wall thickness. The base section shall be available in 10-foot lengths. A hand-operated cutting tool shall be available for the base and cover to ensure clean, square cuts. Wiremold V500, Hubbell V500, and Mono Systems inc. SM500 series are not permitted.
 4. A full complement of fittings shall be furnished, including but not limited to, flat internal and external elbows, tees, entrance fittings, wire clips, cover clips, couplings, support clips, C-hangers and end caps. The fitting color shall match the raceway color. Fittings shall be supplied with a base where indicated and/or required. A take-off fitting shall be furnished as required to adapt to existing flush wall boxes.
 5. Device brackets shall be furnished for mounting single or 2-gang devices within the raceway. Devices shall be provided with the ability of mounting flush or in conjunction with standard steel, stainless steel, or manufacturer's metal faceplates.
 6. The raceway shall be furnished with a complete line of connectivity outlets and modular inserts for unshielded twisted pair including category 5, fiber-optic, coaxial, and other cabling types with face plates and bezels to facilitate installation.
 7. Raceway shall be furnished with corner elbows and tee fittings to maintain a cable bend radius which meets the requirements of fiber-optic and copper cables under EIA/TIA 569 for communications pathways.
- G. Factory Pre-Wired Surface Metal Raceway:
1. Furnish and install pre-wired surface metal raceways as indicated on Drawings and as specified.
 2. Metal Raceway shall be galvanized steel Wiremold V4000, Hubbell 4000 series, or Mono-Systems Inc. SMS-4000 series complete with raceway base, cover, fittings, receptacles and mounting plates required for a complete assembly. Raceway shall have two wiring compartments with integral dividing barrier for isolating the wiring compartments.
 3. Pre-wired assembly shall be UL, or another NRTL listed as a multi-outlet assembly and surface raceway as labeled on interior of assembly.
 4. Wiring devices and other components shall be factory installed, electrically wired and

- covers labeled as indicated on drawings. Each receptacle shall be identified with panel board and circuit number from which it was fed. Grounding shall be maintained by means of factory installed grounding conductors.
5. Where shown on drawings, raceway covers shall have provisions for mounting computer data outlets.
 6. Complete assembly is to consist of required fittings such as elbows, slide couplings for joining raceway sections, blank end caps and flat tees.
 7. Prewired assembly must contain no wire splices.
 8. Receptacles and wiring shall be as indicated on drawings and as specified.
 9. Prior and during installation, verify and comply with manufacturer's installation instructions.
 10. Entire assembly shall be tested for shorts, opens, ground faults, and wire insulation at factory and certified. Raceways shall be electrically continuous and bonded in accordance with the NEC.
 11. Submit shop drawings for approval showing the complete layout of all components of each raceway, raceway lengths, each component description, location and circuit identification.
 12. All wiring devices shall be removable without requiring disassembly of wireway.
- H. Wireways shall be 16 gauge galvanized steel enclosed hinge/screw wiring troughs, surface metal raceway, wireway, and auxiliary gutter designed to enclose electrical wiring. Wireway fittings shall be furnished with removable covers to permit complete installation of conductors throughout the entire wireway run. Wireways shall be UL or another NRTL listed, and shall be NEMA-1 enclosure for interior applications, or NEMA-3R enclosure for exterior applications, by Cooper B-line, Hoffman, Wire Guard, Circle AW, or equal.
- I. Penetration in Fire-Rated Structures: Provide 3M, or equal, caulk and fire barriers for installing fire-rated seals around penetrations through floors, walls, and elevator shafts. Fire stop system must be UL, or another NRTL listed, and classified for through-penetration applications of metallic conduits and busways.
- J. Pull Wires: Install 1/8 inch polypropylene cords in empty or spare conduits.

PART 3 – EXECUTION

3.01 CONDUIT INSTALLATION

- A. General Requirements:
1. Provide complete and continuous systems of conduit, outlet boxes, junction boxes, fittings and cabinets for systems of electrical wiring including lighting, power, and signal systems, except as otherwise specified.
 2. MC cable may be installed in interior concealed applications as referenced above. MC cable shall not be installed in concrete, directly buried underground, outdoors, in boiler rooms, elevator pits, or where subject to damage.
 3. Within buildings, flexible steel conduit or EMT may be installed instead of rigid steel conduit where permitted by code. Flexible steel conduit shall be installed in compliance with the National Electrical Code (NEC).
 4. Liquid-tight flexible steel conduit shall be installed in compliance with the NEC.
 5. Connectors for flexible metal conduit shall be made of steel, and of the types which threads into convolutions of conduit. Connectors for watertight flexible metal conduit shall be as required for installation and shall be installed to provide a watertight connection.

6. Exposed conduit shall be installed vertically and horizontally following the general configuration of the equipment, using cast threaded hub conduit fittings where required and shall be clamped to equipment with suitable iron brackets and one hole pipe strap.
7. If connection is from a flush wall-mounted junction box, install an approved extension box.
8. Underground feeder distribution conduits for systems may be non-metallic conduit instead of rigid conduit except where otherwise specified or indicated.
9. Conduit shall be concealed unless otherwise indicated. Conduits exposed to view, except those in attic spaces and under buildings, shall be installed parallel or at right angles to structural members, walls, or lines of building. Conduits shall be installed to clear access openings.
10. Bends or offsets will be permitted as allowed per the NEC. Radius of each conduit bend or offset shall be as required by ordinance. Bends and offsets shall be performed with standard industry tools and equipment or may be factory fabricated bends or elbows complying with requirements for radius of bend specified. Heating of metallic conduit to facilitate bending is not permitted. As required, low voltage pathways and junction boxes will comply with EIA/TIA and/or servicing utility guidelines.
11. Running threads are not permitted. Provide conduit unions where union joints are necessary. Conduit shall be maintained at least 6 inches from covering of hot water and steam pipes and 18 inches from flues and breechings. Open ends of conduits shall be sealed with permitted conduit seals during construction of buildings and during installation of underground systems.
12. Expansion Joints/Seismic Separations/Separations between buildings/Locations Indicated: Provide Thomas & Betts XJG-TB, O-Z Electrical Mfg. Co. Inc. Type AX with bonding strap and clamps. At exterior locations, provide Thomas & Betts XJG-TB, O-Z Electrical Mfg. Co. Inc. Type EX, or equal. Provide O-Z Electrical Mfg. Co. Type AXDX, or equal Combination Deflection/Expansion Fittings at all seismic separations. Provide manufacturer's internal and external Bonding Jumpers at all locations. Liquid-tight flexible conduit shall not be approved at expansion joints or seismic separations.
13. Where conduits are terminated in groups at panelboards, switchboards, and signal cabinets, etc., provide templates or spacers to fasten conduits in proper position and to preserve alignment. Conduits terminating at signal cabinets shall comply with the manufacturer's guidelines.
14. Conduits above metal lath ceilings shall be rigidly suspended with pipe hangers or pipe racks or shall be secured to superstructure with factory fabricated pipe straps. Conduits in metal lath or steel stud partitions shall be tied to furring channels or studs. In ceiling spaces and in partitions, tie wires shall be spaced not more than 5 feet apart, shall fasten conduit tight against channels and studs at point of tie and shall not support any of conduit weight. Tie wire shall be 16 gauge galvanized double annealed steel.
15. Where auxiliary supports, saddles, brackets, etc., are required to meet special conditions, they shall be fastened rigid and secure before conduit is attached.
16. Conduit in ceiling spaces, stud walls, and under floors, shall be supported with factory fabricated pipe straps or shall be suspended with pipe hangers or pipe racks. Pipe straps shall be attached to and shall fasten conduit tight at point of support against ceiling and floor joists, rafters, and wall studs, or 2-inch x 4-inch headers fitted between joists or wall studs.
17. Conduits installed on exposed steel trusses and rafters shall be fastened with factory fabricated conduit straps or clamps.
18. Conduits installed to underside of buildings shall be strapped with factory fabricated conduit straps to underside of concrete floor or joists, or wood floor joists, or shall be suspended with pipe hangers or pipe racks. Conduits under building are not permitted to be placed directly on grade; they shall be suspended from building or shall be buried

below surface or ground. 1-1/4 inch and larger conduits under buildings shall be installed with conduit hangers or racks.

19. Pipe hangers for individual conduits shall be factory fabricated. Provide galvanized steel rods as required for conduit and rack supports.
20. Pipe racks for groups of parallel conduits and for supporting total weights not exceeding 500 pounds shall be trapeze type and shall consist of a cross channel, Steel City Kindorf B-900, Unistrut P-1000, or equal, suspended with a 3/8 inch minimum diameter steel rod at each end. Rods shall be fastened with nuts, top and bottom to cross-channel and with square washers on top of channel. Conduits shall be clamped to top for cross-channel with conduit clamps, Steel City, Kindorf or Unistrut. Conduits shall not be stacked one on top of another, but a maximum of 2 tiers may be on same rack providing an additional cross-channel is installed. Where a pipe rack is to be longer than 24 inches, or if the supported weight exceeds 500 pounds, submit shop drawings of installation to the Architect for review.
21. Conduits suspended on rods more than 2 feet long shall be rigidly braced to prevent horizontal motion or swaying. Installation shall meet Honolulu seismic requirements.
22. Factory fabricated pipe straps shall be one or 2-hole formed galvanized clamps, heavy-duty type, except where otherwise specified.
23. Hangers, straps, rods, or pipe supports under concrete shall be attached to inserts set at time concrete is placed, or with approved concrete anchors. Under wood, install bolts, lag bolts, or lag screws; under steel joists or trusses, install beam clamps. Contractor shall submit size of anchors, bolts, screws, and installation method to Architect for approval prior to start of any work.
24. Conduits shall be supported at intervals required by code, but not to exceed 10 feet. One inch and smaller exposed conduits shall be fastened with one-hole malleable iron straps. Perforated straps and plumber's tape is not permitted for the support of conduits.
25. Conduits stubbed up through a roof or an arcade shall be flashed with a waterproof flashing. Coordinate flashing and penetration requirements with Division 07 – Thermal and Moisture Protection sub-contractor.
26. Bushings and locknuts for rigid steel conduit shall be steel threaded insulating type. Setscrew bushings are not permitted.
27. Flex conduits shall be cut square and not at an angle.
28. Electrical contractor shall provide all conduits/raceway for telecom, CATV, security and AV systems, wiring for these system is to be provided and installed by telecommunication contractor.
29. Structured Media Enclosures (SME) for telecom/CATV are to be provided by telecommunication contractor and installed by electrical contractor.

B. Underground Requirements:

1. Conduits and multicell raceways installed underground shall be entirely encased in 3 inch thick concrete on all sides, except where otherwise specified. Provide required spacers to prevent any deflection when concrete is placed and to preserve position and alignment. Conduits and raceways shall be tied to spacers. Anchors shall be installed to prevent floating of conduits and raceways during placing of concrete. Provide red colored concrete to encase conduits of systems operating above 600 volts.
2. Underground conduits and raceways shall be buried to a depth of not less than 24 inches below finished grade to top of the concrete envelope, unless otherwise specified.
3. Assemble sections of conduit with required fittings. Cut ends of conduit shall be reamed to remove rough edges. Joints in conduits shall be provided liquid-tight. Bends at risers shall be completely below surface where possible.
4. Conduits and raceways in a common trench shall be separated by concrete or fill as

required per the NEC, or the servicing utility company's requirements. Electrical power and/or lighting conduit runs installed in a common trench with conduits containing signal system wiring such as public address, telephone, intrusion detection, fire alarm, television, computer networking, and clock systems shall maintain a separation of a minimum of 6 inches from these types of signal system conduits and raceways. Electrical power, lighting and signal conduits and raceways installed in a common trench with other utility lines such as gas, water, sewer and storm lines shall maintain 12 inches separation from these types of utility lines.

5. Coordinate with required inspector to observe underground installations before and during concrete placement. A mandrel shall be drawn through each run of conduit in presence of the Inspector before and after placing concrete. Mandrel shall comply with inspection requirements, typically 6 inches length and 1/4 inch diameter less than conduit size tested.
6. Non-metallic conduit installations shall comply with following additional requirements. Joints in PVC conduit shall be sealed by means of required solvent-weld cement supplied by conduit manufacturer. Non-metallic conduit bends and deflections shall comply with requirements of applicable electrical code, except that minimum radius of any bend or offset for conduits sized from 1/2 inch to 1-1/2 inches inclusive shall not be less than 24 inches. Bends at risers and risers shall be PVC-coated rigid steel conduit. Radius of curve of bends or offsets in non-metallic conduit for low voltage systems comply with EIA/TIA and/or servicing utility guidelines.
7. For HEKO primary ductline, furnish and install a 6-inch wide, polyethylene, red underground barrier type 12 inches above full length of concrete reading, "CAUTION ELECTRIC LINE BURIED BELOW".
8. Underground conduit systems provided for utility companies shall be furnished to meet the requirements of the utility companies requiring service.
9. Protect inside of conduit and raceway from dirt and rubbish during construction by capping openings.
10. Add bell-end bushings for conduit stub-up including underground entries to pull boxes, and manholes.
11. Underground conduit for systems operating above 600 volts shall be a minimum size of 4 inches.
12. All underground conduits and raceways shall be swabbed prior to wire pull.

D. Slabs on Grade:

1. Unless specifically reviewed by the Architect, conduits 1-1/4 inches and larger are not permitted to be installed in structural concrete slabs. Where conduits are permitted, and are installed in concrete slabs on grade, slabs shall be thickened at bottom where conduits occur to provide 3 inches of concrete between conduit and earth. Required excavation shall be part of the work of this section.
2. If concrete slab is 5 inches or more in thickness with a moisture barrier plastic sheet between earth and slab, one inch and smaller conduits shall be installed in the slab with a minimum of one inch concrete between earth and conduit.

E. Concrete Walls, Beams, and Floors: Coordinate any required conduit stubs through structural walls, beams and floors. If sleeves are used where conduits pierce concrete walls, beams, and floors, except floor slabs on grade; sleeves shall provide 1/2 inch clearance around conduits. Sleeves shall not extend beyond exposed surfaces of concrete and shall be securely fastened to forms.

3.02 STUBS

- A. Panelboard: Install 2 one inch conduits from each flush mounted panelboard to access under floor space and to access above ceiling space where these conditions occur. Cap conduits with standard galvanized pipe caps.
- B. Floor: At points where floor stubs are indicated in open floor areas, for connections to machines and equipment, conduits shall be terminated with couplings, tops flush with finished floor. Stubs shall extend above couplings the indicated distance. Where capped stubs are designated, couplings shall be closed with cast iron plugs with screw drive slots.
- C. Underground:
 - 1. Underground conduit stubs shall be terminated at locations indicated, and shall extend 5 feet beyond building foundations, steps, arcades, concrete walks and paving. Rigid metallic conduit stubs and non-metallic conduit stubs shall be capped by installing a coupling flush in end wall of concrete encasement and plugging with a permitted plug. Project record drawings shall indicate location of ends of underground conduit stubs fully dimensioned and triangulated with reference to buildings or permanent landmarks. These dimensions, including depth below finished grade, shall be marked on project record drawings in presence of the Inspector before backfilling trench. Where extending existing concrete encased stubs, clean, chip and wire brush end of existing concrete and brush on a heavy coat of neat cement paste or epoxy bonding agent.
 - 2. Over ends of individual underground conduit stubs or groups of conduit stubs, install 4-inch x 18-inch deep PVC filled with concrete, flush with finished grade in asphaltic concrete or lawns, and 2 inches above finished grade in planting areas. Cast a 3-inch x 3-inch brass plate engraved "ELECT" flush in top of concrete. Secure plate to concrete with brass dowels or as indicated on drawings.

3.03 PROTECTION

- A. Coordinate protection of work of this section until substantial completion.

3.04 CLEANUP

- A. Coordinate removal of rubbish, debris and waste materials covered under this section.

END OF SECTION

SECTION 26 05 90

FIRE STOPPING FOR ELECTRICAL

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 1. Penetrations in fire-resistance-rated walls.
 2. Penetrations in horizontal assemblies.
 3. Penetrations in smoke detectors.

1.02 SUBMITTALS

- A. Submit in accordance with Section 01 33 00 – Submittal Procedures.
- B. Product Data: Submit manufacturer's product data and installation procedures for each type of product specified in this section.
- C. Product Schedule: For each penetration fire stopping system. Include location and design designation of qualified testing and inspecting agency. Where project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration fire stopping condition, submit illustration, with modifications marked, approved by penetration fire stopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.03 CLOSEOUT SUBMITTALS

- A. Submit under provisions of Section 01 77 00 - Closeout Procedures.
- B. Installer Certificates: From Installer indicating penetration fire stopping has been installed in compliance with requirements and manufacturer's written recommendations.
- C. Product test reports.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Fire stop Contractors," or been evaluated by UL and found to comply with its "Qualified Fire stop Contractor Program Requirements."
- B. Fire-Test-Response Characteristics: Penetration fire stopping shall comply with the following requirements.
 1. Penetration fire stopping tests are performed by UL, FM Global or a qualified testing agency acceptable to authorities having jurisdiction.

2. Penetration fire stopping is identical to those tested per testing standard referenced in "Penetration Fire Stopping" article. Provide rated systems bearing marking of qualified testing and inspection agency.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. A/D Fire Protection Systems Inc.
 2. Hilti, Inc.
 3. Johns Manville
 4. Specified Technologies Inc.
 5. 3M Fire Protection Products.
 6. USG Corporation.

2.02 PENETRATION FIRESTOPPING

- A. Provide penetration fire stopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration fire stopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.
- B. Penetrations in Fire-Resistance-Rated Walls: Ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa). F-Rating not less than the fire-resistance rating of constructions penetrated.
- C. Penetrations in Horizontal Assemblies: Ratings determined per ASTM E 814 or UL 1479, based on testing at a pressure differential of 0.01-inch wg (2.49 Pa).
 1. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.
 2. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
- D. Penetrations in Smoke Barriers: Provide penetration fire stopping with ratings determined per UL 1479. L-Rating not exceeding 5.0 cfm/sq.ft. (0.025 cu. M.s per sq. m) of penetration opening at 0.30-inch wg (74.7 Pa) at both ambient and elevated temperatures.
- E. Exposed Penetration Fire Stopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- F. VOC Content: Penetration fire stopping sealants and sealant primers shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 1. Sealants: 250 g/L.
 2. Sealant Primers for Nonporous Substrates: 250 g/L.

3. Sealant Primers for Porous Substrates: 775g/L.

- G. Low Emitting Materials: Penetration fire stopping sealants and sealant primers shall comply with the testing and product requirements of the EPA and Hawaii department of Health Services.
- H. Accessories: Provide components for each penetration fire stopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration fire stopping manufacturer and approved by qualified testing and inspecting agency for fire stopping indicated.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the work.
- B. Install penetration fire stopping to comply with manufacturer's written installation instructions and published drawings for products and application indicated.
- C. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire stopping.
- D. Install fill materials for fire stopping by proven techniques to produce the following results:
 1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required, to achieve fire-resistance ratings indicated.
 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 3. For fill materials that will remain exposed after completing the work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.02 FIELD QUALITY CONTROL

- A. Owner will engage a qualified testing agency to perform tests and inspections.
- B. Where deficiencies are found or penetration fire stopping is damaged or removed because of testing, repair or replace penetration fire stopping to comply with requirements.
- C. Proceed with enclosing penetration fire stopping with other construction only after inspection reports are issued and installations comply with requirements.

3.03 PENETRATION FIRE STOPPING SCHEDULE

BENJAMIN WOO ARCHITECTS
PROJECT NO. 1709

LILIA WAIKIKI
HONOLULU, HAWAII

- A. Where UL classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHEZ.
- B. Where FM Global approved systems are indicated, they refer to design numbers listed in FM Global's "Building Materials Approval Guide" under "Wall and Floor Penetration Fire Stops."

END OF SECTION

SECTION 26 08 00
ELECTRICAL SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. General requirements for Commissioning (Cx) of lighting systems components, lighting controls, generator, automatic transfer switch and HVAC systems line voltage interconnection components, including installation, start-up, testing and documentation according to Construction Documents.

1.02 REFERENCES

- A. Applicable Codes, Standards, and References: inspections and tests shall be in accordance with the following applicable codes and standards:
1. National Electrical Testing Association – NETA.
 2. National Electrical manufacturer's Association – NEMA.
 3. American Society for Testing and Materials – ASTM.
 4. Institute of Electrical and Electronic Engineers – IEEE.
 5. American National Standards Institute – ANSI.
 6. National Electrical Safety Code – NESC.
 7. Insulated Power Cables Engineers Association – IPCEA.
 8. Occupational Safety and Health Administration – OSHA.
 9. National Institute of Standards and Technology – NIST.
 10. National Fire Protection Association – NFPA.
 11. ANSI/NFPA 70 – National Electrical Code.
 12. ANSI/NFPA 70B – Electrical Equipment Maintenance.
 13. NFPA 70E – Electrical Safety Requirements for Employee Work Places.
 14. ANSI/NFPA 101– Life Safety Code.

1.04 SUBMITTALS

A. Submittals shall include the following:

1. Submit in accordance with Section 01 33 00 - Submittal Procedures and 01 91 13 - General Commissioning Requirements.
2. Submit required Cx submittals in accordance with Division 1 Specification Sections.
3. List of team members who will represent the Contractor in the Pre-functional Equipment Checks and Functional Performance Testing, at least two weeks prior to the start of Pre-functional Equipment Checks.
4. Detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, checklist documentation and field checklist forms to be used by factory or field technicians, and a copy of full details of Owner-contracted tests, full factory testing reports, if any, and Warranty information, including responsibilities of Owner to keep Warranty in force, clearly defined.

5. Detailed manufacturer's recommended procedures and schedules for Pre-functional Equipment Checks, supplemented by Contractor's specific procedures, and Pre-functional Tests, at least four weeks prior to the start of Pre-functional Performance Tests.
6. After facility's commission is complete, submit completed Pre-functional Equipment Checklists and Functional Performance Test checklists organized by system and by subsystem. Bind information in a single package. The results of failed tests shall be included along with a description of the corrective actions taken.

1.05 MEETINGS, SEQUENCING AND SCHEDULING

- A. Meetings: Attend (Cx) meetings as required.
- B. Sequencing and Scheduling: The work described in this Section shall begin only after work required in related Division 26 sections has been successfully completed, and tests, inspection reports and Operation and Maintenance manuals required in Division 26 sections have been submitted and approved. The start-up and Pre-functional Equipment Checklists shall be completed prior to the Functional Performance Tests.
 1. Coordinate electrical work with the work of other trades prior to scheduling of any Cx procedures.
 2. Coordinate the completion of electrical testing, inspection, and calibration prior to start of Cx activities.

PART 2 – PRODUCTS

2.01 TEST EQUIPMENT

- A. Equipment to be utilized in the commissioning process shall meet the following requirements:
 1. Provide test equipment as necessary for the equipment and systems to be commissioned.
 2. Provide testing equipment and accessories that are free of defects and certified for use.
 3. Provide testing equipment with current calibration labels per NIST Standards.
 4. Testing equipment shall be UL Listed.

PART 3 – EXECUTION

3.01 COMMISSIONING PROCESS REQUIREMENTS

- A. Work to be performed prior to commissioning:
 1. Complete all phases of the work so the system(s) can be started, tested, adjusted, balanced, and otherwise commissioned.
 2. Start-up services required to bring each system into full operational state and ready for functional performance testing:
 - a. Completion of prefunctional checklists.
 - b. Manufacturer's Authorized Representative Start-up as required
 - c. Contractor start-up
 - d. Testing.
 - e. Motor rotation check.

- f. Control sequences of operation.
 - g. Full and part load performance.
 3. If modifications or corrections to the installed systems are required to bring the system(s) to acceptance levels due to Contractor's incorrect installation or defective materials, such modifications or corrections shall be made at no additional cost to the Owner.
 4. Start-up services required to bring each system into full operational state and ready for functional performance testing:
 - a. Completion of prefunctional checklists.
 - b. Manufacturer's Authorized Representative Start-up as required
 - c. Contractor start-up
 - d. Testing.
 - e. Motor rotation check.
 - f. Control sequences of operation.
 - g. Full and part load performance.
 5. Commissioning shall not start until each system is complete and the above items are completed and approval has been received by Owner.
- B. Pre-commissioning Responsibilities: Inspection, calibration and testing of the equipment and apparatuses to commission the following systems:
1. Electrical Lighting Systems.
 2. Lighting Controls.
 3. Generator and Automatic Transfer Switches
 4. HVAC line voltage electrical components.
 5. Line voltage interface of Environmental Controls and Energy Management System with other systems.

3.02 PREPARATION

- A. Provide certified electricians or other qualified personnel as required with tools and equipment necessary to perform Cx activities.
- B. Provide equipment manufacturer's factory representative(s) for commissioning Lighting Controls and Dimming System.

3.03 TESTING

- A. Testing documentation shall include the following minimum information:
 1. Test number.
 2. Equipment used for the test, with manufacturer and model number and date of last calibration.
 3. Date and time of the test.
 4. Indication of whether the record is the first commissioning test or a retest following correction of a previously identified problem or issue.
 5. Identification of the system, subsystem, assembly, or equipment.
 6. Conditions under which the test was conducted, including (as applicable) ambient conditions, set points, override conditions, and status and operating conditions that impact the results of the test.
 7. Systems and assemblies test results, performance and compliance with contract requirements.
 8. Issue number, if any, generated as the result of the test.
 9. Name and signature(s) of witnesses and the person(s) performing the test.

- B. Test lighting and controls systems performance to verify operation, functionality, light levels, energy usage, and compliance with construction documents.
1. Start up, test and document results under the observation of the CxA.
 2. Execute the Functional Performance Test (FPT) under the observation of the CxA who will record the results of the Functional Performance Test procedures.
 3. Functions and Testing Conditions:
 - a. Occupancy sensors and timer controls for lighting:
 - 1) Verify that specified functions and features are set up, debugged and fully operable at time of test.
 - 2) Verify that occupant override feature functions properly and as intended in the contract documents.
 - 3) Verify that sensor durations are set properly.
 - 4) Test the sequence of operation for features and modes and confirm that adjustable timing matches the design specifications and contract documents.
 - b. Electric lighting dimming, photocells and controls:
 - 1) Test the dimming controls during daytime when conditions are such that controls should be dimming electric lighting. Verify that amperage changes in light fixtures are proportional to external light changes. Verify that dimmed light levels at the specified work plane remain within specified limits.
 - 2) Verify that delays and ramp times are set and functioning so that the speed of change of light fixture output is slow enough to not bother occupants and in compliance with the specifications.
 - 3) Verify that dimming does not cause lower than specified light levels in adjacent "non-dimmed" spaces.
 - 4) Verify that the controls and sensors cannot be easily overridden or disabled by occupants.
 - 5) Verify that dimming systems in places of assembly are interfaced with the Central Fire Alarm system. Dimmed lighting in these areas shall come back to full bright during a fire alarm condition.
 - 6) Test at different times during the day, or under Owner-approved simulated conditions, to ensure proper system response and to determine that lighting levels are within specified requirements.
 - 7) Test the system for the different pre-determined settings. Quiet time, AV mode, and normal standard class operation.
 - c. Emergency Lighting System: Verify that the system operates automatically under any condition, without human intervention, and that it resets back to normal operations after the power failure is over or cleared.
 4. Acceptance Criteria: Lighting Controls: For the conditions, sequences and modes tested, the dimming, occupancy, photocell, and timing controls, integral components and related equipment respond to changing conditions and parameters appropriately as defined in the Contract Documents.
- C. HVAC Electrical Component Testing
1. Document HVAC Division 23 electrical components using the startup procedure submitted by Contractor and accepted by the CxA.
 2. Complete requirements of the Prefunctional Checklists.
 3. Verify the following information prior to HVAC system equipment startup.
 - a. Voltage.
 - b. Phase.
 - c. Motor Size.

- d. Lock Rotor Amperage.
 - e. Full Load Amperage.
 - f. Minimum and Maximum Circuit Ampacity.
 - g. Feeder protection or branch circuit protection, breaker or fuse size as applicable.
 - 4. Coordinate and check corresponding unit electrical protection size and code required clearances.
- D. Generator and Automatic Transfer Switches
- 1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems". Certify compliance with test parameters.
 - 2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
 - 3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
 - a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
 - b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
 - c. Verify acceptance of charge for each element of the battery after discharge.
 - d. Verify that measurements are within manufacturer's specifications.
 - 4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
 - 5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
 - 6. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
 - 7. Conduct test using building load by simulating utility failure.
 - 8. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.
 - 9. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 10. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 11. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 12. Remove and replace malfunctioning units and retest as specified above.
 - 13. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
 - 14. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.04 ADJUSTING

- A. Systems improperly adjusted, incorrectly installed equipment or deficient Contractor performance may result in additional work being required for Cx acceptance.
 - 1. Perform work required to correct installations not meeting contract requirements at no additional cost to the Owner.
- B. Corrective work shall be completed in a timely manner to permit completion of the Cx process.
 - 1. If the systems' Cx process goes beyond the scheduled completion of Commissioning without resolution of the problem, the Owner reserves the right to obtain supplementary services or equipment to resolve the problem.

3.05 TRAINING

- A. Provide training and documentation as required in applicable Division 26 specification sections, and other related sections.

END OF SECTION

SECTION 26 09 23

LIGHTING CONTROL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

Section Includes:

1. Furnish and install a low-voltage lighting control system, as indicated on the Drawings and as specified.
2. Systems shall be furnished complete with the required panels, devices, relays, transformers, and control electronics. The system shall be furnished with all hardware and resident software, occupancy sensors, light controllers, exterior light sensors, occupancy sensors, local wall switches and dimmer switches and all required conduit and wiring for a complete and functional installation as shown on the drawings.

1.02 SUBMITTALS

- A. Submit in accordance with Section 01 33 00 – Submittal Procedures.
- B. Submit a complete one-line diagram of the proposed system configuration for Architect/Engineer's review. The riser diagram shall identify but not be limited to all wiring, equipment, components, interconnection with other systems, and location and type of raceways.
- C. Manufacturer's Data: Submit catalog cuts and description of each system component.
- D. Provide wiring diagrams and installation details for lighting control equipment.
- E. Shop Drawings: Submit a complete set of detailed Shop Drawings for the entire lighting control system; the shop drawings shall include but not be limited to control panels with designations and dimensions, day light sensors locations shown on the drawings, and system components with manufacturer's part numbers.
- F. Installation Instructions: Submit manufacturer's written installation instructions, wiring diagrams. Instructions shall include recommendations for handling of equipment and parts, and protection and storage requirements.

1.03 QUALITY ASSURANCE

- A. Components shall be listed and labeled by Underwriters Laboratories (UL), or another Nationally Recognized Testing Laboratory (NRTL).
- B. Lighting Control Systems shall comply with the Honolulu Building Energy Code.
- C. Conduct a coordination meeting to validate the location of all lighting control system components, including daylight sensors. Sensors shall be located based on manufacturer's recommendations.

1.04 WARRANTY

Provide one year warranty on all work performed, unless noted otherwise in specific sections.

PART 2 – PRODUCTS

2.01 COMMON & AMENITY AREA-LIGHTING CONTROL & DIMMING PANELS

Lighting Control and Dimming Panels: Shall control common area, amenity and landscape area lights. Locate panels in the electrical closets. Panels shall be as manufactured by Lutron, Wattstopper, Leviton, or equal. Panels will provide automated dimming, switching and time clock lighting control functions. Panels shall be surface mounted type as indicated on Drawings. Doors shall be hinged furnished with flush type locks. Residential corridor lights will not be connected to the lighting control panels, corridor lights will be breaker controlled. Panels shall include the following components or features:

1. Shall be preassembled with all required control equipment and relays as indicated on the lighting plans.
2. Shall be equipped with suitable dividers separating Class 1 and Class 2 compartments, 120v and 277v compartments as well as "normal and emergency" compartments.
3. Provide lighting control and dimming relays as required. Provide 5% spare relays for all control panels.
4. Shall be equipped with a neatly typewritten schedule with number and name of rooms or areas served by the controlled circuits. Schedule shall indicate panel designation and voltage and shall be mounted in a frame under transparent plastic 1/32" thick on inside of panel cabinet.
5. Each panel shall be rated for the specified voltage.
6. Shall include relays capable of switching 20 amps general lighting loads for 120 or 277 VAC with short circuit rating meeting building electrical system configuration.
7. Provide preset scene control devices, occupancy controls, daylight controls and switch controls as shown on the drawings.

2.02 RESIDENTIAL UNIT-LIGHTING CONTROLS

Where indicated on the drawings, provide lighting controls in residential units. Controls will be by Lutron, or similar. Device controls will provide preset multi scene and/or manual dimming controls. Lighting controls will control residential unit kitchen and living room lights. Hallways, bedroom and bathroom lights will remain local manual switches, and will not be provided with dimming controls.

2.03 LOW VOLTAGE SWITCHES

- A. All low voltage switches shall be wired per the lighting control manufacturer's requirements.
- B. Physical removal of any single switch shall have no effect on the communication between lighting control panel in the rest of the lighting control network. Lighting control systems requiring the continuous connection of all low voltage switches are not acceptable.
- C. Provide nylon or stainless steel switch covers per the Architect's direction.

2.04 OCCUPANCY SENSORS

- A. Ceiling-Mounted Dual Technology Sensors:
 - 1. Sensors shall be dual technology infrared-ultrasonic.
 - 2. Time delay range shall be adjustable up to 30 minutes.
 - 3. Power supply shall be provided by power pack, consisting of a transformer and contact closure relay in one package. Power output of transformer shall be capable of operating a minimum of 2 sensors.
 - 4. Manufacturers: Lutron, Wattstopper, Leviton or equal.

- B. Dual Technology Wall Switch Sensors:
 - 1. Sensors shall be dual technology infrared-ultrasonic.
 - 2. Time delay range shall be adjustable up to 30 minutes.
 - 3. Sensors shall be dual voltage, 120 volt and 277 volt.
 - 4. Manufacturers: Lutron, Wattstopper, Leviton or equal.

PART 3 – EXECUTION

3.01 GENERAL

- A. Lighting control system shall not be used for any other purpose other than its intended use and application.

- B. Provide all required interconnections with other systems such as emergency power sources, fire alarm systems, and building management system as required or indicated on drawings.

- C. Installation shall meet or exceed standard practice of workmanship and quality.

- D. Drawings generally indicate work to be provided, but do not indicate all bends, transitions, or special fittings required to clear beams, girders or other work already in place. Investigate conditions where conduits are to be installed, and furnished and install required fittings.

- E. Manufacturer shall provide detail wiring diagram using building floor plans and riser diagrams showing all control panels and devices interconnection for line and low voltage circuits.

3.02 INSTALLATION AND SET-UP

- A. Verify that conduit for line voltage wires enters panel in line voltage areas and conduit for low-voltage control wires enters panel on low-voltage areas. Refer to manufacturer's drawings for location of line and low-voltage areas.

- B. Provide for Owner specified switches, and wire according to lighting control manufacturers requirements. If requested, provide samples for all switching devices for Owner's approval prior to product procurement.

- C. Digital switches and wire shall be according to lighting control manufacturers requirements.

- D. Connect lighting control system per manufacturer's requirements. Do not exceed manufacturer's total dataline length requirement.
- E. Panels shall be located so that they are readily accessible and not exposed to physical damage.
- F. Panel locations shall be furnished with sufficient working space around panels to comply with the National Electrical Code.
- G. Panels shall be securely fastened to the mounting surface by at least 4 points.
- H. Unused openings in the cabinet shall be effectively closed.
- I. Cabinets shall be grounded in accordance with Article 250 of the National Electrical Code, and manufacturer's recommendations.
- J. Lugs shall be suitable and listed for installation with the conductor being connected.
- K. Conductor lengths shall be maintained to a minimum within the wiring gutter space. Conductors shall be long enough to reach the terminal location in a manner that avoids strain on the connecting lugs.
- L. Maintain the required bending radius of conductors inside cabinets.
- M. Clean cabinets of foreign material such as cement, plaster and paint.
- N. Distribute and arrange conductors neatly in the wiring gutters.
- O. Follow the manufacturer's torque values to tighten lugs.
- P. Before energizing the panelboard, the following steps shall be taken:
 1. Retighten connections to the manufacturer's torque specifications. Verify that required connections have been furnished.
 2. Remove shipping blocks from component devices and the panel interior.
 3. Remove debris from panelboard interior.
- Q. Follow manufacturers' instructions for installation.

3.03 OPERATING/SERVICE MANUALS

- A. Submit operation and service manuals. Complete manuals shall be bound in flexible binders and data shall be typewritten or drafted.
- B. Provide a printed copy of the systems configuration as programmed, including all system labeling codes, and passwords.
- C. Provide an electronic copy on compact disk of the system configuration program.
- D. Manuals shall include instructions necessary for proper operation and servicing of system and shall include complete wiring circuit diagrams of system, wiring destination schedules for

circuits and replacement part numbers. Manuals shall include as-built cable Project site plot plans and floor plans indicating cables, both underground and in each building with conduit, and as-built coding used on cables. Programming forms of systems shall be submitted with complete information.

- E. Record Drawings: Provide a copy of record drawings on Project site indicating location of equipment, conduit and cable runs, and other pertinent information.

3.04 PROTECTION

Protect the Work of this section until Substantial Completion.

3.05 TESTING

Testing of the lighting control system, and Owner instruction shall include:

1. Confirmation of system programming.
2. Confirmation of operation of individual relays, switches, occupancy sensors and daylight sensors.
3. Operation of system's features under normal and emergency operations.
4. Before energizing check that cables and wire connections are free from short circuits, ground faults, and that there is continuity, and necessary insulation.
5. Confirm system operations and functionality.
6. Provide training to cover installation, maintenance, troubleshooting, programming, and repair and operation of the lighting control system.

3.06 INSTRUCTION PERIODS

Before Substantial Completion, arrange and provide four (4) hours for Owner instruction period for designated personnel.

3.07 CLEANUP

Coordinate removal of rubbish, debris, and waste materials of materials covered under this section.

END OF SECTION

SECTION 26 22 00

LOW VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. This specification covers single-phase and three-phase general purpose individually mounted dry-type transformers, 600 V maximum, for power and lighting applications. It includes transformers as specified and as indicated on Drawings.
2. All work, material or equipment shall comply with the codes, ordinances and regulations of the local government having jurisdiction, including the regulations of serving utilities and any participating government agencies having jurisdiction.

B. Codes and Applicable Standards: Products and installation shall meet or exceed the latest edition of the following standards.

1. ANSI/IEEE C57.96, Distribution and Power Transformers, Guide for Loading Dry-Type Transformers; Appendix to ANSI C57.12 Standards.
2. Department of Energy, Energy Act of 2005.
3. National Electrical Code.
4. ANSI/IEEE C89.2, Dry-Type Transformers for General applications.
5. IEEE C57.12.91, Test Code for Dry-Type Distribution and Power Transformers.
6. IEEE C57.110 – IEEE Recommended Practice for establishing capability when feeding nonsinusoidal load currents.
7. NEMA standard 20, Dry-Type Transformers for General applications.
8. UL 506, Specialty Transformers.
9. UL 1561, Dry-Type General Purpose and Power Transformers.
10. NEMA TP-1, 2002; Guide for Determining Energy Efficiency for Distribution Transformers.
11. NEMA TP-2, Standard Test Method for Measuring the Energy Consumption of Distribution Transformers.
12. NEMA TP-3, Standard for the Labeling of Distribution Transformer Efficiency.

C. No requirement of these drawings and specifications shall be construed to void any of the provisions of the above standards. Any conflicts or changes required to the contract documents in order to obtain compliance with applicable codes shall be brought to the immediate attention of the Owner Authorized Representative by the Contractor.

D. Acronyms:

1. ANSI American National Standards Institute
2. AOR Architect of Record
3. EOR Engineer of Record
5. IBC International Building Code
6. IEEE Institute of Electrical and Electronics Engineers
7. IOR Inspector of Record
8. NEC National Electrical Code
9. NEMA National Electrical Manufacturers Association

1.02 DESIGN REQUIREMENTS

- A. Transformers, Dry Type: Distribution transformers shall be provided with aluminum core and wound with aluminum conductors. Performance of transformers shall meet or exceed the requirements of applicable codes and standards.
- B. Transformers shall be self-cooled type with 220 degrees C. insulation and a maximum temperature rise of 150 degrees C. under continuous full load conditions with an ambient of 40 degrees C.
- C. Transformers shall be furnished with four 2.50 percent (2 above and 2 below normal voltage) taps. Windings shall be of fire-resistant type, designed for natural convection cooling through normal air circulation.
- D. Core mounting frames and enclosures shall be of welded and bolted construction with sufficient mechanical strength and rigidity to withstand shipping, installation, and short circuit stresses.
- E. Enclosure cover plates shall be sheet steel, captive bolted to enclosure framework. Enclosure shall provide suitable ventilating openings with rodent-proof screens, NEMA 1 enclosure. Enclosure shall be provided with lifting lugs and jacking plates as required. Transformers installed outdoors shall be provided with weatherproof NEMA 3R enclosure and weather proof kit.
- F. Transformers shall be furnished complete with mounting channels and mounting bolts. Metal parts, excepting cores and core mounting frames shall be furnished clean, rust-proofed, and provided with a coat of an inert primer.
- G. Transformers up to 35 KVA shall be no more than 40 decibels. Transformers 36 KVA or more shall be a minimum of 5 decibels below NEMA standards per unit. Transformers shall be provided with vibration dampers consisting of Korfund spring loaded shock mounts and Elastorib sheeting. Size and number of shock mounts shall be in accordance with manufacturer's recommendations.
- H. Transformers shall be UL listed.
- I. Each transformer to be installed under this section shall be sound tested at the factory.
- J. Equipment shown on drawings to scale is approximate only and based upon a general class of equipment specified. The Contractor shall verify all dimensions and clearances prior to commencement of work.
- K. The Contractor shall verify all points of connection with the manufacturer's requirements, instructions, or recommendations prior to installation. Actual dimensions, weights, clearances and installation requirements shall be verified and coordinated by the contractor.

1.03 SUBMITTALS

- A. Submit in accordance with Section 01 33 00 – Submittal Procedures.

- B. Shop Drawings: Include make, catalog number, dimensions, weight, KVA Rating, % Impedance, finish, type, insulation class, design temperature, sound levels, efficiency and taps provided. Include regulation at 80 percent and 100 percent of full load, no-load loss, full-load loss, percent efficiency, percent impedance, noise level and continuous capacity rating.
- C. Provide manufacturers data and inspection report that confirms transformers to be UL 1561 listed.
- D. Provide a connection schematic diagram.
- E. Provide the following tests reports. IOR will review the reports for conformance with specified criteria, and compliance with the applicable standards. Submit one copy for each set of shop drawings being submitted.
 - 1. Load Losses: Measurements shall be taken at multiple load levels and plotted to show compliance with specifications and correlated to efficiency curve for the transformer size and type.
 - 2. Provide No-Load and Total Losses report.
 - 3. Applied Voltage.
 - 4. Temperature Rise.
 - 5. Induced Voltage.
 - 6. Sound Level.
 - 7. Impulse Test.
 - 8. Manufacturer's nonlinear load test representing real world load mix. Transformers not meeting this requirement shall not be installed.

1.04 WARRANTY

- A. Transformers shall be warranted to be free from defects in materials and workmanship for a period of three years from the date of substantial completion.

PART 2 – PRODUCTS

2.01 EQUIPMENT

- A. Transformers shall be Square D, General Electric, PowerSmiths, Siemens, MGM, Cutler Hammer or owner approved equal.

PART 3 – EXECUTION

3.01 DELIVERY AND STORAGE

- A. Deliver, storage, protect and handle products in accordance with the manufacturer's recommendations.

3.02 INSTALLATION

- A. Transformer core frame shall be installed level on shock absorbing pads within enclosure. Comply with IBC per Honolulu seismic zone requirements.

- B. Mounting bolts on floor mounted transformers shall be extended into pads only and shall not be in direct contact with building structural members.
- C. Flexible jumpers shall be installed for grounding continuity from enclosure to conduits or bus ducts where required.
- D. Transformers installed outdoors or below grade shall be mounted on concrete pads.
- E. Install transformer ventilation openings not closer than 6 inches from wall surfaces.

3.03 VOLTAGE CHECK

- A. Set taps on transformers to provide satisfactory operating voltages with present loads energized, including new loads and existing loads. A check shall be performed in the presence of the IOR at a panel fed from each transformer, which is farthest from transformer. Voltages at transformers ranging from 118 to 122 volts inclusive, for 120 volt systems and proportionately equivalent for higher voltage systems are permitted.
- B. Provide instruments and accessories required to perform checks. Voltmeters shall be accurate within .075 percent or one percent and shall have scales permitting voltage readings to be performed on upper half of scale.
- C. Adjust transformer taps under full load operating conditions, to provide normal operating voltages at the loads.

3.04 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

3.05 CLEANUP

- A. Remove rubbish, debris and waste materials and legally dispose of off Project site.
- B. Repair scratched or marred surfaces affected during the execution of work. Repair surfaces shall match original finish.

END OF SECTION

SECTION 26 24 13

SWITCHBOARDS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Furnish, install and connect main switchboard, including metering facilities as required by utility company.
2. Main switchboards shall be complete with pull, service, and distribution sections.
3. Protective devices in main switchboard shall be furnished with a minimum symmetrical short-circuit interrupting rating, as provided by electric utility company.
4. Provide installation detail and seismic anchorage notes for switchboards.

1.02 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – SUBMITTALS.

B. Shop Drawings:

1. Include a front elevation indicating dimensions and locations of equipment on switchboard, make, kind and size or capacity of equipment and bussing, location of each service conduit entering switchboard, barriers, nameplate inscriptions, finish, total weight and size of switchboard and locations and sizes of anchor bolts.
2. Contractor shall submit short-circuit and coordination studies signed and stamp by a registered electrical engineer. Studies shall be in accordance with IEEE guidelines. Contractor shall submit two copies of each study for Architect/Engineer review prior to ordering and installing any equipment.
3. Provide coordination study for main and branch circuit protective devices including transformers secondary protective devices. Study shall be recorded on log paper. The circuit protective devices shall be set based on the coordination study. A final written record of protective device settings shall be provided to Architect/Engineer.

PART 2 – PRODUCTS

2.01 SWITCHBOARDS

- A. Switchboards shall be product of Square D, Eaton, General Electric, or equal, and shall conform to the following requirements.
- B. Complete assembly, including steel framing and covers, bus system, and breaker mounting, shall satisfy applicable provisions of UL 891 and NEMA PB-2 and the National Electrical Code for low-voltage distribution switchboards. Switchboards shall be furnished with UL labels.
- C. Switchboards shall be floor standing, dead front, dead rear, line bussed, front operated and

connected, circuit-breaker type, unless otherwise indicated and shall contain equipment indicated and specified. Switchboard shall be complete with pull, service, and distribution sections as required.

- D. Required equipment shall be enclosed in fully interchangeable die formed steel sectional cabinets with top and bottom plates and required braces and gussets so that cabinets will be absolutely rigid, plumb and uniform in size. Each cabinet shall be a separate and independent unit with assembly holes die-stamped or jig drilled; openings for interconnections shall be so placed that any cabinet can be located in any position in assembly without drilling or cutting holes on job. Deliver switchboard to project site in completely assembled sections and provide required assembly bolts and blanking plates. Front plates and doors shall be of not less than 12 gage furniture steel, completely removable, secured to cabinet with machine screws, with cup washers uniformly and symmetrically spaced. Provide hinged wire gutter covers for distribution sections. Equipment shall meet NEMA and UL standards.
- E. Main circuit breaker shall be as follows:
 - 1. Main circuit breakers shall be automatic, one-piece molded-case, trip-free, common trip, quick-make, quick-break, thermal-magnetic with solid state trips, bolted to bus with frame size and trip ratings as indicated on drawings. Voltage, amperage ratings and number of poles shall be as indicated on breakers. Main breaker shall provide a minimum short-circuit interrupting capacity as determined by utility company. Provide shunt-trip and integral ground fault devices, as indicated on drawings. Breakers shall be furnished with lockout provisions.
- F. Feeder circuit breakers shall be automatic, one-piece molded-case, trip-free, common trip, quick-make, quick-break, thermal-magnetic or solid state type bolted to bus, with handles clearly indicating tripped position. Breakers shall be furnished with a single handle with no tie-bar. Voltage, amperage, and number of poles shall be as indicated on drawings. Breaker ratings shall be on handle or label. Breakers shall be furnished with lockout provisions for padlocking and shall provide a minimum symmetrical short-circuit interrupting rating. Series rated circuit breaker combinations are not acceptable.
- G. Utility metering provisions shall meet requirements of serving utility (Hawaiian Electric) and shall be furnished with necessary fittings.
- H. Leviton sub-metering shall be provided for commercial tenants.
- I. Provide for all switchboard silver-plated copper bus bars of same capacity as main breaker, or as indicated on drawings, between current transformer and main section and distribution sections; also, full height of breaker space in distribution portions. Copper bus shall have current density of 1000A per square inch of cross section. Bus structure shall be free-fitted, and shall have sufficient strength to withstand short-circuit as indicated on drawings. Connections shall be securely bolted together with corrosion-resistant plated carbon steel, minimum grade 5 machine screws secured with constant pressure-type locking devices. Bus bar bracing shall be designed to withstand maximum available short-circuit current. Connections for cables to all circuit breakers, switches and motor control devices shall be heavy-duty mechanical pressure type terminal lugs. Provide service cable lugs as required by utility company. Cables and internal wiring shall be supported with suitable cleats.
- J. Switchboard distribution sections shall be furnished with full height bussing. Unused spaces shall be provided with blank covers. Switchboards, as complete units, shall be given single

short-circuit current ratings by manufacturer. Such ratings shall be established by actual tests by manufacturer, in accordance with UL specifications, on equipment constructed similarly to the furnished switchboard.

- K. Provide nameplates for components on switchboards. Plates shall be black and white plastic nameplate stock, with characters cut through black exposing white, and shall bear designation of service, or feeders controlled and fuse size. Provide similar nameplates for meter and transformer compartments. A large nameplate identifying switchboard, indicating service voltage, function and current rating shall be furnished with 3/16 inch engraved block letters.
- L. Paint cabinets, framework and plates inside and out with one coat of rust-resistant metal primer and one coat of gray enamel, baked on, or lacquer sprayed on.
- M. Manufacture boards according to reviewed shop drawings. Switchboard shall meet requirements of legally constituted authorities having jurisdiction, and respective serving utility.
- N. Switchboards installed outdoors shall be weatherproof NEMA Type 3R enclosure. Enclosure construction shall be formed of code gage galvanized steel with ANSI No. 61 gray enamel finish. Heavy-duty, 3-point latching, vault type door handles with padlocking provisions shall be furnished on doors. Padlocks shall be furnished keyed to Corbin No. 60 keys. Switchboards installed outdoors shall be specifically required to maintain service during extreme outdoor ambient temperatures of a minimum of 150 degrees Fahrenheit in NEMA Type 3R enclosures.
- O. For grounded Wye electrical service switchboards rated more than 150 volts, to ground and 1,000 amperes or more, provide ground fault protection for main protective device. Ground fault protection shall be UL listed, with ground sensor encircling all phase conductors and neutral conductors integral with the main protective device. Provide testing of ground fault protection system by an independent recognized testing laboratory. Testing lab shall provide necessary testing equipment at the project site and perform a certified test on ground protection system in presence of the Inspector. The ground fault setting shall be selected to coordinate with downstream circuit protective devices. Verify that the system neutral is grounded at the service entrance switchboard only, except neutrals of step down distribution transformers. For branch circuit protective devices, rated 800 amps or more, provide ground fault protection where shown on the drawings, or as described above, for main protective device. Coordinate settings with main protective device ground fault protection.
- P. In main and distribution switchboards provide a multifunctional digital meter with true RMS measured Amperes (each phase and neutral) Volts (line-to-line and line-to-neutral), Power Factor, Frequency, VA, VAR, Watts, KWH, KVARH, KVAH, voltage/current unbalance, and demand metering: W, VAR, Amperes, VA. Meter to have a front mounted RS232 port to allow programming and meter values via laptop computer and supplied software. The meter shall be Leviton with BACnet translator capabilities. Metering equipment shall be pre-approved by Owner.
- Q. Connections to any bussing shall be securely bolted together with corrosion-resistant plated carbon steel, minimum grade 5 machine screws secured with constant pressure-type locking devices.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Switchboards shall be located so that they are readily accessible and not exposed to physical damage.
- B. Switchboard locations shall provide sufficient working space around the switchboard to comply with the National Electrical Code.
- C. Switchboards shall be securely fastened to the mounting surface.
- D. Switchboard cabinets shall be grounded as specified in Article 250 of the National Electrical Code.
- E. Conduits shall be installed so as to prevent moisture or water from entering and accumulating within the enclosure.
- F. Lugs shall be suitable and as required for installation with the conductor being connected.
- G. Conductor lengths shall be maintained to a minimum within the wiring gutter space. Conductors shall be long enough to reach the terminal location in a manner that avoids strain on the connecting lugs.
- H. Maintain the required bending radius of conductors inside the cabinet.
- I. Distribute and arrange conductors neatly in the wiring gutters.
- J. Tightening the wire lugs or any conductor connections shall be performed in the presence of the Inspector. Torque values shall be those recommended by manufacturer.
- K. Remove shipping blocks from component devices.
- L. Manually exercise circuit breakers to verify they operate freely.
- M. Remove debris from switchboard interior.
- N. Follow manufacturer's instructions for installation.
- O. Furnish one spare fuse for each fusible switch installed. Spare fuses shall be of the same type and rated as those installed.
- P. Do not install in highly corrosive environments such as pool equipment, and corrosive materials storage rooms, and similar areas. When equipment is installed in such areas, it shall be labeled and listed for the application.
- Q. Switchboard equipment and system components shall be free from short circuits and grounds, other than required grounds. The contractor shall be responsible for the testing of bolted electrical connections, and perform insulation resistance tests on each bus section, phase-to-phase and phase-to-ground for one minute in accordance with requirements stated in NETA-ATS 2007 table 100.1. Test shall be performed in the following manner.
 - 1. Utilize the services of an approved independent testing laboratory to perform megger time-

resistance insulation testing of bussing, circuit breakers and/or fused switches. The fused switches shall be equipped with fuses or temporary jumpers in place of fuses. Breaker and fused switches shall be tested in the closed position. No wiring shall be connected to the line or load side of the switchgear during testing.

- a. Provide calibration program records to assure the testing instruments to be within rated accuracy. The test equipment accuracy shall be in accord with the requirements stated by the National Institute of Standards and Technology (NIST).
- b. Test equipment shall be provided with a label stating the date of last calibration. As a minimum the equipment shall have been calibrated within the past 12 months.
- c. Test reports shall include the following:
 - 1) Identification of the testing organization.
 - 2) Equipment identification.
 - 3) Ambient conditions.
 - 4) Identification of the testing technician.
 - 5) Summary of project.
 - 6) Description of equipment being tested.
 - 7) Description of tests.
 - 8) Test results.
 - 9) Analysis, interpretation and recommendations.
2. Perform tests in the presence of the Inspector.
3. During testing, provisions shall be made to prevent damage to any solid state components, or electronic equipment such as TVSS equipment that may be tied onto switchboard bussing.
4. Test results shall meet manufacturer's recommendations or NETA ATS- 2007 recommendations, whichever is more stringent.

3.02 PADS AND ANCHORING

- A. Where free-standing equipment is installed at exterior locations or in locations below grade, concrete pads shall be provided as specified in Section 03 30 00 - Cast-In-Place Concrete.
- B. Where a utility meter is installed in a switchboard, concrete pad shall extend 3 feet from face of switchboard door or board, whichever is greater. Concrete pad installation shall comply with electric utility company requirements.
- C. Anchor bolts for freestanding equipment shall meet Oahu seismic zone requirements, and manufacturer's installation recommendations. The more stringent requirements will be enforced.
- D. Project Record Documents: Provide project record drawings of switchboards as installed, indicating main and branch circuit ratings, circuit numbers and part numbers.
- E. For ground fault relays and sensors, the following information shall be provided:
 1. Certified Calibration and Acceptance Test.
 2. Installation Instructions.
 3. Operating Instructions.
 4. Maintenance Instructions.
 5. Replacement Parts List.
 6. Final Test Report.
- F. Test information shall be submitted to the Architect. Nameplates may be fabricated of engraved

laminated plastic or etched metal and shall be permanently attached with escutcheon pins or screws.

3.03 PROTECTION

- A. Protect the work of this section until substantial completion.

3.04 CLEANUP

- A. Remove rubbish, debris, and waste materials and legally dispose of off project site.

END OF SECTION

SECTION 26 24 16

PANELBOARDS AND SIGNAL TERMINAL CABINETS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Lighting and power distribution facilities, including panelboards.

1.02 SUBMITTALS

- A. Submit in accordance with Section 01 33 00 – Submittal Procedures.
- B. Shop Drawings: Include a front elevation indicating cabinet dimensions, make, location and capacity of equipment, size of gutters, type of mounting, finish, and catalog number of locks. General layout of internal devices, wiring drawings with wire numbers and device connections, vendor cut sheets of devices in enclosure and bill of materials listing description, manufacturer, part number, and quantity of items shall be included.
- C. Installation Instructions: Submit manufacturer's written installation instructions.

1.03 DESIGN REQUIREMENTS

A. Panelboards:

1. Panelboards shall be wall-mounted, enclosed safety type with 120/240 volt, 3-wire solid neutral 277/480 volt, 4-wire or 120/208 volt, 4-wire solid neutral mains. First panelboard of each building shall be provided with main or sub-feeder circuit breakers where so indicated.
2. Single pole branches shall be molded case, thermal magnetic circuit breakers with inverse time delay, trip free, quick-make, quick-break mechanism and silver alloy contacts. Circuit breakers shall be fully rated, with ampere rating marked on handle and shall indicate on/off and tripped positions. Ground fault interrupters shall be incorporated into circuit breakers where indicated. They shall be listed by UL, or other NRTL as ground fault devices. Provide appropriate lug kit of sufficient size to accommodate the feeders.
3. Two- and 3-pole branches shall be enclosed, and shall be thermal magnetic circuit breakers with inverse time delay, tamper-proof, ambient compensated, single handle, internal common trip, and quick-make, quick-break mechanism with silver alloy contacts. Circuit breakers shall be fully rated.
4. Main and subfeeder circuit breakers shall be enclosed, thermal magnetic type with inverse time delay, single handle common trip, quick-make, quick-break mechanism, corrosion-resistant bearings and silver alloy contacts. Ampere frame size and trip rating shall be as indicated on drawings. Breakers over 225 amperes shall be furnished with interchangeable trip units. Handles of main and subfeeder circuit breakers shall be provided cabinet door. Voltage rating shall be as indicated on drawings.
5. Circuit breakers shall be fully rated and of one-piece, bolt-on type and shall meet short-circuit interrupting capacity requirements indicated on drawings. Series rated circuit breaker combinations are not acceptable.

6. Provide complete submetering systems for unit metering. Submetering system will be integral within unit distribution panel. Furnish submetering complete with CTs and wiring. Intent is for electrical submetering system software to integrate and network with an overall master metering and monitoring system. Coordinate interface requirements with owner's vendor. Submetering system will be furnished complete with software, programming, start up, testing and billing support for owner's property management company to operate. Include training and support for submetering system operation.
 7. Arc fault interrupters shall be provided for areas required by current NEC.
 8. Internal connections shall be fabricated with plated copper bus bars and the busses shall extend for full length of space available for branch circuit breakers. Feeder cable connectors shall be installed at point of feeder entrance. Terminals shall be furnished with copper conductors. Panelboards fed by conductors having over-current protection greater than 200 amperes shall be protected on supply side by over-current devices having a rating not greater than that of panelboards. Copper bussing shall be fully rated. Heat rated bussing is not acceptable
 9. Except where otherwise indicated, circuit breakers shall be in 2 vertical rows connected to bus bars in a distributed phase arrangement. Two-pole branches shall be balanced on busses. Single pole branches shall be numbered adjacent to its circuit breaker, with odd numbers on left and even numbers on right.
 10. Specified circuit breaker spaces shall be furnished with hardware required for future installation of circuit breakers.
 10. Provide locking devices for individual circuit breakers. Padlocking devices shall be secured to circuit breakers and by panel dead front plates.
- B. Surge Suppressors: Where indicated on drawings, provide transient voltage surge suppressors as an integral part of panelboards. Panelboards shall be complete with 200 percent rated copper neutral bus, ground bus and isolated ground bus in addition to requirements of this section. Surge suppressors shall be as follows:
1. Surge Capacity:
 - a. Line-to-neutral for wye systems: 80 KA.
 - b. Line-to-ground: 80 KA.
 - c. Neutral-to-ground: 80 KA, 3-phase wye.
 - d. Line-to-neutral plus line-to-ground: 160 KA.
 2. UL 1449 2nd Edition Suppressed Voltage Rating for 208/120 Wye System:
 - a. Line-to-neutral: 400 volts.
 - b. Line-to-ground: 400 volts.
 - c. Neutral-to-ground: 400 volts.
 - d. Maximum continuous over-voltage: 150 volts.
 3. EMI/RFI High-Frequency Noise Power Filter (Characteristics):
 - a. 100 KHz at 444 dB.
 - b. 100 MHz at 44 dB.
 - c. 10 MHz at 44 dB.
 - d. 100 MHz at 444 dB.
 4. MOVs shall be thermally protected for low current faults and shall be fused with surge-rated fuses. The surge-rated surge current passes and clears the circuit safely if the surge capacity is exceeded. Enhanced diagnostics shall continuously monitor the unit's status and shall include LEDs to signal a reduction in surge capacity or the loss of a suppression circuit. An audible alarm, with test and silence features, shall be furnished in diagnostic package.
 5. Each phase or the entire unit shall be replaceable and have bolted-on, tin-plated copper connections. Unit to have UL witnessed fault current rating of 65,000 symmetrical

- amperes.
6. Surge suppression units shall comply with the following:
- a. UL certified.
- b. UL 1283.
- c. UL 1449 2nd Edition.
- d. IEEE C 62.45.
- e. IEEEI C 62.41.
- f. Nationally Recognized Testing Laboratory (NRTL) or equal.
- C. Panelboard Cabinets:
1. Panelboard cabinets shall be code gage galvanized steel or blue steel; fronts, doors, and trims shall be code gage furniture steel. Cabinets shall be furnished with at least 6-inch high gutters at top and bottom where feeder cable size exceeds 4 gauge or where feeder cable passes through cabinet vertically. Cabinets shall be furnished with top and bottom gutters sized as required by inspection department having jurisdiction, but never less than 6 inches where more than one feeder enters top or bottom of cabinets. Side gutters shall not be less than 4 inches wide. Width of cabinets shall be 20 inches, unless otherwise indicated on drawings.
2. Doors shall be cut true, shall accurately fit opening and finish smooth across joints. Rabbets shall be inside. Hinges shall be entirely concealed except for barrels and pins. Hinge flanges shall be welded to door and trim. Doors shall be equipped with flush type, spring-latching, Corbin locks for metal doors, keyed to Corbin No. 60 keys.
3. Where contactors, time switches, and control devices are specified or indicated to be installed within panelboard cabinets, a separate compartment and door shall be provided at top of cabinet for such devices. Door shall be sized as required to permit removal of contactor and other devices intact. Gutters shall be provided at sides and top of compartment. Doors shall be equipped with flush type, spring-latching, Corbin locks for metal doors keyed to Corbin No. 60 keys.
4. Provide and install panelboard manufacturer's permanent circuit number kit option.
5. Panelboards with control devices in compartment shall arrive at the project site completely assembled with control devices installed and wired.
6. Outdoor cabinets shall be NEMA Type 3R. Construction shall be formed from code gauge galvanized steel with ANSI No. 61 gray enamel finish. Provide heavy-duty, 3-point latching, vault type door handles with padlocking provisions. Provide stainless steel or galvanized butt hinges on doors. Padlocks shall be furnished, keyed to Corbin No. 60 keys.
7. Self-tapping screws and bolts not permitted.
- D. Panelboard Schedule: Provide a neatly typewritten schedule with number or name of room or area, or load served by each panelboard circuit. Room numbers or names shall be determined at the project site and shall not necessarily be those indicated on the drawings. Schedule shall also indicate panel designation, voltage and phase, building and distribution panel or switchboard from which it is fed. Schedule shall be installed in a frame under transparent plastic 1/32 inch thick on inside of each panelboard cabinet door.
- E. Panelboard Standards: Panelboards shall be UL, or other NRTL listed and labeled. Panelboards shall meet latest revisions of following standards.
1. National Electric Code, Article 384.
2. UL 67, Panelboards.
3. UL 50, Cabinets and Boxes.
4. UL 943, GFCI.

5. UL 489, Molded Case Circuit Breakers.
6. NEMA PB1.
7. Federal Specifications W-P- 115C and WC-375B.

F. Signal Terminal Cabinets:

1. Signal terminal cabinets shall conform to the specifications for panelboard cabinets, except as modified herein.
2. Terminal cabinets shall be flush type, with 2-inch trim or surface mounted type, as indicated on drawings. Terminal cabinets shall be furnished with sections and barriers to separate each system. Sections over 24 inches in width shall be provided with double doors and locks. Terminal cabinets, or sections of terminals housing separate systems, shall measure 12 inches long x 18 inches high x 5-3/4 inches deep, unless otherwise indicated on drawings. Trims for sectional cabinets shall be of one-piece construction.
3. Terminal cabinets shall be furnished with 3/4 inch thick plywood. Plywood shall be fastened in place with machine screws or factory installed mounting screws.
4. Flush-mounted terminal cabinets shall be finished as specified for flush-mounted panelboard cabinets. Surface and semi-flush mounted terminal cabinets shall be finished as specified for surface-mounted panelboard cabinets.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Panelboards shall be manufactured by Siemens, General Electric, Eaton, Square D or equal.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Panelboards shall be located so they are readily accessible and not exposed to physical damage.
- B. Panelboards installed outdoors shall be specifically listed for wet locations and shall be weatherproof in NEMA Type 3R cabinets.
- C. Panelboard locations shall provide sufficient working space around panels to comply with the National Electrical Code.
- D. Panelboards shall be securely fastened to structure and mounted on surface by at least 4 points.
- E. Unused openings in cabinets shall be effectively closed as required by the manufacturer.
- F. Cabinets shall be grounded as specified in Article 250 of the National Electrical Code.
- G. Conduits shall be installed so as to prevent moisture or water from entering and accumulating within the enclosure.

- H. Lugs shall be suitable and listed for installation with the conductor being connected.
- I. Conductor lengths shall be maintained to a minimum within the wiring gutter space. Conductors shall be long enough to reach the terminal location in a manner that avoids strain on the connecting lugs.
- J. Maintain the required bending radius of conductors inside the cabinet.
- K. Clean the cabinet of foreign material such as cement, plaster, and paint.
- L. Distribute and arrange conductors neatly in the wiring gutters.
- M. Use the manufacturer's torque values to tighten lugs.
- N. Before energizing panelboards, the following steps shall be taken.
 - 1. Retighten connections to the manufacturer's torque specifications. Verify that required connections have been provided.
 - 2. Remove shipping blocks from component devices and panelboard interiors.
 - 3. Manually exercise circuit breakers to verify they operate freely.
 - 4. Remove debris from panelboard interior.
- O. Follow manufacturer's instructions for installation.
- P. Do not install in highly corrosive environments, unless rated for the application.

3.02 PROTECTION

- A. Protect the work of this section until substantial completion.

3.03 CLEANUP

- A. Remove rubbish, debris, and waste materials and legally dispose of off the project site.

END OF SECTION

SECTION 26 25 00

BUSWAYS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Materials and installation of busways.
- B. Applicable Standards: Products shall meet or exceed the latest edition of the following standards.
 - 1. NEMA BU.1
 - 2. ANSI/UL 857
 - 3. CSA
- C. No requirement of these drawings and specifications shall be construed to void any of the provisions of the above standards. Any conflicts or changes required to the contract documents in order to obtain compliance with applicable codes shall be brought to the immediate attention of the Owner Authorized Representative by the Contractor.

1.02 DESIGN REQUIREMENTS

- 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 busway shall bear a UL label.

1.03 SUBMITTALS

- A. Submit in accordance with Section 01 33 00 – Submittal Procedures.
- B. Manufacturer's product data sheets for busways, plug-in units, fittings, accessories, and supports.
- C. Busway ratings including short-circuit rating, voltage, and continuous current.
- D. Major component ratings including voltage, and continuous current, and interrupting ratings.

- E. 1/4-inch scale minimum dimensioned layout and elevation drawings showing busway, electrical ratings, elbows, offsets, tap locations, plug-in unit locations, concrete curbs, and support locations and types.
- F. The following information shall be submitted:
 - 1. The following information shall be submitted for record purposes:
 - 2. Final as-built drawings and information for items listed in Paragraph 1.04, and shall incorporate all changes made during the manufacturing process
 - 3. Certified production test reports
 - 4. Installation information
 - 5. Seismic certification and equipment anchorage details

PART 2 – PRODUCTS

2.01 BUSWAYS

- A. Busways shall be Square D, General Electric, Siemens, MGM, Cutler Hammer or owner approved equal.
- B. 208 volts, 3-phase, 4-wire with housing ground bus. Ampere ratings, approximate footage, fitting, plug-in units, etc. as indicated on the Drawings.
- C. The busways and fittings shall be braced to withstand the maximum available short circuit current indicated on the Drawings and not less than as follows:
 - 100 kA RMS symmetrical for ratings through 1350 Amp
 - 125 kA RMS symmetrical for ratings through 1600 Amp
 - 150 kA RMS symmetrical ratings through 2500 Amp
 - 200 kA RMS symmetrical for ratings through 5000 Amp.
- D. The busway and associated fittings shall consist of aluminum or copper conductors totally enclosed in a 2-piece extruded steel or aluminum housing. Provide indoor, sprinkler-proof plug-in busway. Fittings –(elbows, tees, flanges, etc.) shall be identical for use with both the plug-in and feeder types of busway. The busway shall be capable of being mounted flat-wise, edgewise, or vertically without derating. The busway shall consist of standard 10-foot sections with special sections and fittings provided to suit the installation. Horizontal runs shall be suitable for hanging on 10-foot maximum centers. Vertical runs shall be suitable for mounting on 16-foot maximum centers. Provide one (1) hanger for every ten (10) feet of horizontally mounted duct. On vertical runs provide one adjustable hanger per floor.
- E. Bus bars shall be either fabricated from high strength 55% conductivity aluminum or 98% conductivity copper, and silver-plated at all electrical contact surfaces.
- F. Bus bars shall be insulated over their entire length, except at joints and contact surfaces, with NEMA Class B (130 degrees C) rated insulating material. Tape or heat-shrink sleeve insulation, or any other method of insulation, which can allow air-gaps or insulation breakdown, shall not be acceptable.

- G. The busway shall be capable of carrying rated current continuously without exceeding a temperature rise of 55 degrees C based on a 40 degrees C ambient.
- H. Each busway section shall be furnished complete with joint hardware and covers. The busway joints shall be a single-bolt, non-rotating, removable bridge design. All bridge joints shall be furnished with torque-indicating double head joint bolts and Belleville washers. De-energization of busway shall not be required for safe testing of joint tightness.
- I. The busway housing shall be code gauge steel or aluminum, totally enclosed, non-ventilated type. The busway enclosure finish shall be ANSI 61 gray baked epoxy powder paint applied by an electrostatic process.
- J. Where required, busway shall be of the plug-in type. Plug-in busway shall be available in 10-foot lengths, with plug-in openings provided on both sides of the busway sections. Plug-in covers shall prohibit dirt and debris from entering contact plug-in openings in the busway. The design shall allow for ten (10) hinged cover outlets per ten (10) feet of plug-in length, and covers shall be field-convertible to hinge on either side. A standard housing ground connection shall be supplied in each plug-in opening.

2.02 PLUG-IN UNITS

- A. Where required, plug-in units of the types and ratings indicated on the plans and specifications shall be supplied. Plug-in units shall be mechanically interlocked with the busway housing to prevent their installation or removal while the switch is in the "ON" position. The enclosure of any plug-in unit shall make positive ground connection to the duct housing before the stabs make contact with the bus bars. All plug-in units shall be equipped with an interlock that can be defeated to prevent the cover from being opened while the switch is in the "ON" position and to prevent accidental closing of the switch while the cover is open. The plugs shall be provided with a means for padlocking the cover closed and padlocking the disconnect device in the "OFF" position.
- B. Fusible-type plugs shall have a quick-make/quick-break disconnect switch and positive pressure UL Class R fuse clips of the sizes indicated on the Drawings.

PART 3 – EXECUTION

3.01 DELIVERY AND STORAGE

- A. Deliver, storage, protect and handle products in accordance with the manufacturer's instructions.

3.02 TESTING

- A. Provide factory and field testing of busway installation in accordance with NETA specifications including:
 1. Physical inspection
 2. Torque value of joints
 3. Dielectric withstand tests
 4. Megger tests
 5. Hi-Pot tests

6. Adjustment values of spring suspension hangers

B. All tests shall be in accordance with the latest version of ANSI and NEMA standards.

3.03 INSTALLATION

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

3.04 PROTECTION

A. Protect the work of this section until substantial completion.

3.05 CLEANUP

A. Remove rubbish, debris, and waste materials and legally dispose of off project site.

END OF SECTION

SECTION 26 32 13

DIESEL ENGINE GENERATOR

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Packaged engine-generator set for Emergency Power supply with the following features:
1. Diesel engine.
 2. Unit-mounted cooling system.
 3. Unit-mounted control and monitoring.
 4. Performance requirements for sensitive loads.
 5. Air Discharge Silencer.
 6. Critical Grade Exhaust Muffler.

1.02 DEFINITIONS

- A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.03 EQUIPMENT SUBMITTALS

- A. Submit in accordance with Section 01 33 00 – Submittal Procedures.
- B. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
1. Thermal damage curve for generator.
 2. Time-current characteristic curves for generator protective device.
- C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
 2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
 4. Wiring Diagrams: Power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

- A. Manufacturer Seismic Qualification Certification: Submit certification that belly tank, complete engine-generator set, batteries, battery racks, accessories, and components will withstand seismic forces per IBC requirements. Equipment Importance Factor = 1.5 shall be the basis of the equipment IBC Certification.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Qualification Data:
 - 1. This generator shall be Caterpillar or approved equal by Cummins or MTU, who has been regularly engaged in the production of engine-generator sets and associated controls for a minimum of ten years in Hawaii, thereby identifying one source of supply and responsibility. EQUAL means, having the same system configuration, operation, footprint of the genset, SKVA rating, fuel consumption, exhaust emissions, same sound emission data of the genset with same sizing solution.
 - 2. The manufacturer shall provide factory-trained service and parts support through a factory authorized dealer/supplier that is regularly doing business within 50 miles in the area of the installation.
 - 3. The manufacturer shall have printed literature and brochures describing the standard system specified, not a one of a kind fabrication.
 - 4. As part of qualification process; an authorized dealer/supplier, herein known as the dealer shall represent the manufacturer. To qualify as the dealer/supplier, it must be a full product line sales and service dealer and shall have 24-hour service availability. The dealer/supplier must have certified generator service technicians, inventory of parts to support after sales service and can prove 10 years of experience in the engine generator field.
- C. Source Quality-Control Test Reports:
 - 1. Certified summary of prototype-unit test report.
 - 2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
 - 3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
 - 4. Report of factory test on units to be shipped for this project, showing evidence of compliance with specified requirements.
 - 5. Report of exhaust emissions showing compliance with applicable regulations.
 - 6. Certified Torsional Vibration Compatibility: Comply with NFPA 110.
 - 7. Field quality-control test reports.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals include the following:
 - 1. List of tools and replacement items recommended being stored at project for ready access.
 - 2. Include part and drawing numbers, current unit prices, and source of supply.

1.06 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
 - 2. Belts: One set of each alternator and fan belt

1.07 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this project.
 - 1. Maintenance Proximity: Not more than two (2) hours' normal travel time from Installer's place of business to project site.
 - 2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including shop drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this project.
- B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 50 miles of project site, a service center capable of providing training, parts, and emergency maintenance repairs.
- C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with ASME B15.1.
- F. Comply with NFPA 37.
- G. Comply with NFPA 70.
- H. Comply with NFPA 99.
- I. Comply with NFPA 110 requirements for emergency power supply system.
- J. Comply with UL 2200.
- K. Engine Exhaust Emissions: Comply with applicable state and local government requirements.
- L. The emergency generator system shall comply with the following codes and standards: NFPA Codes and related adoptions (amendments) by the State of Hawaii, City of Honolulu, IEEE Standards, Environmental Protection Agency (EPA) Emission Standards, and ANSI/NEMA standards.

1.08 PROJECT CONDITIONS

A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: 40 deg C
2. Relative Humidity: 0 to 95 percent.
3. Altitude: Sea level to 500 feet.

1.09 COORDINATION

A. Coordinate size and location of concrete bases for package engine generators and radiator mounted on grade. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators, associated auxiliary components and instrumentation panel, that fail in materials or workmanship, free of charge within specified warranty period.
- B. Warranty Period: Five (5) years/3,000 hours comprehensive extended warranty from date of substantial completion. Engine generator set parts and labor for sixty (60) months or 3,000 operation hours will begin with the first commissioning of the product.

1.11 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include semi-annual exercising to check for proper starting, load transfer, and running under load. One (1) visit to provide load bank testing. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. The generator shall be Caterpillar or approved equal by Cummins or MTU with dimension fitting the building design configuration.

2.02 ENGINE-GENERATOR SET

- A. Factory-assembled and -tested, engine-generator set.
- B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
- C. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of

gravity.

D. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated. Minimum performance basis must meet at a minimum a Load Factor of 85%.
2. Output Connections: Three-phase, 4-wire.
3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

E. Generator-Set Performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics.
7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time: Comply with NFPA 110, Type 10, system requirements.

F. Generator-Set Performance for Sensitive Loads:

1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.
2. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.
3. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
4. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
5. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
6. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
7. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
8. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined

- according to NEMA MG 1, shall not exceed 50 percent.
- 9. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.
 - 10. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.
 - 11. Provide permanent magnet excitation for power source to voltage regulator.
 - 12. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.03 ENGINE

- A. Fuel: Fuel oil, Diesel Grade DF-2.
- B. Rated Engine Speed: 1800 rpm.
- C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm (11.4 m/s).
- D. Lubrication System: The following items are mounted on engine or skid.
 - 1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
 - 2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
 - 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- E. Engine Fuel System:
 - 1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
 - 2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
- F. Coolant Jacket Heater: Thermal circulation type water heater with integral thermostatic control, 6000 watts sized to maintain engine jacket water at 90 degrees and suitable for operation on 208VAC single phase. Comply with NFPA 110 requirements for heater capacity.
- G. Governor: Electronic Control Module (ECM), with 24 volt control of the high pressure common rail fuel injection system.
 - 1. The ECM shall be enclosed in an environmentally sealed, die cast aluminum housing which isolates and protects electronic components from moisture and dirt contamination. Speed droop shall be adjustable from 0 (isochronous) to 10%, from no load to full rated load. Steady state frequency regulation shall be +/- 0.25%. A provision for remote speed adjustment shall be included.
 - 2. The ECM shall adjust fuel delivery according to exhaust smoke, altitude and cold mode limits. In the event of a DC power loss, the forward acting actuator will move to the minimum fuel position.
- H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
 - 1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water,

- with anticorrosion additives as recommended by engine manufacturer.
- 2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
- 3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
- 4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
- 5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
 - a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180° F (82° C), and non-collapsible under vacuum.
 - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
- I. Critical Grade Silencer: Performance of the filter/silencer shall provide minimum reductions; Exhaust Sound Reduction to 60dBA @ 23 feet.
- J. Air-Intake Filter: Standard-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
- K. Starting System: 24-V electric, with negative ground.
 - 1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
 - 2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
 - 3. Cranking Cycle: As required by NFPA 110 for system level specified.
 - 4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least three times without recharging.
 - 5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
 - 6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
 - 7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
 - 8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:
 - a. Operation: Equalizing-charging rate of 20 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
 - b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
 - c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.

- d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
- e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
- f. Enclosure and Mounting: NEMA 250, Type 1, cabinet.

2.04 FUEL OIL STORAGE

- A. Comply with NFPA 30.
- B. Base-Mounted Fuel Oil Tank: Comply with City and State standard, UL 142, sub-base, factory-fabricated fuel tank assembly, with 600-gallon capacity. Features including the following:
 - 1. Containment: Dual-wall with emergency tank and rupture basin vents.
 - 2. Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of tank leak.
 - 3. Tank Capacity: As recommended by engine manufacturer for an uninterrupted period of 8 hours' operation at 100 percent of rated power output of engine-generator system without being refilled.
 - 4. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel supply pump at 110 percent of rated capacity, including fuel returned from engine.
 - 5. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.
 - 6. High-Level Alarm Sensor: Liquid-level device operates alarm and redundant fuel shutoff contacts at midpoint between overflow level and 100 percent of normal fuel level.
 - 7. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, vent line, overflow line; and tank drain line with shutoff valve.

2.05 CONTROL AND MONITORING

- A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.
- B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.
- C. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set

vibration.

D. Digital Generator Controller:

1. Generator Mounted Control Panel: Provide a generator mounted control panel includes communication via Ethernet for complete control and monitoring of the engine and generator set functions.
2. The gen-set shall have capability to incorporate broader communications network and shall have communication capability for USB, RS485 using Modbus (Slave), SAE J1939 engine ECU capability and separate RS485 for providing communications to a remote display panel for NFPA-110 indication.
3. Generator Control Panel Protection Features: KWH/KVARH meter, Engine (Over speed, battery over/under voltage, auxiliary excitation & speed/frequency mismatch), Generator (over/under voltage, over/under frequency, unbalanced voltage, dead bus detection, overload, reverse/reduced power, definite over current and time over current, inverse time over current, measured ground fault, phase rotation), Mains (load, frequency, voltage, phase shift, active/reactive power).

E. Indicating and Protective Devices and Controls:

1. Engine-coolant temperature gage.
2. Engine lubricating-oil pressure gage.
3. Running-time meter.
4. Ammeter-voltmeter, phase-selector with LCD display.
5. Generator-voltage adjusting rheostat.
6. Start-stop switch.
7. Over speed shutdown device.
8. Coolant high-temperature shutdown device.
9. Coolant low-level shutdown device.
10. Oil low-pressure shutdown device.
11. Fuel tank derangement alarm.
12. Fuel tank high-level shutdown of fuel supply alarm.
13. Generator overload.

F. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

G. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals.

H. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.

1. Over crank shutdown.
2. Coolant low-temperature alarm.
3. Control switch not in auto position.
4. Battery-charger malfunction alarm.
5. Battery low-voltage alarm.

I. Common Remote Audible Alarm: Signal the occurrence of any events listed below without differentiating between event types. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset.

1. Engine high-temperature shutdown.
 2. Lube-oil, low-pressure shutdown.
 3. Over speed shutdown.
 4. Remote emergency-stop shutdown.
 5. Engine high-temperature pre-alarm.
 6. Lube-oil, low-pressure pre-alarm.
 7. Fuel tank, low-fuel level.
 8. Low coolant level.
- J. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface-or flush-mounting type to suit mounting conditions indicated.
- K. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.06 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Circuit Breaker: GE Power Break II Insulated case type; 100 percent rated; complying with NEMA AB 1 and UL 489.
1. Tripping Characteristic: Designed specifically for generator protection.
 2. Trip Rating: Matched to generator rating.
 3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
 4. Mounting: Adjacent to or integrated with control and monitoring panel.
- B. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:
1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
 2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
 3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
 4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.
- C. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

2.07 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H or Class F.
- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, over speed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- F. Instrument Transformers: Mounted within generator enclosure.
- G. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.
- H. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- I. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- J. Sub transient Reactance: 12 percent, maximum.

2.08 ENCLOSURE

- A. Open Unit

2.09 VIBRATION ISOLATION DEVICES

- A. Restrained Spring Isolators: Freestanding, steel, Caldyn or VMC Group open-spring isolators with seismic restraint.
 - 1. Housing: Steel with resilient vertical-limit stops to prevent spring over extension.
 - 2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
 - 3. Minimum Additional Travel: 50 percent of required deflection at rated load.
 - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.10 FINISHES

- A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.11 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

- B. Project-Specific Equipment Tests: Factory test engine-generator set and other system components and accessories manufactured specifically for this project. Perform tests at rated load and power factor. Include the following tests:
1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
 2. Full load run.
 3. Maximum power.
 4. Voltage regulation.
 5. Transient and steady-state governing.
 6. Single-step load pickup.
 7. Safety shutdown.
 8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
 9. Report factory test results within 10 days of completion of test.

PART 3 – EXECUTION

3.01 PERMITS

- A. Provide all required documentation and obtain from the City of Honolulu and from any other regulatory agency having jurisdiction all necessary permits to construct and operate the diesel generator.
- B. Pay all fees or costs associated with obtaining the construction and operations permit(s); provide all labor necessary to demonstrate full compliance with all applicable codes and regulations to secure and deliver a valid permit to operate the installed generator. Permit(s) shall be secured at start of construction.

3.02 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.
- B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 INSTALLATION

- A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.
- B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- C. Install packaged engine generator with vibration spring isolators having a minimum deflection

of 1.07 inch on 10-inch high concrete base. Secure sets to anchor bolts installed in concrete bases.

- D. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.04 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.
- B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.
- C. Connect cooling-system water piping to engine-generator set and radiator with flexible connectors.
- D. Connect engine exhaust pipe to engine with flexible connector.
- E. Connect fuel piping to engines with a gate valve and union and flexible connector.
- F. Ground equipment according to Section 26 05 26 - Grounding and Bonding.
- G. Connect wiring according to Section 26 05 19 - Low-Voltage Wires.

3.05 IDENTIFICATION

- A. Identify system components according to Section 20 00 00 – Mechanical Basic Materials and Methods and Section 26 05 00 – Electrical Basic Materials and Methods.

3.06 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems". Certify compliance with test parameters.
 2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
 3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
 - a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
 - b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.

- c. Verify acceptance of charge for each element of the battery after discharge.
- d. Verify that measurements are within manufacturer's specifications.
- 4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
- 5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
- 6. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
- D. Conduct test using building load by simulating utility failure.
- E. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.
- F. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- G. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
- H. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- I. Remove and replace malfunctioning units and retest as specified above.
- J. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- K. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.07 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

END OF SECTION

SECTION 26 36 23

AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Materials and installation of automatic transfer switches.

1.02 SUBMITTALS

- A. Submit in accordance with Section 01 33 00 – Submittal Procedures.
- B. Shop Drawings: Include make, catalog number, dimensions, weight, KVA Rating, % Impedance, finish, type, insulation class, design temperature, sound levels, efficiency and taps provided.
- C. Submit manufacturer's descriptive data including ratings, circuit diagrams, dimensional data, conduit entry restrictions, and a list of accessories.

1.03 MANUFACTURER'S SERVICES

- A. Provide manufacturer's services at the jobsite for the minimum of two man-days, travel time excluded. Two man-days to check the installation, supervise start-up, and supervise testing and adjustments of the transfer switches.

1.04 QUALITY ASSURANCE

- A. The automatic transfer switch shall be in conformance with the following standards.
 1. UL 1008: Underwriters Laboratories standard for automatic transfer switches.
 2. CSA: C22.2 No. 178 certified at 600 VAC.
 3. IEC: 947-6-1 certified at 480 VAC.
 4. NFPA 70: National Electrical Code.
 5. NFPA 101: Life Safety Code.
 6. NFPA 110: Standard for emergency and standby power systems.
 7. IEEE 241: I.E.E.E. recommended practice for electrical power systems in commercial buildings
 8. IEEE 446: I.E.E.E. recommended practice for emergency and standby power systems
 9. NEMA ICS10: AC automatic transfer switch equipment
 10. UL 50/508: Enclosures
 11. ICS 6: Enclosures
 12. ANSI C33.76: Enclosures
 13. NEMA 250: Enclosures
 14. IEEE 472: (ANSI C37.90A). Ringing wave immunity.

PART 2 – MATERIALS

2.01 TRANSFER SWITCH

- A. Transfer switch shall be open type and installed in a NEMA-1 standalone enclosure meeting Honolulu seismic zone requirements. Transfer switch shall have number of poles, amperage, and voltage ratings as shown in the drawings. Withstand current rating shall not be less than 100,000-ampere rms symmetrical.
- B. Switch shall be listed per UL 1008 as a recognized component for emergency systems and rated for all classes of loads.
- C. Transfer switch shall be electrically operated and mechanically held in each direction by a single operating mechanism momentarily energized from the source to which the load shall be transferred. Total operating transfer time shall not exceed one-sixth of a second.
- D. Operation shall be inherently double throw where normal and emergency contacts operate simultaneously with no momentary delay in a midposition. An overload or short circuit shall not cause the switch to go to a neutral position. Do not use main contact structures not originally manufactured for transfer switch service (molded case circuit breakers or contactors). Inspection and replacement of all contacts (stationary and arcing) shall be possible from the front of the switch without any disassembly of operating linkages or power conductors. Provide a handle to permit no-load manual operation.

2.02 ACCESSORIES

- A. Provide a solid-state sensing and control logic panel. Include the following operational characteristics:
 1. Adjustable (0.5 to 6.0 seconds) time delay on engine starting to override momentary dips in normal source, set at 1 second.
 2. Full phase voltage relay supervision of the normal source with at least one close differential relay to detect "brownout" condition, set at 70% dropout and 90% pickup.
 3. Voltage/frequency lockout relay to prevent premature transfer, set at 90% voltage and 90% frequency.
 4. Engine starting control contacts (one normally open and one normally closed).
 5. Adjustable (2 to 25 minutes) time delay on retransfer to normal, set at 15 minutes.
 6. Unloaded running time delay for generator cool down (adjustable 0.1 to 10 minutes), set at 5 minutes.
 7. Transfer to emergency time delay (adjustable 1 to 300 seconds), set at 1 second.
- B. Provide a system test switch (momentary type) on the front of the enclosure.
- C. Manual push button to bypass the time delay on retransfer.
- D. Pilot lights to indicate source to which the load is connected.
- E. Pilot light to indicate presence of normal power source.
- F. Provide pre-transfer auxiliary contact.
- G. Auxiliary contacts for remote indication of switch position, one normally open and one

normally closed contact for normal and emergency position.

- H. The complete assembly including anchors shall be capable of withstanding seismic forces per International Building Code meeting Honolulu seismic zone criteria.

- I. Provide serial communication capability.

2.03 MANUFACTURERS

- A. The transfer switch shall be Asco or approved equal by generator manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install transfer switch in switchboard. Secure transfer switch rigidly to mounting pad with anchor bolts or Phillips Drill Company concrete anchors. Anchor bolts or concrete anchors shall be carbon steel per ASTM A 307, Grade B.

3.02 TESTING

- A. Perform electrical inspection and testing per requirements addressed under Division 26 - Electrical.

END OF SECTION

SECTION 26 50 00

LIGHTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Furnishing and installing lighting fixtures, including lamps, ballasts, wiring, and lighting controls. Light fixtures model numbers were determined at the time this specification was written; model numbers may need to be modified, or may require the addition or deletion of options to fully meet specification requirements.

1.02 SUBMITTALS

- A. Submit in accordance with Section 01 33 00 – Submittal Procedures.
- B. List of Materials: Submit a complete list of materials proposed for this section.
- C. Shop Drawings: Provide detailed and dimensioned shop drawings indicating kind, weight and thickness of materials, method of fitting and fastening parts together, location and number of sockets, size of lamps, and complete details of method of fitting suspension and fastening fixtures in place. Provide wiring diagrams for lighting control equipment. Drawings shall contain sufficient information to assemble and install equipment at the project site without further instructions.
- D. Prior to start of construction; provide photometric calculations with graphic of luminance levels of work plane, ceiling and walls of each representative classroom, library and multipurpose room. Calculations shall comply with IESNA recommendations.
- E. Installation Instructions: Submit manufacturer's written installation instructions for fixtures and accessories.
- F. Light fixtures shall be Underwriters Laboratory (UL) or Nationally Recognized Testing Laboratory (NRTL) listed, and in compliance with applicable industry standards and codes.
- G. Submittals must comply with contract general provisions.

1.03 MOUNTING REQUIREMENTS

- A. Design of lighting fixtures, accessories, supports, and method of fixture installation shall comply with requirements for earthquake-resistant construction of Oahu, Hawaii.
- B. Provide suspension points at no more than 2 feet from fixture ends. Spacing between supports shall not exceed 8 feet.

1.04 QUALITY ASSURANCE

A. Components and fixtures shall be listed and approved for the intended application by Underwriter's Laboratories (UL), or other Nationally Recognized Testing Laboratory (NRTL).

B. Owner's approval shall be obtained for any equipment or materials substitutions.

1.05 GUARANTEE

A. Length of Guarantee: Guarantee materials and workmanship for a period of one year from date of final acceptance for the project or through one entire system operating season if this exceeds year date.

B. Guarantee Includes: All material and labor to repair or replace defective items within any system, and extends to material and labor required to repair adjacent surfaces disturbed by malfunction.

PART 2 – PRODUCTS

2.01 MATERIAL AND FABRICATION

- A. Lighting fixtures shall be the type indicated on drawings and as specified. Fixtures of same type shall be of one manufacturer.
- B. Fixtures shall be of the types and manufacturers described in the "FIXTURE TYPES" section below, with lamps, wattage and voltage as indicated on drawings. Specific manufacturer and model number references are indicated as a standard of performance and quality; other manufacturers' models may be supplied provided the product meets or exceeds the specifications. The alternate fixtures must achieve the same photometric levels and uniformity ratios.
- C. All fixtures shall be baked-on enamel or powder-coated, unless otherwise specified in subsections below.
- D. Fluorescent fixtures shall be equipped with low or tall profile, medium Bi-Pin fluorescent lamp holders of high-strength, and quickwire pressure terminals with recessed wire wells to insulate against shorting. Lamp holders shall be manufactured of chemical-resistant thermoplastic body and be equipped with a captive nut.
- E. Lighting fixtures shall have a minimum luminaire efficiency rating (LER) equal or greater than 75 unless approved by the architect.

2.02 LIGHT FIXTURES, LAMPS AND BALLASTS

- A. Fluorescent Lamps and LED shall have minimum output of 75 lumens per watt and color rendering index (CRI) better than 82. Comply with requirements of all governing State and City & County Codes and Standards. Provide products and equipment which comply with all governing State and City & County Codes and Standards, including the Energy Code as adopted by the City. Provide products which meet or exceed criteria for meeting Hawaii Energy Rebate program standards. All electric powered equipment and electrical devices

- shall be listed by UL or comparable listing agency.
- B. Provide all required fixture mounting accessories.
 - C. Manufacturers shall be per lighting fixture schedule or approved equal.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Install a lighting fixture for each lighting outlet indicated and mark new ballasts with day of installation.
- B. Fixture voltage shall be as indicated on drawings.
- C. Install recessed and surface-mounted fixtures, with plaster frames compatible with ceiling and wall systems employed; secure fixtures mechanically to frames.
- D. Align rows of suspended and surface-mounted fluorescent fixtures to form straight lines at uniform elevations.
- E. Recessed fixtures shall fit snugly against ceilings to prevent light leakage.
- F. All fixture installations shall comply with Oahu seismic requirements.
- G. Emergency light fixtures shall be labeled “Emergency Fixture” with 1 inch high letters produced with a P-touch or similar labeling system.
- H. Surface mount fixtures shall be attached to structure. Toggle bolts are NOT permitted. Provide backing where required.

3.02 TESTING

- A. Check and adjust fixtures for required illumination.
- B. Replace defective lamps and ballasts.
- C. Test and adjust lighting control equipment for proper operation.

3.03 TRAINING

- A. Training and education of lighting and control systems shall be provided by Contractor to the Owner's Representatives.
- B. Equipment material specifications and written training manuals shall be provided to Owner's Representatives.

3.04 SPARE PARTS

- A. Furnish 10 percent spare lamps with a minimum of one spare lamp of each type.
- B. Furnish 10 percent spare motion detectors of each type with a minimum of one spare detector of each type.
- C. Furnish 10 percent spare ballasts of each type with a minimum one spare ballast of each type.

3.05 PROTECTION

- A. Protect the work of this section until substantial completion.

3.06 CLEANUP

- A. Remove rubbish, debris, and waste materials from all areas of work each day.
- B. Clean fixture surfaces of dirt, cement, plaster and debris. Furnish cleansers compatible with material surfaces being cleaned.

3.07 HAZARDOUS WASTE DISPOSAL

- A. All hazardous waste disposals shall be handled and disposed of by an approved, licensed contractor.
- B. Any and all ballasts are assumed to contain PCB unless clearly marked "NO PCB."
- C. Place ballasts and lamps in appropriate containers provided by hazardous waste contractor labeled clearly with:
 1. Project Name.
 2. Quantity of Lamps.
 3. Date Lamps Became Waste.
- D. Store, remove, transport and dispose of hazardous materials in all accordance with state and federal regulations.
- E. Provide Owner with copy of manifest and certificate of destruction.

END OF SECTION

SECTION 26 01 00

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY:

Section Includes: The basic requirements for electrical installations and includes requirements common to more than one section of DIVISION 26 - ELECTRICAL.

1.02 BASIC ELECTRICAL REQUIREMENTS:

A. Quality :

1. Workers possessing the skills and experience obtained in performing work of similar scope and complexity shall perform the work of this Division.
2. Refer to other sections of the specifications for other qualification requirements.

B. Drawings and Specifications Coordination:

1. For purposes of clearness and legibility, drawings are essentially diagrammatic and the size and location of equipment is indicated to scale whenever possible. Verify conditions, dimensions, indicated equipment sizes, and manufacturer's data and information as necessary to install the work of this Division. Coordinate location and layout with other work.
2. Verify final locations for rough-ins with field measurements and with the requirements of the equipment to be connected.
3. Drawings indicate required size and points of termination of conduits, number and size of conductors, and diagrammatic routing of conduits. Install conduits with minimum number of bends to conform to structure, avoid obstructions, preserve headroom, keep openings and passageways clear, and comply with applicable code requirements.
4. Routing of conduits may be changed, provide additional conduits, wiring and pull boxes as required.
5. Outlet locations shall be coordinated with architectural elements prior to start of construction. Locations indicated on the drawings may be distorted for clarity.
6. Coordinate electrical equipment and materials installation with building components and the work of other trades.
7. As much as practical, connect equipment for ease of disconnecting, with minimum interference with other installations.
8. Coordinate connection of electrical systems with existing underground utilities and services.
9. Contractor shall provide as-built record drawings using AutoCAD 2014 software and submit all electronic files to owner with 2 sets of compact disks.

C. Terminology:

1. Signal Systems: Applies to clock, bell, fire alarm, annunciator, sound, public address, buzzer, telephone, television, inter-communication, elevator access controls, lighting control systems and security systems.
2. Low Voltage: Applies to signal systems operating at 120 volts and less, and power systems operating at less than 600 volts.

3. Medium Voltage: Applies to power systems operating at more than 600 volts.
 4. UL: Underwriter's Laboratories Inc, Nationally Recognized Testing Laboratory (NRTL), or equal.
- D. Regulations: Comply with requirements of all governing State and City & County Codes and Standards. Provide products and equipment which comply with all governing State and City & County Codes and Standards, including the Energy Code as adopted by the City. Provide products which meet or exceed criteria for meeting Hawaii Energy Rebate program standards. All electric powered equipment and electrical devices shall be listed by UL or comparable listing agency.
- E. Structural Considerations for Conduit Routing:
1. Coordinate with structural engineer, where conduits pass through or interfere with any structural member, or where notching, boring or cutting of the structure is necessary, or where special openings are required through walls, floors, footings, or other building elements.
 2. Coordinate with structural engineer, where a concrete encasement for underground conduit abuts a foundation wall or underground structure which conduits enter.
- F. Electrically Operated Equipment and Appliances:
1. Furnished Equipment and Appliances:
 - a. Work shall include furnishing and installing wiring enclosures for, and the complete connection of electrically operated equipment and appliances and electrical control devices which are specified to be furnished and installed in this or other sections of the specifications, wiring enclosures shall be concealed whenever possible.
 - b. Connections shall be provided as necessary to install equipment ready for use. Equipment shall be tested for proper operation and, if motorized, for proper rotation.
 2. Equipment and Appliances Furnished by Others:
 - a. Equipment and appliances indicated on drawings as "not in contract" (NIC), "furnished by others," or "furnished by the Owner," will be delivered to the project site and installed by the supplying contractor. Required electrical connections shall be performed for such equipment and appliances. Motorized equipment will be furnished with one point electrical connection with pre-wired integrally mounted variable frequency drives, breakers, starters and smoke detectors. Appliances will be furnished equipped with pre-wired portable cord and cap. Provide disconnect switches where required by National Electric Code (NEC).
 - b. Connections to equipment furnished under this Division shall be part of the work of this section. Work shall include furnishing and installing suitable outlets, disconnecting devices, push-button stations, selector switches, conduit, junction boxes, and wiring necessary for a complete electrical installation.
 - c. Electrical equipment furnished under other sections, for installation and connection under work of this section, will be delivered to the Project site ready for installation.
 - d. Mechanical equipment furnished under other sections, and requiring electrical connection under this section, will be set in place as part of the work of the section furnishing such equipment unless noted otherwise. Mechanical equipment will be furnished with one point electrical connection with pre-wired integrally mounted variable frequency drives, breakers, starters and smoke detectors. Co-ordinate with mechanical contractor for equipment configuration.
- G. Cleaning:

1. Exposed parts of work shall be left in a neat, clean, usable condition.
2. Apparatus, fixtures and equipment shall be furnished new with factory finish.

1.03 WARRANTIES:

- A. Provide one year warranty on all work performed, unless noted otherwise in specific sections.

PART 2 – PRODUCTS

2.01 EQUIPMENT AND MATERIALS

- A. Provide products and materials that are new, clean, free of defects, and free of damage and corrosion.
- B. Products and materials shall not contain asbestos, PCB, or any other material that is considered hazardous by the Environmental Protection Agency or any other Authority having jurisdiction.
- C. Replace materials of less than specified quality and relocate work incorrectly installed as directed by the Architect at no additional cost to the Owner.
- D. Provide name/data plates on major components of equipment with manufacturer's name, model number, serial number, capacity data, and electrical characteristics attached in a conspicuous place.
- E. Install materials and equipment with qualified trades people.
- F. Maintain uniformity of manufacturer for equipment used in similar applications and sizes.
- G. Fully lubricate equipment where required.
- H. Follow manufacturer's instructions for installing, connecting, and adjusting equipment. Provide a copy of such instructions at the equipment during installation.
- I. Where factory testing of equipment is required to ascertain performance and attendance by the Owner's representative is required to witness such tests, associated travel costs and subsistence shall be paid for by the Contractor.
- J. Equipment capacities, ratings, etc., are scheduled or specified for job site operating conditions. Equipment sensitive to altitude shall be derated with the method of derating identified on the submittals.
- K. Enclosures for electrical equipment installed in mechanical equipment rooms shall be NEMA type 1 gasketed. Enclosures for electrical equipment installed outdoors shall be NEMA type 3R.
- L. Energy consuming equipment shall be certified for use in the State of Hawaii and shall meet the Hawaii Energy Code and local energy ordinances.

2.02 SUBSTITUTIONS

- A. Contract Documents are based on equipment manufacturers as called out in the specifications and indicated on the drawings. Acceptance of substitute equipment manufacturers does not relieve the Contractor of the responsibility to provide equipment and materials, which meet the performance as stated or implied in the Contract Documents.
- B. Submit proposals to provide substitute materials or equipment, in writing, with sufficient lead time for review prior to the date equipment must be ordered to maintain project schedule. Reimburse Owner for costs associated with the review of the proposed substitution whether substitution is accepted or rejected.
- C. Indicate revisions required to adapt substitutions including revisions by other trades. Substitutions that increase the cost of the work and related trades are not permitted.
- D. The proposed substitution shall conform to the size, ratings, and operating characteristics of the equipment or systems as specified and shown on the Drawings.
- E. Proposals for substitutions shall include the following information:
 1. A description of the difference between the Contract Document requirements and that of the substitution, the comparative features of each, and the effect of the change on the end result performance. Include the impact of all changes on other contractors and acknowledge the inclusion of additional costs to the other trades.
 2. Schematic drawings and details.
 3. List of revisions to the Contract Documents that must be made if the substitution is accepted.
 4. Estimate of costs the Owner may incur in implementing the substitution, such as test, evaluation, operating and support costs.
 5. Statement of the time by which a Contract modification accepting the substitution must be issued, noting any effect on the Contract completion time or the delivery schedule.
 6. A statement indicating the reduction to the Contract price if the Owner accepts the substitution. Include required modifications to all related trades.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Coordinate and schedule required electrical inspections.
- B. If required, coordinate painting of exposed conduits to match the surfaces adjacent to installation.
- C. Salvaged materials removed from buildings shall be removed from the project site as required by the Owner's authorized representative.
- D. Trenches outside of barricade limits shall be backfilled and paved after being inspected by Inspector.
- E. Coordinate approval with structural engineer, where existing structural walls are cored for new conduit runs. All coring to be laid out and reviewed by Architect prior to drilling. Contractor to coordinate location of structural steel, rebar, stress cabling or similar prior to layout.

- F. Electrical equipment shall be braced and anchored per Oahu seismic requirements, or as otherwise indicated on the drawings.

3.02 FEES AND PERMITS

- A. Pay all required fees and obtain all required permits related to the electrical installation.
- B. Pay royalties or fees in connection with the use of patented devices and systems.
- C. Provide controlled inspection where required by authorities having jurisdiction or by these specifications.

3.03 SUBMITTALS AND REVIEWS

- A. Submit shop drawings, manufacturer's product data sheets, samples, and test reports as specified.
- B. Switchgear manufacturer shall provide short circuit analysis, protective device coordination study, arc flash analysis and all code required labels for approval prior to equipment delivery.
- C. Within two months after notice to proceed by the Owner or Owner's Representative, or after execution of Owner/Contractor Agreement, submit a complete typed list of all electrical equipment manufacturers and material suppliers for the equipment proposed to be provided on this project, as well as, names of all subcontractors.
- D. Within four months after notice to proceed by the Owner or Owner's Representative, or after execution of Owner/Contractor Agreement, prepare an index of all submittals for the project. Include a submittal identification number, a cross-reference to the specification sections or drawing number, and an item description. Prefix the submittal identification number by the specification sections to which they apply. Indicate on each submittal, the submittal identification number in addition to the other data specified. All subcontractors shall utilize the assigned submittal identification number.
- E. After the Contract is awarded, obtain complete shop drawings, product data and samples from the manufacturers, suppliers, vendors, and all subcontractors, for all materials and equipment as specified. Submit data and details of such materials and equipment for review. Prior to submission, certify that the shop drawings, product data and samples are in compliance with the Contract Documents. Check all materials and equipment upon their arrival on the job site and verify their compliance with the Contract Documents. Modify any work, which proceeds prior to receiving accepted shop drawings as required to comply with the Contract Documents and the shop drawings.
- F. Review of submittals is for general compliance with the design concept and Contract Documents. Comments or absence of comments shall not relieve the Contractor from compliance with the Contract Documents. The Contractor remains solely responsible for details and accuracy, for confirming and correlating all quantities and dimensions, for selecting fabrication processes, for techniques of construction, for performing the work in a safe manner, and for coordinating the work with that of other trades.
- G. No part of the work shall be started in the shop or in the field until the shop drawings and

samples for that portion of the work have been submitted and accepted.

- H. A minimum period of ten working days, exclusive of transmittal time, will be required in the Engineer's office each time a shop drawing, product data and/or samples are submitted for review. This time period must be considered by the Contractor in the scheduling of the work.
- I. Submit materials and equipment by manufacturer, trade name and model number. Include copies of applicable brochure or catalog material. Maintenance and operating manuals are not acceptable substitutes for shop drawings.
- J. Identify each sheet of printed submittal pages (using arrows, underlining, or circling) to show applicable sizes, types, model numbers, ratings, capacities, and options actually being proposed. Cross out non-applicable information. Note specified features such as materials or paint finishes.
- K. Include dimensional data for roughing in and installation and technical data sufficient to verify that equipment meets the requirements of the Contract Documents. Include wiring, piping, and service connection data.
- L. Maintain a complete set of reviewed and stamped shop drawings and product data on site.
- M. For each room or area of the building containing electrical equipment, submit the following:
 - 1. Floor Plans: Plan and elevation layout drawings indicating the equipment in the exact location in which it is intended to be installed. These plans shall be of a scale not less than 1/4 inch to 1 foot. They shall be prepared in the following manner:
 - a. Indicate the physical boundaries of the space including door swings and ceiling heights and ceiling types (as applicable).
 - b. Illustrate all electrical equipment proposed to be contained therein. Include top and bottom elevations of all electrical equipment. The Drawings shall be prepared utilizing the dimensions contained in the individual equipment submittals. Indicate code and manufacturer's required clearances.
 - c. Illustrate all other equipment therein such as conduits, detectors, luminaries, ducts, registers, pull boxes, wireways, structural elements, etc.
 - d. Indicate the operating weight of each piece of equipment.
 - e. Indicate the heat release from each piece of electrical equipment in terms of BTU per hour. This information shall be that which is supplied by the respective manufacturers.
 - f. Illustrate concrete pads, curbs, etc.
 - g. Indicate dimensions to confirm compliance with code-required clearances.
 - h. Indicate maximum normal allowable operating temperature for each piece of equipment (as per each respective manufacturer's recommendation).
 - i. Equipment removal routes.
- N. The work described in shop drawing submissions shall be carefully checked by all trades for clearances (including those required for maintenance and servicing), field conditions, maintenance of architectural conditions and coordination with other trades on the job. Each submitted shop drawing shall include a certification that related job conditions have been checked by the Contractor and each Subcontractor and that conflicts do not exist.
- O. The Contractor is not relieved of the responsibility for dimensions or errors that may be contained on submissions, or for deviations from the requirements of the Contract Documents.

The noting of some errors but overlooking others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the shop drawings, product data and samples, the Contract Documents govern the work and are neither waived nor superceded in any way by the review of shop drawings, product data and samples.

- P. Inadequate or incomplete shop drawings, product data and/or samples will not be reviewed and will be returned to the Contractor for resubmittal.
- Q. Indicate the following on the lower right hand corner of each shop drawing and on the front cover of each product data brochure cover: The submittal identification number; title of the sheet or brochure; name and location of the project; names of the Architect, Engineer, Contractor, Subcontractor, manufacturer, supplier, and vendor; the date of submittal; and the date of each correction, version and revision. Number all pages and drawings in product data brochures consecutively from beginning to end. Unless the above information is included, the submittal will be returned for resubmission. Resubmittals of product data or brochures shall include a cover letter summarizing the corrections made in response to the review comments.
- R. The distribution equipment, short circuit and coordination study, and room layout submittals shall be submitted concurrently. Failure to submit concurrently may result in the immediate return of the submittal marked "REVISE AND RESUBMIT".

3.04 COORDINATION OF WORK

- A. The Contract Documents establish scope, materials and quality but are not detailed installation instructions. Drawings are diagrammatic.
- B. Coordinate work with related trades and furnish, in writing, any information necessary to permit the work of related trades to be installed satisfactorily and with the least possible conflict or delay.
- C. The electrical drawings show the general arrangement of equipment and appurtenances. Follow these drawings as closely as the actual construction and the work of other trades will permit. Provide offsets, fittings, and accessories, which may be required but not shown on the Drawings. Investigate the site, and review drawings of other trades to determine conditions affecting the work, and provide such work and accessories as may be required to accommodate such conditions.
- D. The locations of lighting fixtures, outlets, panels and other equipment indicated on the Drawings are approximately correct, but they are understood to be subject to such revision as may be found necessary or desirable at the time the work is installed in consequence of increase or reduction of the number of outlets, or in order to meet field conditions, or to coordinate with modular requirements of ceilings, or to simplify the work, or for other legitimate causes.
- E. Exercise particular caution with reference to the location of panels, outlets, switches, etc., and have precise and definite locations accepted by the Architect before proceeding with the installation.
- F. The Drawings show only the general run of raceways and approximate locations of outlets. Any significant changes in location of outlets, cabinets, etc., necessary in order to meet field conditions shall be brought to the immediate attention of the Architect for review before such

alterations are made. Modifications shall be made at no additional cost to the Owner.

- G. Verify with the Architect the exact location and mounting height of outlets and equipment not dimensionally located on the Drawings prior to installation.
- H. Circuit tags in the form of numbers are used where shown to indicate the circuit designation numbers in electrical panels. Show the actual circuit numbers on the as-built Record Drawings and on the associated typed panelboard directory card. Where circuiting is not indicated, provide required circuiting in accordance with the loading indicated on the Drawings and/or as directed.
- I. The Drawings generally do not indicate the number of wires in conduit for the branch circuit wiring of fixtures and outlets, or the actual circuiting. Provide the correct wire size and quantity as required by the indicated circuiting and/or circuit numbers indicated, the control intent, referenced wiring diagrams (if any), the specified voltage drop or maximum distance limitations, and the applicable requirements of the NEC.
- J. Carefully check space requirements with other trades to insure that equipment can be installed in the spaces allotted.
- K. Wherever work interconnects with work of other trades, coordinate with other trades to insure that they have the information necessary so that they may properly install the necessary connections and equipment. Identify items (remote ballast, pull boxes, etc.) requiring access in order that the ceiling trade will know where to install access doors and panels.
- L. Consult with other trades regarding equipment so that, wherever possible, motor controls and distribution equipment are of the same manufacturer.
- M. Furnish and set sleeves for passage of electrical risers through structural masonry and concrete walls and floors and elsewhere as required for the proper protection of each electrical riser passing through building surfaces.
- N. Provide firestopping around all pipes, conduits, ducts, sleeves, etc. which pass through rated walls, partitions and floors.
- O. Provide detailed information on openings and holes required in precast members for electrical work.
- P. Provide required supports and hangers for conduit and equipment, designed so as not to exceed allowable loadings of structures.
- Q. Examine and compare the Contract Documents with the drawings and specifications of other trades, and report any discrepancies between them to the Architect and obtain written instructions for changes necessary in the work. Install and coordinate the work in cooperation with other related trades. Before installation, make proper provisions to avoid interferences.
- R. Wherever the work is of sufficient complexity, prepare additional detail drawings to scale to coordinate the work with the work of other trades. Detailed work shall be clearly identified on the Drawings as to the area to which it applies. Submit these drawings to the Architect for review. At completion include a set of these drawings with each set of Record Drawings.

- S. Furnish services of an experienced Superintendent, who shall be in constant charge of all work, and who shall coordinate work with the work of other trades. No work shall be installed before coordinating with other trades.
- T. Coordinate with the local electric utility company and the local telecommunications company as to their requirements for service connections and provide all necessary metering provisions, grounding, materials, equipment, labor, testing, and appurtenances.
- U. Before commencing work, examine adjoining work on which this work is in any way affected and report conditions, which prevent performance of the work. Become thoroughly familiar with actual existing conditions to which connections must be made or which must be changed or altered.
- V. Adjust location of conduits, panels, equipment, etc., to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each conduit prior to fabrication.
 - 1. Right-of-Way: Lines which pitch have the right-of-way over those which do not pitch. For example: condensate, steam, and plumbing drains normally have right-of-way. Lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.
 - 2. Provide offsets, transitions and changes in direction of conduit as required to maintain proper headroom and pitch on sloping lines.
- W. In cases of doubt as to the work intended, or in the event of need for explanation, request supplementary instructions from the Architect.

3.05 EXAMINATION OF SITE

- A. Prior to the submitting of bids, visit the project site and become familiar with all conditions affecting the proposed installation and make provisions as to the cost thereof.
- B. The Contract Documents do not make representations regarding the character or extent of the sub-soils, water levels, existing structural, mechanical and electrical installations, above or below ground, or other sub-surface conditions which may be encountered during the work. Evaluate existing conditions, which may affect methods or cost of performing the work, based on examination of the site or other information. Failure to examine the Drawings or other information does not relieve the Contractor of responsibility for the satisfactory completion of the work.

3.06 EXCAVATION AND BACKFILL

- A. Provide excavation for the work of this Division. Excavate all material encountered, to the depths indicated on the Drawings or as required. Remove from the site excavated materials not required or suitable for backfill. Provide grading as may be necessary to prevent surface water from flowing into trenches or other excavations. Remove any water, which accumulates. Provide sheeting and shoring as may be necessary for the protection of the work and for the safety of personnel.
- B. Provide trenches of widths necessary for the proper execution of the work. Grade bottom of the trenches accurately to provide uniform bearing and support the work on undisturbed soil at every point along its entire length. Except where rock is encountered, do not excavate below

the depths indicated. Where rock excavations are required, excavate rock to a minimum overdepth of four inches below the trench depths indicated on the Drawings or required. Backfill overdepths in the rock excavation and unauthorized overdepths with loose, granular, moist earth, thoroughly machine-tamped to a compaction level of at least 95 percent to standard proctor density or 75 percent relative density or as specified by the Architect. Whenever unstable soil that is incapable of properly supporting the work is encountered in the bottom of the trench, remove soil to a depth required and backfill the trench to the proper grade with coarse sand, fine gravel or other suitable material.

- C. Excavate trenches for utilities that will provide the following minimum depths of cover from existing grade or from indicated finished grade, whichever is lower, unless otherwise specifically shown:
 - 1. Electric Service: two feet minimum
 - 2. Telephone Service: two feet minimum
- D. Trenches should not be placed within ten feet of foundation or soil surfaces, which must resist horizontal forces.
- E. Do not backfill trenches until all required tests have been performed and installation observed by the Architect. Comply with the requirements of other sections of the Specifications. Backfill shall consist of non-expensive soil with limited porosity. Deposit in six layers and thoroughly and carefully tamp until the work has a cover of not less than one foot. Backfill and tamp remainder of trench at one-foot intervals until complete. Uniformly grade the finished surface.

3.07 CUTTING AND PATCHING

- A. Where cutting, channeling, chasing or drilling of floors, walls, partitions, ceilings or other surfaces is necessary for the proper installation, support or anchorage of conduit or other equipment, lay out the work carefully in advance. Repair any damage to the building, piping, equipment or defaced finished plaster, woodwork, metalwork, etc., using skilled trades people of the trades required at no additional cost to the Owner.
- B. Do not cut, channel, chase or drill unfinished masonry, tile, etc., unless permission from the Architect is obtained. If permission is granted, perform this work in a manner acceptable to the Architect.
- C. Where conduit or equipment are mounted on a painted finished surface, or a surface to be painted, paint to match the surface. Cold galvanize bare metal whenever support channels are cut.
- D. Provide slots, chases, openings and recesses through floors, walls, ceilings, and roofs as required. Where these openings are not provided, provide cutting and patching to accommodate penetrations at no additional cost to the Owner.

3.08 MOUNTING HEIGHTS

- A. Mounting heights shall conform to ADA requirements.
- B. Verify exact locations and mounting heights with the Architect before installation.
- C. Electrical and telecommunications outlets shall be mounted no higher than 48 inches above

finished floor to top of the outlet box and no lower than 15 inches above finished floor to bottom of the outlet box.

- D. Electrical switches shall be mounted no higher than 48 inches above finished floor to top of the outlet box and no lower than 36 inches above finished floor to bottom of the outlet box.
- E. Fire alarm manual pull stations shall be mounted no higher than 48 inches above finished floor to top of the outlet box and no lower than 36 inches above finished floor to bottom of the outlet box.
- F. Outlets for public and other wall-mounted type telephones shall be installed so that the particular telephone installed conforms to ADA mounting height requirements.
- G. Visual Alarms: Mount not less than 80 inches to the bottom or 96 inches to the top of the device.
- H. Wall-Mounted Exit Signs: Two inches above top of door to bottom of sign.
- I. Low-Level Exit Signs: Six inches to bottom of sign.
- J. Stairwell and utility corridor wall-mounted lighting fixtures shall be mounted 8 feet-6 inches above finished floor or one foot below ceiling or structure above, whichever is lower.

3.09 CONTINUANCE OF EXISTING SERVICES

- A. Existing electrical services not specifically indicated to be removed or altered shall remain as they presently exist.
- B. Where existing services interfere with new construction, alter or reroute such existing equipment to facilitate new construction after obtaining written permission from the Architect. Notification in writing giving two weeks advance notice of planned alteration is required.
- C. Preserve continuity of service of existing facilities (related to damage or alteration due to new construction). Unauthorized alteration to existing equipment shall be corrected without additional cost to the Owner.

3.10 DEMOLITION

- A. Remove relocate, and reroute existing electrical equipment to facilitate new construction or remodeling work.
- B. Examine the site before submitting a bid to observe existing conditions.
- C. Schedule demolition in advance. Schedule work to avoid disruption of normal operations.
- D. Electrical equipment to be removed that is in good working order shall be carefully removed and offered to the Owner. Items rejected by the Owner shall be removed from the project site and properly disposed of.

3.11 CLEANING UP

- A. Avoid accumulation of debris, boxes, loose materials, crates, etc., resulting from the installation of this work. Remove from the premises each day all debris, boxes, etc., and keep the premises clean and free of dust and debris.
- B. Clean all fixtures and equipment at the completion of the project. Wipe clean exposed lighting fixture reflectors and trim pieces with a non-abrasive cloth just prior to occupancy.
- C. All electrical equipment shall be thoroughly vacuumed and wiped clean prior to energization and at the completion of the project. Equipment shall be opened for observation by the Architect as required.

3.12 WATERPROOFING

- A. Avoid, if possible, the penetration of any waterproof membranes such as roofs, machine room floors, basement walls, and the like. If such penetration is necessary, make penetration prior to the waterproofing and furnish all sleeves or pitch-pockets required. Advise the Architect and obtain written permission before penetrating any waterproof membrane, even where such penetration is shown on the Drawings.
- B. Restore waterproofing integrity of walls or surfaces after they have been penetrated without additional cost to the Owner.

3.13 SUPPORTS

- A. Support work in accordance with the best industry practice. Provide supports, hangers, auxiliary structural members and supplemental hardware required for support of the work.
- B. Provide supporting frames or racks extending from floor slab to ceiling slab for work indicated as being supported from walls where the walls are incapable of supporting the weight. In particular, provide such frames or racks in electric closets and mechanical equipment rooms.
- C. Provide supporting frames or racks for equipment which is to be installed in a freestanding position.
- D. Supporting frames or racks shall be of standard angle, standard channel or specialty support system steel members, rigidly bolted or welded together and adequately braced to form a substantial structure. Racks shall be of ample size to assure a workmanlike arrangement of all equipment mounted on them.
- E. Adequate support of equipment (including outlet, pull and junction boxes and fittings) shall not depend on electric conduits, raceways, or cables for support.
- F. Electrical equipment shall not rest on or depend for support on suspended ceiling media (tiles, lath, plaster, as well as splines, runners, bars and the like in the plane of the ceiling). Provide independent support of electrical equipment. Do not attach to supports provided for ductwork, piping or work of other trades.
- G. Provide required supports and hangers for conduit, equipment, etc., so that loading will not exceed allowable loadings of structure. Electrical equipment and supports shall not come in contact with work of other trades.

3.14 FASTENINGS

- A. Fasten equipment to building structure in accordance with the best industry practice.
- B. Where weight applied to building attachment points is 100 pounds or less, conform to the following as a minimum:
 1. Wood: Wood screws.
 2. Concrete and solid masonry: Bolts and expansion shields.
 3. Hollow construction: Toggle bolts.
 4. Solid metal: Machine screws in tapped holes or with welded studs.
 5. Steel decking or sub-floor: Fastenings as specified below for applied weights in excess of 100 pounds.
- C. Where weight applied to building attachment points exceeds 100 pounds, but is 300 pounds or less, conform to the following as a minimum:
 1. At concrete slabs provide 24-inch by 24-inch by 1/2-inch steel fishplates on top with through bolts. Fishplate assemblies shall be chased in and grouted flush with the top of slab screed line, where no fill is to be applied.
 2. At steel decking or sub-floor for all fastenings, provide through bolts or threaded rods. The tops of bolts or rods shall be set at least one inch below the top fill screed line and grouted in. Suitable washers shall be used under bolt heads or nuts. In cases where the decking or sub-floor manufacturer produces specialty hangers to work with their decking or sub-floor, such hangers shall be provided.
- D. Where weight applied to building attachment points exceeds 300 pounds, coordinate with and obtain the approval of Architect and conform to the following as a minimum:
 1. Provide suitable auxiliary channel or angle iron bridging between building structural steel elements to establish fastening points. Bridging members shall be suitably welded or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.
- E. For items, which are shown, as being ceiling-mounted at locations where fastening to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging tying to the building structural elements.
- F. Wall-mounted equipment may be directly secured to wall by means of steel bolts. Groups or arrays of equipment may be mounted on adequately sized steel angles, channels, or bars. Prefabricated steel channels as manufactured by Kindorf or Unistrut are acceptable.

3.15 IDENTIFICATION

- A. Identify electrical equipment with permanently attached black phenolic nameplates with 1/2-inch high white engraved lettering. Identification shall include equipment name or load served as appropriate. Nameplates for equipment connected to the emergency power system shall be red with white lettering. Nameplates shall be attached with cadmium-plated screws; peel-and-stick tape or glue-on type nameplates are not allowed.
- B. Cable tags shall be flameproof secured with flameproof non-metallic cord.
- C. Provide an engraved nameplate for each switch controlling loads, which are not local to the switch.

D. Wherever raceways for future use are terminated outside of the building, stake the location with a 2-foot long, 1-inch by 1-inch clear heart redwood stake.

E. See individual Sections for additional identification requirements.

3.16 PROHIBITED LABELS AND IDENTIFICATIONS

- A. In all public areas, tenant areas, and similar locations within the project, the inclusion or installation of any equipment or assembly which bears on any exposed surface any name, trademark, or other insignia which is intended to identify the manufacturer, the vendor, or other source(s) from which such object has been obtained, is prohibited, unless otherwise approved by Owner.
- B. Required UL labels shall not be removed nor shall identification specifically required under the various technical sections of the Specifications be removed.

3.17 EQUIPMENT PADS AND ANCHOR BOLTS

- A. Provide concrete pads under all floor-mounted electrical equipment. Equipment pads shall conform to the shape of the piece of equipment it serves with a minimum 1-inch margin around the equipment and supports. Pads shall be a minimum of 4 inches high and made of a minimum 28 day, 2500 psi concrete reinforced with 6-inch by 6-inch 6/6 gauge welded wire mesh. Trowel tops and sides of pad to smooth finishes, equal to those of the floors, with all external corners bullnosed to a 3/4-inch radius. Shop drawings stamped "NO EXCEPTIONS NOTED" shall be used for dimensional guidance in sizing pads.
- B. Provide galvanized anchor bolts for all equipment placed on concrete equipment pads, inertia blocks, or on concrete slabs. Provide bolts of the size and number recommended by the manufacturer of the equipment and locate by means of suitable templates. Equipment installed on vibration isolators shall be secured to the isolator. Secure the isolator to the floor, pad, or support as recommended by the vibration isolation manufacturer.
- C. Where equipment is mounted on gypsum board partitions, the mounting screws shall pass through the gypsum board and securely attach to the partition studs. As an alternative, the mounting screws may pass through the gypsum board and be securely attached to 6 inches square, 18 gauge galvanized metal backplates, which are attached to the gypsum board with an approved non-flammable adhesive. Toggle bolts installed in gypsum board partitions are not allowed.

3.22 DELIVERY, DRAYAGE AND HAULING

- A. Provide drayage, hauling, hoisting, shoring and placement in the building of equipment specified and be responsible for the timely delivery and installation of equipment as required by the construction schedule. If any item of equipment is received prior to the time that it is required, the Contractor shall be responsible for its proper storage and protection until the time it is required. Pay for all costs of drayage or storage.
- B. If equipment is not delivered or installed at the project site in a timely manner as required by the project construction schedule, the Contractor shall be responsible for resulting

disassembly, re-assembly, manufacturer's supervision, shoring, general construction modification, delays, overtime costs, etc., at no additional cost to the Owner.

3.18 EQUIPMENT AND MATERIAL PROTECTION

- A. Protect the work, equipment, and material of other trades from damage by work or workmen of this trade, and correct damaged caused without additional cost to the Owner.
- B. Take responsibility for work, materials, and equipment until finally inspected, tested and accepted. Protect work against theft, injury, or damage, and carefully store material and equipment received on site, which is not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of obstructing material. Cover and protect equipment and materials from damage due to water, spray-on fireproofing, construction debris, etc. Store equipment to moisture damage in dry, heated spaces.
- C. Provided adequate means for fully protecting finished parts of materials and equipment against damage from whatever cause during the progress of the work until final acceptance. Protect materials and equipment in storage and during construction in such a manner that no finished surfaces will be damaged or marred, and moving parts are kept clean and dry. Do not install damaged items; take immediate steps to obtain replacement or repair.
- D. Lighting fixture troffers with parabolic reflectors shall be installed with factory-mounted plastic protective bags around parabolic reflector assembly. Remove protective bag just prior to occupancy.

3.19 TESTING OF ELECTRICAL SYSTEMS

- A. Comply with the project construction schedule for the date of final performance and acceptance testing, and complete work sufficiently in advance of the Contract completion date to permit the execution of the testing prior to occupancy and Contract close-out. Complete any adjustments and/or alterations, which the final acceptance tests indicate as necessary for the proper functioning of all equipment prior to the completion date. See individual Sections for extent of testing required.
- B. Provide a detailed schedule of completion indicating when each system is to be completed and outlining when field testing will be performed. Submit completion schedule for review within six months after the notice to proceed by Owner's Representative has been given. Update this schedule periodically as the project progresses.

3.20 OPERATING INSTRUCTIONS

- A. Provide the services of factory-trained specialists to provide an operating instructions seminar for equipment and systems. The seminar shall be conducted over a five-day (consecutive) period. Instruction time is defined as straight time working hours and does not include nights, weekends, or travel time to and from the project.
- B. Submit seminar agenda, schedule and list of representatives to the Owner for approval 30 days prior to suggested date of seminar. Do not commence seminar until the Owner has issued a written acceptance of the starting time and attendees. Confirm attendance of seminar by written notification to participants.

- C. Instruct Owner's operating personnel in proper starting sequences, operation, shut-down, general maintenance and preventative maintenance procedures, including normal and emergency procedures.
- D. Submit final copies of Record Drawings and Operating and Maintenance Manuals to Owner at seminar.

3.21 OPERATING AND MAINTENANCE MANUALS

- A. Provide Operating and Maintenance Manuals for equipment and materials furnished under this Division.
- B. Submit three final copies of Operating and Maintenance Manuals for review at least ten weeks before the completion date. Assemble data in a completely indexed volume or volumes in three-ring binders and identify the size, model, and features indicated for each item. Print the project name on the outside of the binders.
- C. Maintenance manuals shall include complete cleaning and servicing data compiled in a clear and easily understandable format. Show model numbers of each piece of equipment, complete lists of replacement parts, capacity ratings, and actual loads.
- D. Provide the following information where applicable:
 1. Identifying name and mark number
 2. Locations (where several similar items are used, provide a list)
 3. Complete nameplate data
 4. Certified Record Drawings and Final Reviewed submittals
 5. Parts list
 6. Performance curves and data
 7. Wiring diagrams
 8. Manufacturer's recommended operating and maintenance instructions with all non-applicable information deleted
 9. List of spare parts recommended for normal service requirements
 10. Assembly and disassembly instructions with exploded-view drawings where necessary
 11. Test reports
 12. Trouble shooting diagnostic instructions, where applicable.

3.22 RECORD DRAWINGS

- A. The Contractor shall maintain on a daily basis at the Project site a complete set of Record Drawings. The Record Drawings shall initially consist of a set of blueline prints or AutoCAD files of the Contractor's Coordination Drawings. The prints shall be marked or the AutoCAD files electronically updated to show the precise location of all buried or concealed work and equipment, including embedded conduit, raceways and boxes, and all changes and deviations in the Electrical work from that shown on the Contract Documents. This requirement shall not be construed as authorization for the Contractor to make changes in the layout or work without definite written instructions from the Architect or Engineer. The updated Coordination Drawings shall be used to produce the final Record Drawings that shall be delivered to the Owner in AutoCAD electronic format media upon Project completion.
- B. Record dimensions clearly and accurately to delineate the work as installed. Suitably identify locations of all equipment by at least two dimensions to permanent structures.

- C. Upon completion of the work, the Contractor and Subcontractor(s) shall certify all Record Drawings.
- D. Prior to final acceptance of the Work of this Division, the Contractor shall submit properly certified Record Drawings to the Architect and Engineer for review and shall make changes, corrections, or additions as the Architect and/or Engineer may require to the Record Drawings. After the Architect's and Engineer's review, and any required Contractor revisions, the Record Drawings shall be delivered to the Owner on electronic media in AutoCAD format. The Architect and Engineer do not assume any responsibility for the accuracy or completeness of the Record Drawings.

3.23 FINAL PUNCHLIST

- A. Prior to the Final Punchlist, certify that systems and equipment are complete, operational, and are in compliance with the Contract Documents.
- B. During the Final Punchlist, provide personnel with access keys, hand held radios, and necessary expertise to operate each system and piece of equipment to demonstrate operational compliance with the Contract Documents.
- C. Any deficiencies noted on the Final Punchlist shall be expeditiously corrected and certified in writing.

3.24 EARLY OCCUPANCY

- A. Complete those systems which are necessary to allow partial early occupancy of the building.
- B. Verify and comply with requirements for temporary occupancy with the local Building and Fire Departments.

END OF SECTION

SECTION 26 05 00

ELECTRICAL BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SUMMARY:

- A. Section Includes:
 - 1. Boxes, enclosures, keys and locks, receptacles and switches, and identifications and signs.

PART 2 – PRODUCTS

2.01 BOXES, ENCLOSURES, KEYS AND LOCKS

- A. Outlet Boxes and Fittings:
 - 1. Outlet boxes installed in concealed work shall be galvanized steel, pressed, or welded type, with knockouts.
 - 2. In exposed work, where conduit runs change direction or size, outlet boxes and conduit fittings shall be cast metal with threaded hubs cast integral with box or fitting.
 - 3. Fittings shall be cast metal and non-corrosive. Ferrous metal fittings shall be cadmium-plated or zinc galvanized. Castings shall be true to pattern, smooth, straight, with even edges and corners, of uniform thickness of metal, and shall be free of cracks, gas holes, flaws, excessive shrinkage, and burnt-out sand.
 - 4. Covers for fittings shall be galvanized steel or non-corrosive aluminum and shall be designed for particular fitting installed.
 - 5. Light fixture outlets shall be 4-inch octagon, 4-inch square, 2-1/8 inches deep or larger, depending upon number of conductors or conduits therein. Plaster rings shall be furnished with round opening with 2 ears drilled 2-23/32 inches center to center.
 - 6. For local device outlets provide 4-inch square 2-1/8 inch deep, boxes for single gang, 5-inch square boxes for two-gang, and special solid gang boxes with gang plaster ring for more than 2 switches.
 - 7. Plaster rings shall be provided on flush-mounted outlet boxes except where otherwise indicated or specified. Plaster rings shall be same depth as finished surface. Install approved ring extension to obtain depth to finish surface.
 - 8. In existing plywood wall or drywall construction, and where flexible steel conduit is fished into walls, one-gang and 2-gang outlets for wiring devices may be sectional steel boxes with plaster ears. Boxes shall be fastened to plywood with flat-head screws in each plaster ear screw hole. Boxes fastened to gypsum board shall be Gripsite by Raco, or equal.
 - 9. Factory made knockout seals shall be installed to seal box knockouts, which are not intact.
 - 10. Where flexible conduit is extended from flush outlet boxes, provide and install weatherproof universal box extension adapters.
- B. Junction and Pull Boxes:
 - 1. Junction and pull boxes, in addition to those indicated, shall only be used in compliance

- with codes, recognized standards, and contract documents.
2. Interior and non-weatherproof boxes shall be constructed of blue or galvanized steel with ample laps, spot welded, and shall be rigid under torsion and deflecting forces. Boxes shall be furnished with auxiliary angle iron framing where necessary to ensure rigidity.
 3. Covers shall be fastened to box with a sufficient number of brass machine screws to ensure continuous contact all around. Flush type boxes shall be drilled and tapped for cover screws if boxes are not installed plumb. Surfaces of pull and junction boxes and covers shall be labeled in black marker ink designating system, panel board and circuit designation contained in box. In exposed work, designation shall be installed on inside of pull box or junction box cover.
 4. Weatherproof NEMA 3R pull and junction boxes shall conform to foregoing for interior boxes with following modifications:
 - a. Cover of flush mounting boxes shall be furnished with a weather-tight gasket cemented to, and trimmed even with, cover all around.
 - b. Surface or semi-flush mounting pull and junction boxes shall be UL, or another Nationally Recognized Testing Laboratory (NRTL) listed as rain-tight and shall be furnished complete with threaded conduit hubs.
 - c. Exposed portions of boxes shall be galvanized and finished with one prime coat and one coat of baked-on gray enamel, unless already furnished with factory baked-on finish.
 5. Junction and pull boxes shall be rigidly fastened to structure and shall not depend on conduits for support.
 6. Underground Concrete Pull Boxes:
 - a. Pre-cast concrete pull boxes. Concrete pull boxes shall be traffic type, reinforced for H-20 wheel loading, pre-cast concrete. Pull boxes 3' x 3' or smaller shall consist of a base section, top ring, and cover. Base section shall be furnished with 2 knockouts measuring 10 inch x 10 inch in each 3 feet side, and one 20 inch x 20 inch knockout in each 2-foot side. Pull boxes with inside dimension larger than 3'x3' shall consist of a base section, midsection, topping, and cover. Base section shall be furnished with 2 knockouts measuring 8 inches x 16 inches on each of 2 opposite sides, and one 20 inch x 20 inch knockout on each of other 2 opposite sides. Pull boxes shall be furnished with a minimum of 6-inch diameter sump knockout and one inch diameter ground rod knockout. In pull boxes, furnish and install cable racks on walls. Racks shall be furnished with 3 porcelain cable holders on vertical steel mounting bars. Pull boxes shall be furnished with 3/4 inch diameter pull irons. Covers shall be traffic-type consisting of steel safety plate bolted to frame. Covers shall be marked as electrical, power, or signal as required. Pull boxes shall be as manufactured by Jansen, Quickset, or equal.
 - b. Provide end bells in duct entrances. Terminate each metal conduit with insulated bushing provided with a grounding terminal.
 - c. Install pulling irons on opposite walls and below horizontal centerlines of ducts and bricked-up openings, and in bottom. Install pulling irons with each end hooked around a reinforcing bar.
 - d. Remove floor drain knockout and provide a depth of 24 inches of crushed rock below box extending a minimum of 12 inches beyond on all sides.
 - e. Permanently and effectively ground metal equipment cases, cable racks, and similar items in pull boxes to site grounding electrode system. Provide grounding conductor in compliance with NEC Article 250.
 - f. Provide 6-inch deep sand base under pull boxes.
 - g. Identify power and signal cables by tagging in manholes and pull boxes. Tie securely to cables with nylon cord.

- h. Top of steel plate shall provide a minimum coefficient of static friction of 0.5 for either wet or dry locations, when tested for any shoe sole material. Test shall comply with ASTM D 1047 or F 489 or F 609 standards. Submit manufacturer's test results for Architect's review as part of materials and equipment submittals.
7. Underground utility boxes shall be reinforced concrete with non-setting shoulders to prevent settlement following installation. Boxes shall be furnished with cast iron cover with finger hole, size as indicated on drawings. Utility boxes shall be as manufactured by Quickset, or equal.
8. Manholes, vaults, and pull boxes required by a utility company, and installed as part of this contract, shall meet requirements of servicing utility company.

C. Keys and Locks:

1. Provide 2 keys with furnished door locks, including cabinet door locks and switchboard locks, 2 keys for lock switches on switchboards or control panels, and 2 keys with interlocks or other furnished lock switches. Deliver keys to Owner's Representatives.
2. Locks shall be keyed to Corbin No. 60 keys for access to operate equipment and Corbin No. 70 keys for service access. Special keys and locks shall only be provided where specified.

2.02 RECEPTACLES AND SWITCHES

A. Receptacles:

1. Duplex receptacles shall be NEMA 5-20R, 120V, 20A heavy-duty specification grade, grounding type. Terminal screws shall be back and side wired with internal screw pressure plates. Mounting strap shall feature heavy-duty brass construction. Receptacle back body shall be PVC. Receptacle face shall be stainless steel. Receptacles shall have triple wipe brass power contacts. Tamper-resistance, GFCI and AFCI units shall be used where required by Codes. Devices shall be manufactured by Leviton, Hubbell or Pass & Seymour.
2. Provide tamper-resistant receptacles with thermoplastic dual mechanism shutter system to help prevent insertion of foreign objects. Receptacles shall have extra heavy-duty brass, one-piece mounting strap with integral ground.
3. Provide transient voltage surge suppression (TVSS) receptacles offering metal oxide varistors (MOVs) protecting normal and common modes, (L-N, L-G, N-G) with 500V suppressed voltage. TVSS devices shall offer 3-mode equal protection with 210 joules minimum per mode of energy absorption and 13,000 amp maximum surge capability. TVSS devices shall have 3 thermal fuses and two over-current protection fuses. TVSS devices shall have LED visual only surge status indicator to alert user to surge suppression circuit condition. Visual indicator will be illuminated (red) when power is on and surge suppression circuit is fully functional. Visual indicator will not be illuminated when power is off or unit experiences loss of surge suppression protection. Terminals shall be back and side wire including ground terminal. Color shall be blue.
4. Receptacles within 6 feet of water fountains, counter tops, or any sources of water and all outlets in the kitchen, bathrooms and restrooms shall be GFCI type.

B. Switches:

1. Local Switches: Provide local switches, high strength thermoplastic toggle, specification grade, rated 20 amps at 120-277 volts AC only, with plaster ears, external screw pressure plate back and side wired, and standard size composition cups which fully enclose mechanism. Switches shall be approved for installation at currents up to full rating on resistive, inductive, tungsten filament lamp and fluorescent lamp loads, and for up to 80

percent of rating for motor loads. Switches shall have oversized silver alloy contacts for long life and better heat dissipation. Provide switches as single pole, double pole, 3-way, 4-way, non-lock type. Provide non-lock type switches with ivory handles. Devices shall be manufactured by Leviton, Hubbell or Pass & Seymour. Pneumatic-electric air switch by Emerson Electric shall be provided at each kitchen for garbage disposal control.

2. Time Switches and Photoelectric Controls.
 - a. For lighting control, provide time switches with digital and astronomic capabilities. Provide 365 days with holiday capabilities with 16 single dates and 5 holiday blocks of unlimited duration utilizing eighth and ninth day schedules. Provide 2 separately controllable relay closure output circuits. Each circuit to be single pole, double throw, with contacts rating of 10 amp resistive at 120/250V and 7.5 amp inductive at 120/250V. Provide 48 events per circuit per week; separate scheduling for each day of week. Provide selectable daylight saving or standard time, automatic leap year correction, and 72-hour memory backup with rechargeable battery. Time switch; Tork series DZS-400BP 4-channel control. Provide external 20A contactors as required to control multiple circuits on the same channel.
 - b. Photoelectric Control: Photoelectric control rated 2,000 watts, 120V with single pole, single throw, normally closed contact, enclosed in a die-cast aluminum gasketed enclosure with 1/2 inch conduit fitting, Tork series 2100, or equal.

C. Device Faceplates:

1. Device faceplates in residential and common areas shall be Decora style screw-less type.
2. Stainless steel faceplates shall be used in parking garages and utility spaces.

2.03 IDENTIFICATION AND SIGNS

A. Identification Plates:

1. Provide identification plates for the following unless otherwise specified, for switchboards, unit substations, motor control centers, control panels, push-button stations, time switches, contactors, motor starters, motor switches, panelboards, and terminal cabinets.
2. Identification plates shall be of plastic stock and shall adequately describe function, voltage and phase of identified equipment. Where identification plates are detailed or described on drawings, inscription and size of letters shall be as indicated. For lighting and power panels, identification plates shall indicate panel designation, voltage, and phase of panel. For terminal cabinets, identification plates shall indicate system contained in terminal cabinet.
3. Identification plates shall be black-and-white nameplate stock of Bakelite with characters cut through black exposing white. Plates shall be furnished with beveled edges and shall be securely fastened in place with No. 4 Phillips-head, cadmium-plated steel, self-tapping screws. Characters shall be 3/16 inch high, unless otherwise indicated.

B. Markings:

1. Install identification markings to surface-mounted starters, switches, disconnect switches, contactors, and other devices controlling motors and appliances. Provide abbreviations required along with an identifying number. Markings to be provided with locking type stencils using paint of a contrasting color. Figures shall be 3/8 inch high unless otherwise indicated. Dymo Industries Inc., self-sticking plastic labels, with embossed characters made with a typewriter may be installed instead of stencils and paint; p-touch self adhesive plastic, or Brother P-Touch self sticking laminated plastic labels may be installed.
2. High Voltage: High voltage switchboards, cabinets, boxes, and conduits exposed in accessible locations, including under buildings and in attics, are required to be marked

"DANGER-HIGH VOLTAGE". Markings for switchboards shall consist of 18 gage steel, porcelain enamel sign of standard manufacture. Markings for boxes, cabinets, and conduits shall be by means of stenciling or printed self-adhesive markers, Westline Tel-A-Pipe, or equal. Provide letters of black on orange background and not less than 1-7/8 inches high. On conduit runs, install markings at intervals not exceeding 10 feet in any individual area. Markings shall be installed after other painting work is complete.

C. Warning Signs:

1. Provide a warning sign on outside of each door or gate to rooms or enclosures containing high voltage equipment. Signs required to read, "WARNING - HIGH VOLTAGE - KEEP OUT". Provide 2 inch high lettering.
2. Provide a warning sign on each high-voltage non-load break disconnect and fused cutout (not oil filled). Signs required to read, "DO NOT OPEN UNDER LOAD". Provide 2 inch high lettering.
3. Provide signs of standard manufacture, 18 gage steel, with porcelain enamel finish. Provide red lettering on a white background.
4. Contractor shall perform arc flash analysis and provide warning labels at power equipment locations per current NEC requirements.

PART 3 - EXECUTION

3.01 INSTALLATION AND SUPPORT OF BOXES

- A. Install outlet boxes flush with finished surface of wall or ceiling. Install plumb and securely fastened to structure, independent of conduit. Except where otherwise indicated, provide factory-fabricated bar hangers to support outlet boxes. When installation is performed in fire rated walls, maintain the wall's rating integrity by means of approved fire stop methods.
- B. Outlet boxes installed in suspended or furred ceilings with steel runner or furring channels shall be supported, except where otherwise indicated, by a Unistrut P-4000 channel spanning main ceiling runner channels. Each box shall be supported from its channel by a 3/8 inch 16 threaded steel rod with a Unistrut P-4008 nut and a Tomic No. 711-B Adapta-Stud. Rod shall be tightened to a jamb fit with channel and its nut. Box shall be locked to rod by means of a 1/2 inch locknut on stud and a 3/8 inch 16 hex nut locking stud to rod.

3.02 COVER PLATES

- A. Provide a plate on each switch, plug, pilot light, data, interphone, public telephone, and television outlet, and on existing and reset outlets where so indicated or required. Plates shall be of stainless steel unless otherwise specified.
- B. Flush wiring device and signal system outlets indicated to be blank covered, shall be covered with screw-less blank plates. Flush lighting outlets to be blanked shall be covered with cover faceplate, painted to match surrounding finish. Provide stainless steel covers to blank indicated or required surface-mounted outlets.
- C. In the following cases, and at required locations. Switch and receptacle plates shall be engraved with the device(s), or fixtures being controlled, or as indicated.
 1. Three-gang and larger gang switches in locations other than classrooms.

2. Lock switches.
 3. Pilot switches.
 4. Switches so located that operator cannot see fixtures, or items of equipment controlled while his hand is on the switch.
 5. Switches not in same room with fixtures or items of unit heaters, air curtains, fly fans, etc.
 6. Receptacles operating at other than 120 V shall be labeled with the operating voltage.
 7. Switches operating on 277 V shall be labeled with the operating voltage.
 8. Where indicated on drawings.
- D. Designations shall follow Architect instruction.

3.03 IDENTIFICATION OF CIRCUITS AND EQUIPMENT

- A. Provide descriptive nameplates or tags permanently attached to switchboards, motor control centers, transformers, panelboards, circuit breakers, disconnect switches, starters, pushbutton control stations and other apparatus installed for operation or control of circuits, appliances, fire alarm control panel(s), fire alarm annunciator(s), power supplies, terminal cabinets, energy management control units, and information technology system backbone and distribution equipment points.
- B. Provide nameplates of engraved laminated plastic, or etched metal. Submit shop drawings denoting dimensions and format to Architect before installation. Fasten to equipment with escutcheon pins, rivets, self-tapping screws, or machine screws. Self-adhering or adhesive backed nameplates are not permitted.
- C. Fasten tags to feeder wiring in conduits at every point where runs are broken or terminated, including pull wires in empty conduits. Indicate circuit, phase, and function. Tag branch circuits in panel boards and motor control centers. Tags may be manufactured of pressure-sensitive plastic or embossed self-attached stainless steel or brass ribbon.
- D. Provide circuit identification cards and cardholders in all panel boards. Cardholders shall consist of metal frame retaining a clear plastic cover permanently attached to inside of panel door. List of circuits shall be typewritten on a card. Circuit description shall include name or number of circuit, area and connected load.
- E. Junction and pull boxes shall have covers stenciled with box number when indicated on drawings, or circuit numbers according to panel schedules. Data shall be lettered in a conspicuous manner with a color contrasting with finish.
- F. Name shall be correctly engraved, with a legend indicating function or areas.

3.04 PROTECTION

- A. Protect Work of this section until substantial completion.

3.05 CLEANUP

- A. Remove rubbish, debris, and waste materials and legally dispose of off project site.

BENJAMIN WOO ARCHITECTS
PROJECT NO. 1709

LILIA WAIKIKI
HONOLULU, HAWAII

END OF SECTION

SECTION 26 05 19

LOW VOLTAGE WIRES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Low-voltage wire, splices, terminations and installation.

1.02 SUBMITTALS

- A. Submit in accordance with Section 01 33 00 – Submittal Procedures.

PART 2 – PRODUCTS

2.01 WIRES

- A. Wires shall be single conductor type THHN / THWN insulated with polyvinyl chloride and covered with a protective sheath of nylon, rated at 600 volts. Wires may be operated at 90 degrees C. maximum continuous conductor temperature in dry locations, and 75 degrees C. in wet locations and shall be listed by UL Standard 83 for thermoplastic insulated wires, listed by Underwriter's Laboratories (UL) for installation in accordance with Article 310 of the National Electrical Code (CEC). Power distribution cables run underground shall be XHHW type. Conductors shall be solid copper for 12 AWG and smaller conductors, and stranded copper for 10 AWG and larger conductors. Conductors shall be insulated with PVC and sheathed with nylon. Wires shall be identified by surface markings indicating manufacturer's identification, conductor size and metal, voltage rating, UL symbol, type designations and optional rating. Indentations for lettering are not permitted. Wires shall be tested in accordance with the requirements of UL standard for types XHHW, THWN and THHN. Aluminum conductors #1 and larger (100A) will be allowed. MC cables following NEC criteria can be used within residential units, and common area 20A power and lighting branch circuit jumpers. Common area home run circuits will remain in conduit, MC cable not allowed. Aluminum MC cable feeders will be allowed to feed residential units.
- B. Conductors shall be solid Class B or stranded Class C, annealed uncoated copper in accordance with UL standards, or another Nationally Recognized Testing Laboratory (NRTL).

2.02 STANDARDS

- A. XHHW/THWN/THHN wires shall comply with the following standards:
 - 1. UL 83 for thermoplastic insulated wires.
 - 2. UL 1063 for machine tool wires and cables.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Wires shall not be installed until debris and moisture is removed from conduits, boxes, and cabinets. Wires stored at site shall be protected from physical damage until they are installed and walls are completed.
- B. Wire-pulling compounds furnished as lubricants for installation of conductors in raceways shall be compounds approved and listed by UL, NRTL, or equal. Oil, grease, graphite, or similar substances are not permitted. Pulling of 2 AWG or larger conductors shall be performed with a cable pull machine. Any runs shorter than 50 feet are exempt. When pulling conductors, do not exceed manufacturer's recommended values.
- C. At outlets for light, power, and signal equipment, pigtail splices with 8-inch circuit conductor leads for connection to fixtures, equipment, and devices.
- D. Pressure cable connectors, pre-insulated Scotchlok, 3M, or equal. Y, R or B spring-loaded twist-on type, may be furnished in splicing number 8 AWG or smaller wires for wiring systems; except public address and telephone systems.
- E. All Joints, splices, taps, and connections to switchboard neutral, bonding or grounding conductors, conductors to ground busses, and transformer connections for wires 6 gauge and larger shall be performed with high-pressure cable connectors approved for installation with copper conductors. Connectors shall be insulated with heavy wall heat shrink WCSM, or cold-applied roll-on sleeve RVS. Insulation level shall be a minimum of 600V and joints, splices, and taps shall be qualified to ANSI C 119.2, UL, NRTL, or equal listed mechanical pressure connections.
- F. Connections to any bussing and high-press cable connectors shall be securely bolted together with corrosion-resistant plated carbon steel, minimum grade 5 machine screws secured with constant pressure-type locking devices.
- G. Connection of any bonding or grounding conductors shall be securely bolted together with corrosion-resistant plated carbon steel, minimum grade 5 machine screws secured with constant pressure-type locking devices.
- H. Wire switchboards, panel cabinets, pull boxes, and other cabinets except public address, shall be neatly grouped and tied in bundles with nylon ties at 10-inch intervals. In switchboards, panels and terminal blocks, wires shall be fanned out to terminals. If bundles are longer than 24 inches, a maximum of 9 current carrying conductors may be bundled together.
- I. Install conductor lengths with a minimum length within the wiring space. Conductors must be long enough to reach the terminal location in a manner that avoids strain on the connecting lug.
- J. Maintain the conductor required bending radius.
- K. Neutral conductors larger than 6 gauge, which are not color identified throughout their entire length, shall be taped, painted white or natural gray, or taped white where they appear in switchboards, cabinet, gutters or pull boxes. Neutral conductors 6 gauge and smaller shall be white color identified throughout their entire length.

- L. Fire alarm and low voltage wiring shall be continuous from terminal cabinets or from equipment to each device. Splices are not permitted between devices and/or terminal cabinets at junction and pull boxes. Wiring shall be terminated at terminal blocks or devices only.
- M. Wiring systems shall be free from short circuits and grounds, other than required grounds. The contractor shall be responsible for the testing of feeder and branch circuit conductor's insulation resistance. The tests to be performed are as follows:
 - 1. Utilize the services of an approved independent testing laboratory to perform megger time-resistance insulation testing of feeder conductors. Tests must be conducted with wires disconnected at both ends.
 - a. Provide calibration program records to assure the testing instrument to be within rated accuracy. The test equipment accuracy shall be in accord with the requirements stated by the National Institute of Standards and Technology (NIST).
 - b. Test equipment shall be provided with a label stating the date of last calibration. As a minimum the equipment shall have been calibrated within the past 12 months.
 - c. Test reports shall include the following:
 - 1) Identification of the testing organization.
 - 2) Equipment identification.
 - 3) Ambient conditions.
 - 4) Identification of the testing technician.
 - 5) Summary of project.
 - 6) Description of equipment being tested.
 - 7) Description of tests.
 - 8) Test results.
 - 9) Analysis, interpretation and recommendations.
 - 2. Utilize the services of an approved independent testing laboratory or a qualified contractor's employee (Technician certified in accordance with ANSI/NETA ETT-2000 Standard for Certification of Electrical Testing Personnel) to perform megger time-resistance insulation testing of branch circuit conductors. Tests must be conducted with wires disconnected at both ends. Test equipment and report requirements stipulated under section 3.01.N.1 apply to branch circuit testing.
 - 3. Tests shall be performed in the presence of the IOR.
 - 4. Insulation resistance shall not be less than 100 mega-ohms.

3.02 COLOR CODES

A. General Wiring:

- 1. Color code conductor insulation as follows:

SYSTEM VOLTAGE		
Conductor	208Y/120	480Y/277
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Neutral	White	Natural Gray

- 2. Neutrals shall be colored-distinguished if circuits of two voltage systems are used in the same raceway.
- 3. For phase and neutral conductors 6 gauge or larger, permanent plastic-colored tape may be furnished to mark conductor end instead of coded insulation. Tape shall cover not less

than 2 inches of conductor insulation within enclosure.

3.03 FEEDER IDENTIFICATION

- A. Feeder wires and cables shall be identified at each point the conduit run is broken by a cabinet, box, gutter, etc. Where terminal ends are available, identification shall be by means of heat shrink wire markers, which provide terminal strain relief. Markers shall be Brady Perma-Sleeve, or equal. Identification in other areas shall be by means of wrap-around tape markers Brady Perma-Code or equal. Markers shall include feeder designation, size, and description.

3.04 TAPE AND SPLICE KITS

- A. Splices, joints, and connectors joining conductors in dry and wet locations shall be covered with insulation equivalent to that provided on conductors. Free ends of conductors connected to energized sources shall be taped. Voids in irregular connectors shall be filled with insulating compound before taping. Thermoplastic insulating tape approved by UL, NRTL, or equal for installation as sole insulation of splices shall be furnished and shall be installed according to manufacturer's printed specifications.

3.05 PROTECTION

- A. Protect the work of this section until substantial completion.

3.06 CLEANUP

- A. Remove rubbish, debris and waste materials and legally dispose of off the project site.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Providing and installing of grounding system as indicated or required.

1.02 QUALITY ASSURANCE (REFERENCE STANDARDS)

- A. IEEE 142 Green Book.
- B. Underwriter's Laboratories (UL).
- C. National Electrical Code (NEC).
- D. Building Industry Consultant Services International (BICSI) (Signal).
- E. EIA/TIA (Signal and power).
- F. Nationally Recognized Testing Laboratory (NRTL) or equal.

1.03 SYSTEM DESCRIPTION

- A. Metallic objects on the project site that enclose electrical conductors, or that are likely to be energized by electrical currents, shall be effectively grounded.
- B. Metal equipment parts, such as enclosures, raceways, and equipment grounding conductors, and earth grounding electrodes shall be solidly joined together into a continuous electrically conductive system.
- C. Metallic systems shall be effectively bonded to the main grounding electrode system.
- D. A separately derived AC source shall be grounded to the equipment grounding conductor, and to separate "made" electrode of building grounding electrode system.
- E. Electrical continuity to ground metal raceways and enclosures, isolated from equipment ground by installation of non-metallic conduit or fittings, shall be provided by a green insulated grounding conductor of required size within each raceway connected to isolated metallic raceways, or enclosures at each end. Each flexible conduit over 6 feet in length shall be provided with a green insulated grounding conductor of required size.
- F. Cold water, or other utility piping systems, shall not be utilized as grounding electrodes due to the installation of insulating couplings and non-metallic pipe in such installations. In addition to bonding to cold water pipe provide at least one of the following made grounding electrodes:

1. A dedicated "made" electrode, fabricated of at least 20 feet of galvanized 1/2 inch diameter rebar encased by at least 2 inches of concrete, and placed next to the bottom of a concrete foundation, or footing in direct contact with earth. A welded extended portion shall surface at the location of the common grounding electrode bus bar and be extended by a 3/0 CAD welded bare copper cable, or be CAD welded directly to the bus. The CAD weld shall be at least 4 inches above finished floor in a dry location. The main grounding electrode and associated grounding conductors shall be in an enclosure and in conduit.
 2. Grounding electrodes as specified hereafter in this section.
 3. Concrete enclosed electrode, fabricated of at least 20 feet of No. 2 AWG, minimum size, bare copper conductor, encased by at least 2 inches of concrete, located within or near bottom of a concrete foundation, or footing, which is in direct contact with earth. Footing rebar shall be connected to copper wire with approved connectors. An external electrode, as specified hereafter or as required by the NEC, shall be installed and connected to foundation or footing rebar.
 4. Existing grounding infrastructure with resistance less than the maximum value allowed by NEC can be used.
- G. Non-current carrying metal parts of high-voltage equipment enclosures, signal and power conduits, switchboard and panelboard enclosures, motor frames, equipment cabinets, and metal frames of buildings shall be permanently and effectively grounded. Provide a NEC sized grounding conductor in every raceway.
- H. Metallic or semi-conducting shields and lead sheaths of cables operating at high voltage shall be permanently and effectively grounded at each splice and termination.
- I. Neutral of service conductors shall be grounded as follows:
1. Neutral shall be grounded at only one point within the project site for that particular service. Preferable location of grounding point shall be at the service switchboard, or main switch.
 2. Equipment and conduit grounding conductors shall be bonded to that grounding point.
 3. If other buildings or structures on the project site are served from a switchboard or panelboard in another building, power supply is classified as a feeder and not as a service.
 4. Equipment grounding conductor is installed from switchboard to each individual building. At building, grounding conductor is bonded with power equipment enclosures, metal frames of building, etc., to "made" electrode for that building.
 5. Feeder neutrals shall be bonded at service entrance point only, neutrals of separately derived systems shall be bonded at the source only.
- J. If there is a distribution transformer at a building the secondary neutral conductor shall be grounded to "made" electrode serving the building.
- K. Within every building, the main switchboard or panelboard, shall be bonded to the cold water line. Metallic piping systems such as gas, fire sprinkler, or other systems shall be bonded to the cold water line.

1.04 SUBMITTALS

- A. Submit in accordance with Section 01 33 00 – Submittal Procedures.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Furnished yard boxes shall be precast concrete and shall be approximately 14 inches wide by 19 inches long by 12 inches deep or larger, if necessary to obtain required clearances. Boxes shall be furnished with bolt-down, checkered, cast iron covers and cast iron frames cast into boxes. Yard boxes shall be Brooks 36, or equal.
- B. "Made" electrodes shall be copper-clad steel ground rods, minimum 3/4 inch diameter by 10 feet long.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Grounding electrodes shall be installed in the nearest suitable planting area, where not otherwise indicated on drawings, and each electrode shall terminate within a concrete yard box installed flush with finish grade. In planting areas, finish elevation of concrete yard boxes shall be 2 inches above planting surfaces.
- B. If concrete enclosed electrode is provided, grounding wire shall be terminated to a suitable copper plate with grounding lugs and must be enclosed in a raceway or box.
- C. Grounding rods shall be driven to a depth of not less than 10 feet. Permanent ground enhancement material, as manufactured by Erico Electrical Products, or equal, shall be installed at each ground rod to improve grounding effectiveness. Install in accordance with manufacturer's installation instructions.
- D. Grounding electrodes shall provide a resistance to ground of not more than 25 ohms.
- E. When installing grounding rods, if resistance to ground exceeds 25 ohms, 2 or more rods connected in parallel, or coupled together shall be provided to meet grounding resistance requirements.
- F. Ground rods shall be separated from one another by not less than 10 feet.
- G. Parallel grounding rods shall be connected together with recognized fittings and grounding conductors in galvanized rigid steel conduit, buried not less than 12 inches below finish grade.

3.02 TESTING

- A. Provide the services of an approved independent testing laboratory to test grounding resistance of "made" electrodes, ground rods, bonding of building steel, water pipes, gas pipes and other utility piping. Tests shall be performed as follows:
 1. Visually and mechanically examine ground system connections for completeness and adequacy.
 2. Perform fall of potential tests on each ground rod or ground electrode where suitable

locations are available per IEEE Standard No. 81, Section 8.2.1.2. Where suitable locations are not available, measurements will be referenced to a known dead earth or reference ground.

3. Perform the two point method test per IEEE No. 81, Section 8.2.1.1 to determine ground resistance between ground rod and building steel, and utility piping - such as water, gas and panelboard grounds. Metal railings at building entrances and at handicapped ramps shall also be tested.
4. Test shall be performed in the presence of the Inspector.

- B. Submit 3 copies of test results to the Architect. Test results shall be submitted on an official form from the independent testing laboratory recording project location, test engineer, test conditions, test equipment data, ground system layout or diagram, and final test results.

3.03 PROTECTION

- A. Protect the work of this section until substantial completion.

3.04 CLEANUP

- A. Remove rubbish, debris, and waste materials and legally dispose of off the project site.

END OF SECTION

DIVISION 27 COMMUNICATIONS

SECTION 27 05 26 – GROUNDING AND BONDING FOR COMMUNICATION SYSTEMS

PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS

Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

Work of this Section applies to all other Sections and Sub-sections of Division 27, Communications

1.02 SECTION INCLUDES

The Work of this Section includes all labor, material, equipment and services necessary to complete the common work associated with installing Communications under Division 27.

1.03 RELATED SECTIONS

- A. 26 00 00 – Electrical
- B. 27 05 33 Conduits and Backbones for Communications Systems
- C. 27 11 16 Communications Cabinets, Racks, Frames and Enclosures
- D. 27 11 23 Communications Cable Management and Ladder Rack
- E. 27 11 26 Communications Rack Mounted Power Protection and Power Strips
- F. 08 33 10 Overhead Coiling Grilles
- G. 11 12 00 Parking Control Equipment

1.04 QUALITY ASSURANCE

- A. Workers: Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- B. All grounding and bonding equipment shall be UL Listed.
- C. Reference Documents: These standards are to be followed in addition to applicable Electrical Codes.

1. ANSI/NECA/BICSI 568-2006 – Standard for Installing Commercial Building Telecommunications Cabling.
2. ANSI/NECA/BICSI-607 – Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
3. ANSI/TIA-568-C.0 – Generic Telecommunications Cabling for Customer Premises
4. ANSI/TIA-568-C.1 – Commercial Building Telecommunication Cabling Standard
5. ANSI/TIA-568-C.2 – Balanced Twisted-Pair Telecommunication Cabling and Components Standard
6. ANSI/TIA-568-C.3 – Optical Fiber Cabling Components Standard
7. ANSI/TIA-569-B – Commercial Building Standard for Telecommunications Pathways and Spaces
8. ANSI/TIA-606-A – Administration Standard for Commercial Telecommunications Infrastructure
9. ANSI/TIA-607-B – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
10. IEEE 802.3af – Power over Ethernet (PoE) Standard
11. IEEE 802.3at – Power over Ethernet+ (Plus) Standard
12. IEEE 802.11 – Wireless Standard
13. BICSI-TDMM-2009 – Telecommunications Distribution Methods Manual

1.05 SUBMITTALS

- A. Procedural requirements for submittals is addressed in Division 01.
- B. Action or Informational Submittals.
- C. Contractor will provide product catalog cut-sheets prior to installation for approval.

1.06 PRODUCT HANDLING

- A. Equipment shall be delivered in original packages with labels intact and identification clearly marked.
- B. Equipment shall not be damaged in any way and shall comply with manufacturer's operating specifications
- C. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust or other contaminants. Equipment damaged prior to system acceptance shall be replaced at no cost to the owner.

PART 2 – PRODUCTS

MATERIALS, EQUIPMENT AND SERVICES

2.01 TELECOMMUNICATIONS MAIN GROUNDING BUSBAR (TMGB)

- A. Telecommunications Main Grounding Busbar (TMGB) shall be constructed of .25" (6.4 mm) thick solid copper bar.

- B. The busbar shall be 4" (100 mm) high and 20" (510 mm) long and shall have 30 attachment points (two rows of 15 each) for two-hole grounding lugs.
- C. The hole pattern for attaching grounding lugs shall meet the requirements of ANSI-J-STD – 607-A and shall accept 27 lugs with 5/8" (15.8 mm) hole centers and 3 lugs with 1" (25.4 mm) hole centers.
- D. The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 4" (100 mm) standoff from the wall.
- E. Telecommunications Grounding Busbar (TGB)
 - 1. Telecommunications Grounding Busbar (TGB) shall be constructed of .25" (6.4 mm) thick solid copper bar.
 - 2. The busbar shall be 2" (50 mm) high and 12" (300 m) long and shall have 9 attachment points (one row) for two-hole grounding lugs.
 - 3. The hole pattern for attaching grounding lugs shall meet the requirements of ANSI-J-STD – 607-A and shall accept 6 lugs with 5/8" (15.8 mm) hole centers and 3 lugs with 1" (25.4 mm) hole centers.
 - 4. The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 4" (10 mm) standoff from the wall.
- F. Vertical Rack Busbar
 - 1. Vertical rack-mount busbar shall be constructed of 1/4" (6.4 mm) thick by 5/8" (15.8 mm) high hard-drawn electrolytic tough pitch 110 alloy copper bar.
 - 2. Bar shall be 72" (1830 mm) or 36" (910 mm) high (as specified below) for mounting vertically on relay racks.
 - 3. 72" (1830 mm) high bar shall have 13 threaded 1/4-20 attachment points for two-hole lugs with 5/8" (15.8 mm) hole centers and one pair of threaded studs for a two-hole lug with 1" (2.4 mm) hole centers.
 - 4. 36" (910 mm) high bar shall have 8 threaded 1/4-20 attachment points for two-hole lugs with 5/8" (15.8 mm) hole centers and one pair of threaded studs for a two-hole lug with 1" (2.4 mm) hole centers.
 - 5. Each bar shall include a #2 AWG two-hole compression lug for 1" (25.4 mm) hole centers, insulator blocks and mounting screws.
- G. Vertical Rack Ground Bar
 - 1. Vertical rack-mount ground bar shall be constructed of .05" (1.3 mm) thick by .68" (17 mm) wide thinned copper strip.

2. Bar shall be 78" (1997 mm) high for mounting vertically on relay racks and shall have holes punched on 5/8"-5/8"-1/2" alternating vertical centers to match the EIA-310-D Universal Hole Pattern for a 45 RMU rack.
 3. Each bar shall include three #12-24 zinc-plated thread forming hex washer head installation screws, an abrasive pad and antioxidant joint compound.
- H. Two Mounting Hold Ground Terminal Block
1. Grounding terminal block shall be made of electroplated tin aluminum extrusion.
 2. Ground terminal block shall accept conductors ranging from #14 AWG through 2/0.
 3. The conductors shall be held in place by two stainless steel set screws.
 4. Ground terminal block shall have two 1/4" (6.4 mm) holes spaced on 5/8" (15.8 mm) centers to allow secure two-bolt attachment to the rack or cabinet.
- I. Compression Lugs
1. Compression lugs shall be manufactured from electroplated tinned copper.
 2. Compression lugs shall have two holes spaced on 5/8" (15.8 mm) or 1" (25.4 mm) centers, as stated below, to allow secure two bolt connections to busbars.
 3. Compression lugs shall be sized to fit a specific size conductor, sizes #6 to 4/0.
- J. Antioxidant Joint Compound
1. Oxide inhibiting joint compound for copper-to-copper, aluminum-to-aluminum or aluminum-to-copper connections.
- K. C-Type, Compression Taps
1. Compression taps shall be manufactured from copper alloy.
 2. Compression taps shall be C-shaped connectors that wrap around two conductors forming an irreversible splice around the conductors; installation requires a hydraulic crimping tool.
 3. Compression taps shall be sized to fit specific size conductors, sizes #2 AWG to 4/0.

4. Compression taps shall be UL Listed.

L. Pedestal Clamp With Grounding Connector

1. Pedestal clamp shall be made from electroplated tinned copper or bronze. Installation hardware will be stainless steel.
2. Pedestal clamps shall be sized to fit a specific size conductor, size #6 and/or 2/0.
3. Pedestal clamp shall provide straight (in-line) or cross (intersection) support for up to two conductors.

M. Equipment Ground Jumper Kit

1. Kit includes one 24" L insulated ground jumper with a straight two hole compression lug on one end and an L-shaped two hole compression lug on the other end, two plated installation screws, an abrasive pad and a .5 ounce tube of antioxidant joint compound.
2. Ground conductor is an insulated green/yellow stripe #6 AWG wire.
3. Lugs are made from electroplated tinned copper and have two mounting holes spaces .5" to .625" apart that accept 1/4" screws.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Wall-Mount Busbars

1. Attach busbars to the wall with appropriate hardware according to the manufacturer's installation instructions.
2. Conductor connections to the TMGB or TGB shall be made with two-hole bolt-on compression lugs sized to fit the busbar and the conductors.
3. Each lug shall be attached with stainless steel hardware after preparing the bond according to manufacturer recommendations and treating the bonding surface on the busbar with antioxidant to help prevent corrosion at the bond.
4. The wall-mount busbar shall be bonded to ground as part of the overall Telecommunications Bonding and Grounding System.

B. Rack-Mount Busbars and Ground Bars

1. When a rack or cabinet supports active equipment or any type of shielded cable or cable termination device requiring a ground connection, add a rack-mount vertical busbar or ground bar to the rack or cabinet. The rack-mount busbar or ground bar provides multiple bonding points on the rack

for rack and rack-mount equipment.

2. Attach rack-mount busbars and ground bars to racks or cabinets according to the manufacturer's installation instructions.
3. Bond the rack-mount busbar or ground bar to the room's TMGB or TGB with appropriately sized hardware and conductor.

C. Ground Terminal Block

1. Every rack, cabinet and ladder rack shall be bonded to the TMGB or TGB
2. Minimum bonding connection to racks, cabinets and ladder racks shall be made with a rack-mount two-hole ground terminal block sized to fit the conductor and rack and installed according to manufacturer recommendations.
3. Remove paint between rack, cabinet and ladder rack and terminal block, clean surface and use antioxidant between the rack and the terminal block to help prevent corrosion at the bond.

D. Pedestal Clamp

1. At minimum, bond every sixth raised access floor pedestal with a minimum #6 AWG conductor to the TMGB or TGB using a pedestal clamp sized to fit the pedestal and the conductor and installed according to the manufacturer's recommendations.
2. If pedestal clamps are used to construct a signal reference grid, bond the signal reference grid to the TMGB or TGB and bond each rack and/or cabinet to the signal reference grid using a compression tap or similar non-reversible bonding component sized to fit both conductors.
3. Remove paint between the pedestal and pedestal clamp, clean surface and use antioxidant between the pedestal and the clamp to help prevent corrosion at the bond.
4. Remove insulation from conductors where wires attach to the pedestal clamp.

E. Pipe Clamp

1. Bond metal pipes located inside the data center computer room with a minimum #6 AWG conductor to the TMGB or TGB using a pipe clamp sized to fit the pipe and the conductor and installed according to the manufacturer's recommendations.
2. Remove paint between the pipe and the pipe clamp, clean surface and use antioxidant between the pipe and the clamp to help prevent corrosion at the

bond.

3. Remove insulation from conductors where wires attach to the pipe clamp.

F. Equipment Ground Jumper Kit

1. Bond equipment to a vertical rack-mount busbar or ground bar using ground jumper according to the manufacturer's recommendations.
2. Clean the surface and use antioxidant between the compression lugs on the jumper and the rack-mount busbar or ground bar to help prevent corrosion at the bond.

END OF SECTION

SECTION 27 05 33 – CONDUITS AND BACKBONES FOR COMMUNICATION SYSTEMS

PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS

- A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.
- B. Work of this Section applies to all other Sections and Sub-sections of Division 27, Communications.
- C. Electrical contractor will install cabling pathways, including conduits, stub-ups, j-hooks and boxes.
- D. Cabling to be furnished and installed by Low Voltage, Telecommunications Contractor.

1.02 SECTION INCLUDES

- A. The Work of this Section includes all labor, materials, equipment and services necessary to complete the common work associated with installing Communications under Division 27.

1.03 RELATED SECTIONS

- A. 26 00 00 – Electrical
- B. 27 05 26 Grounding and Bonding for Communications Systems
- C. 27 11 16 Communications Cabinets, Racks, Frames, and Enclosure
- D. 27 11 23 Communications Cable Management and Ladder Rack
- E. 27 11 26 Communications Rack Mounted Power Protection and Power Strip
- F. 08 33 10 Overhead Coiling Grilles
- G. 11 12 00 Parking Control Equipment

1.04 QUALITY ASSURANCE

- A. Workers: Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods necessary for proper performance of the work of this Section.

- B. Reference Documents: These standards are to be followed in addition to applicable Electrical Codes.
1. ANSI/NECA/BISCI 568-2006 – Standard for Installing Commercial Building Telecommunications Cabling.
 2. ANSI/NECA/BISCI-607 – Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
 3. ANSI/TIA-568-C.0 – Generic Telecommunications Cabling for Customer Premises
 4. ANSI/TIA-568-C.1 – Commercial Building Telecommunications Cabling Standard
 5. ANSI/TIA-568-C.2 – Balanced Twisted-Pair Telecommunications Cabling and Components Standard
 6. ANSI/TIA-568-C.3 – Optical Fiber Cabling Components Standard
 7. ANSI/TIA-569-B – Commercial Building Standard for Telecommunications Pathways and Spaces
 8. ANSI/TIA-606-A – Administration Standard for Commercial Telecommunications Infrastructure
 9. ANSI/TIA-607-B – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
 10. IEEE 802.3af – Power over Ethernet (PoE) Standard
 11. IEEE 802.3at – Power over Ethernet+ (Plus) Standard
 12. IEEE 802.11 – Wireless Standard
 13. BICSI-TDMM-2009 – Telecommunications Distribution Methods Manual

1.05 SUBMITTALS

- A. Procedural requirements for submittals is addressed in Division 01.

1.06 PRODUCT HANDLING

- A. Equipment shall be delivered in original packages with labels intact and identification clearly marked.
- B. Equipment shall not be damaged in any way and shall comply with manufacturer's operating specifications.

- C. Equipment and components shall be protected from weather, humidity, temperature variations, dirt, dust or other contaminants. Equipment damaged prior to system acceptance shall be replaced at no cost to the owner.

PART 2 – PRODUCTS

2.01 MATERIALS, EQUIPMENT AND SERVICES

- A. EMT Conduits – Use Electrical metallic tubing (EMT) that is UL Listed, and manufactured in accordance with ANSI C80.3, UL-797 and federal specifications WW-C-563e.
- B. Bushing – Install plastic insulating bushings at open ends of *all* metallic conduits (reference: NEC Article 300-15c). (Arlington Industries EMTxxx or equivalent)
- C. Pull Boxes – Use Pull Boxes sized based on the following table –

Conduit trade size	Width	Length	Depth	Width increase for additional conduit
1 in.	4 in.	16 in.	3 in.	2 in.
1¼ in.	6 in.	20 in.	3 in.	3 in.
1½ in.	8 in.	27 in.	4 in.	4 in.
2 in.	8 in.	36 in.	4 in.	5 in.
3 in.	12 in.	48 in.	5 in.	6 in.
4 in.	15 in.	60 in.	8 in.	8 in.

- D. A 1" conduit entering and leaving a pull box will be 4"x16"x3".
- E. Conduit Bodies can be used, but they must conform to conduit bodies specifically built for telecommunications. – Smart Pathways manufacturers conduit bodies from 3/4" to 4" that will guarantee that copper or fiber cable will meet the bend radius requirements for 90° bends.
- F. Telecommunication Outlet Boxes – Use Telecommunication Outlet Boxes specifically designed for telecommunications cable (Category 5e, 6, Augmented 6, 7 and optical fiber cables). Dimensions are: 5 in. Square x 2.875 in. Deep, Metal Box construction with Cable Management built into the box. Randl Industries T-55017 or equivalent.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Examine the areas and conditions in which the pathways are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected

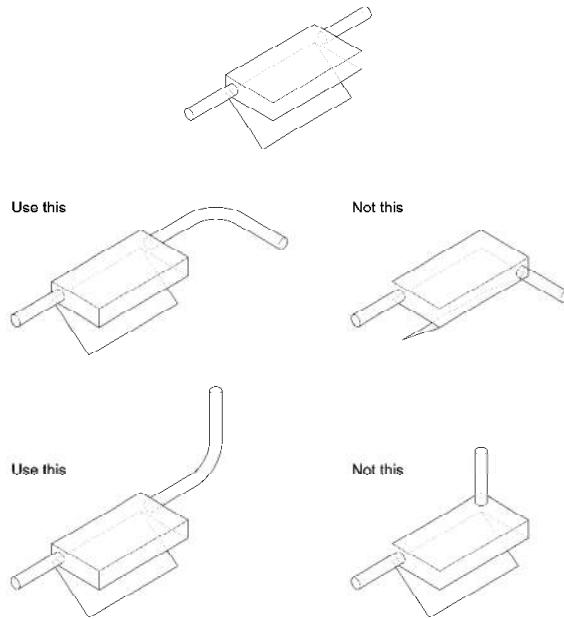
to permit proper installation of the work.

3.02 INSTALLATION

- A. Cabling to be furnished and installed by Low Voltage, Telecommunications Contractor
- B. Installation of the conduits and back-boxes will be performed by a certified electrical contractor.
- C. Often a low voltage contractor will be contracted to install the cables through pathway systems installed by the electrical contractor. The following installation instructions should be followed to insure that the pathways are suitable for the low voltage cables.
- D. A pull cord with a minimum test rating of 200 lb shall be installed in every conduit.
- E. Conduits:
 - 1. All conduit ends will be reamed and fit with an insulated bushing to eliminate sharp edges.
 - 2. Install one 1" EMT conduit in a continuous length (no daisy-chaining) up to 100 ft. in length from the Telecom Space (MDF or IDF) to each telecommunication outlet box for up to 4 data cables. Based on an O.D. cable diameter of .27 inches, and two 90° bends. Runs longer than 100' will require a pull box.
 - 3. Install one 1 ¼" EMT conduit in a continuous length (no daisy-chaining) up to 100 ft. in length from the Telecom Space (MDF or IDF) to each telecommunication outlet box for up to 7 data cables. Based on an O.D. cable diameter of .27 inches, and two 90° bends. Runs longer than 100' will require a pull box.
 - 4. Route conduits in the shortest, most direct path to the terminating Telecommunication space.
 - 5. Limit bend radii for conduits to:
 - a. 4 times the outside cable diameter for UTP cabling, i.e. 1" for Cat6 cabling.
 - b. 10 times the outside cable diameter for multipair copper cable.
 - c. 8 times the outside cable diameter for Telecommunications Bonding Bus (TBB).
 - 6. If the conduit requires a bend.
 - a. Generally limit the number of bends to no more than two 90° bends per

100 foot run; for total of 180° of bends.

- b. If a third 90° bend must be added, then a pull point or pull box must be placed between two of the bends.
- c. A bend greater than 90° is considered a reverse bend, and must have a pull point or pull box at each bend between 100° and 180°. Locate the pull point within 12" of the bend and prior to the bend to allow the cable to be pushed through the bend.
- d. An offset should be considered the same as 90° bend.
- e. Pull boxes should not be used for making bends. The following diagram represents acceptable methods for connecting to a pull box. Conduits always enter at opposite ends.



7. Three 90° bends is permissible in a run if the following is true.
 - a. Total run is less than or equal to 33'.
 - b. The conduit size is increased to the next trade size.
 - c. One of the bends is located within 12" of the cable feed end.
 - d. De-rate the capacity of the run by 15% for each 90° bend.
8. A conduit extending from a Telecommunications room should not extend to more than two, and shall not extend to more than three, telecommunication

- outlet boxes.
9. Avoid placing conduit underground if possible, (reference: ANSI/TIA-569-B, NEC Article 346-11). If conduit is used within slab on grade, be aware that the conditions might warrant the cable to be considered to be installed in a "wet" environment.
 10. Do *not* use flex conduit in any conduit run, except for extending to modular furniture, or as noted elsewhere. If flexible conduit must be used, its size should be increased by one trade size.
- F. Pull Box – If a hard lid ceiling is used, the access panel lid can also serve as the cover of the box. It must be marked and easily accessible. Size the pull box based on the table under Products.
- G. Telecommunication Outlet Boxes.
1. Should not be mounted back to back in a wall.
 2. Telecommunication Outlet Boxes should be placed within 3' of an electrical outlet and at the same installed height as the electrical outlet. The faceplate for the Telecommunications Outlet should be of the same color as the faceplate for the Electrical outlet.

END OF SECTION

SECTION 27 11 05 – COMMUNICATION EQUIPMENT ROOM FITTINGS

PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS

- A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.02 SECTIONS INCLUDES

- A. The Work of this Section includes all labor, materials, equipment and services necessary to complete the build out of the Tel/Com Rooms (MDFs), Server Rooms, Floor Distributors (IDFs) and Enclosures.

1.03 RELATED SECTIONS

- A. 26 00 00 – Electrical
- B. 27 05 26 Grounding and Bonding for Communications Systems
- C. 27 05 33 Conduits and Backbones for Communications Systems
- D. 27 11 16 Communications Cabinets, Racks, Frames, and Enclosures
- E. 27 11 23 Communications Cable Management and Ladder Rack
- F. 27 11 26 Communications Rack Mounted Power Protection and Power Strips
- G. 08 33 10 Overhead Coiling Grilles
- H. 11 12 00 Parking Control Equipment

1.04 QUALITY ASSURANCE

- A. Workers: Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and methods needed for proper performance of the work of this Section.
- B. Reference Documents: These standards are to be followed in addition to applicable Electrical Codes.
 1. ANSI/NECA/BICSI 568-2006 – Standard for Installing Commercial Building Telecommunications Cabling.
 2. ANSI/NECA/BICSI-607 – Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
 3. ANSI/TIA-568-C.0 – Generic Telecommunications Cabling for Customer Premises

4. ANSI/TIA-568-C.1 – Commercial Building Telecommunication Cabling Standard
5. ANSI/TIA-568-C.2 – Balanced Twisted-Pair Telecommunication Cabling and Components Standard
6. ANSI/TIA-568-C.3 – Optical Fiber Cabling Components Standard
7. ANSI/TIA-569-B – Commercial Building Standard for Telecommunications Pathways and Spaces
8. ANSI/TIA-606-A – Administration Standard for Commercial Telecommunications Infrastructure
9. ANSI/TIA-607-B – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
10. IEEE 802.3af – Power over Ethernet (PoE) Standard
11. IEEE 802.3at – Power over Ethernet+ (Plus) Standard
12. IEEE 802.11 – Wireless Standard
13. BICSI-TDMM-2009 – Telecommunications Distribution Methods Manual

1.05 **SUBMITTALS**

- A. Procedural requirements for submittals is addressed in Division 01.

1.06 **PRODUCT HANDLING**

- A. Equipment shall be delivered in original packages with labels intact and identification clearly marked.
- B. Equipment shall not be damaged in any way and shall comply with manufacturer's operating specifications.
- C. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust and other contaminants. Equipment damaged prior to system acceptance shall be replaced at no cost to the owner.

PART 2 – PRODUCTS

2.01 **MATERIALS, EQUIPMENT AND SERVICES**

- A. Backboard

1. 3/4" Plywood Backboard A/C grade or better, void-free.

2. Plywood will either be fire-rated or treated on all sides with at least 2 coats of fire-retardant light-colored paint.

B. Sleeves

1. 4" Metal sleeves

PART 3 – EXECUTION

3.01 INSTALLATION

A. Backboards

1. Telecommunication Spaces

- a. Use either fire-rated plywood or regular plywood treated with fire-rated paint, but do not use fire-retardant paint on fire-rated plywood.
- b. Install plywood backboard along two walls, 8' high.
- c. Bottom edge will be mounted 8" AFF.
- d. Grade A surface exposed.
- e. Plywood must be mounted so as to anticipate the total static and dynamic loads of the equipment and cabling being attached.

B. Sleeves

1. To extend 1" above the floor level from the vertically aligned telecommunication room directly below.
2. Use plastic rings around the conduit to protect the cable
3. Apply firestopping in the annular space and within the sleeve between the cables.

END OF SECTION

7. Product will have removable side panel (for creating stand alone or to create ends of row).
 8. Black powder coat paint

B. Racks

1. Provide products similar to Ortronics/Legrand Standard EIA floor racking system, product number OR-604004600 or similar.
 2. The assembled rack shall measure 7' (2.1 m)/84" (2133 mm) high; 20.2" (520 mm) wide and 15" (381.0 mm) deep.
 3. Provide freestanding 2 post racks to store networking equipment.
 4. Racks shall be manufactured from steel or aluminum.
 5. Each rack shall have two L-shaped top angles, two L-shaped base angles and two C-shaped equipment-mounting channels. The rack shall assemble with nut and bolt hardware. The base angles shall be pre-punched for attachment to the floor.
 6. Equipment mounting channels shall be 3" (76 mm) deep and punched on the front and rear flange with the EIA-310-D Universal hole pattern, 1-3/4" (44.45 mm) rack-mount spaces of 45(U). Each mounting space (U) shall be marked and numbered on the mounting channel.
 7. When assembled with top and bottom angles, equipment-mounting channels shall be spaced to allow attachment of 19" EIA rack-mount equipment. Equipment attachment points shall be threaded with 12-24 roll-formed threads. The rack shall include assembly and equipment-mounting hardware. Racks shall include 50 each combination pan head, pilot point mounting screws.
 8. The sides (webs) of the equipment-mounting channels shall be punched to allow attachment of vertical cable managers along the sides of the rack or for rack-to-rack baying.
 9. Assembly hardware shall electrically bond the top angles, side channels and base angles together when assembled, and there shall be a masked ground attachment point with 1/4-20 threaded studs spaced 5/8" apart on the inside of the side channel to attach a ground lug allowing easy attachment to the Telecommunications Ground.
 10. The rack shall be rated for a minimum of 750 lb of equipment.
 11. The rack shall be UL listed.
 12. Color will be black.

SECTION 27 11 16 – COMMUNICATION CABINETS, RACKS, FRAMES, AND
ENCLOSURES

PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS

- A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.
- B. Electrical contractor will install cabling pathways, including conduits, stub-ups, j-hooks and boxes.
- C. Communications Cabinets, Racks, Frames, and Enclosures to be furnished and installed by Low Voltage, Telecommunications Contractor.

1.02 SECTIONS INCLUDES

- A. The Work of this Section includes all labor, materials, equipment and services necessary to complete the build out of the Tel/Com Rooms (MDFs), Server Rooms, Floor Distributors (IDFs) and Enclosures.

1.03 RELATED SECTIONS

- A. 26 00 00 – Electrical
- B. 27 05 26 Grounding and Bonding for Communications Systems
- C. 27 05 33 Conduits and Backbones for Communications Systems
- D. 27 11 23 Communications Cable Management and Ladder Rack
- E. 27 11 26 Communications Rack Mounted Power Protection and Power Strips
- F. 08 33 10 Overhead Coiling Grilles
- G. 11 12 00 Parking Control Equipment

1.04 QUALITY ASSURANCE

- A. Workers: Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance for the work of this Section.
- B. Reference Documents: These standards are to be followed in addition to applicable Electrical Codes.

1. ANSI/CEA-310-E – Cabinets, Racks, Panels, and Associated Equipment

2. ANSI/TIA-569-B – Commercial Building Standard for Telecommunications Pathways and Spaces
3. ANSI/TIA-606-A – Administration Standard for Commercial Telecommunications Infrastructure
4. ANSI/TIA-607-B – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
5. TIA/EIA 570-A
6. BICSI-TDMM-2009 – Telecommunications Distribution Methods Manual

1.05 **SUBMITTALS**

- A. Procedural requirements for submittals is addressed in Division 01

1.06 **PRODUCT HANDLING**

- A. Equipment shall be delivered in original packages with labels intact and identification clearly marked.
- B. Equipment shall not be damaged in any way and shall comply with manufacturer's operation specifications
- C. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust or other contaminants. Equipment damaged prior to system acceptance shall be replaced at no cost to the owner.

PART 2 – PRODUCTS

2.01 **MATERIALS, EQUIPMENT AND SERVICES**

A. Cabinets

1. Freestanding equipment cabinets to store computer, data storage, networking, security and A/V equipment in the Tel/Com Rooms (MDF) or Server Room.
2. Provide products similar to Ortronics/Legrand Mighty Mo Cabinets, part number MMC422446-00003.
3. Cabinet size 42RU x 24" wide x 48" deep.
4. Frame configured with cable opening at bottom rear.
5. Frame Levelers
6. Full profile mesh front door.

C. Enclosures

1. For placement in IDFs
 - a. Wall mounted cabinet similar to Ortronics/Legrand Might Mo Wall Mount Cabinet, model OR-MMW192420S-B
 - b. Cabinet size 19RT x 24" wide x 20" deep
 - c. A dedicated, 120 vac nominal, non-switched circuit shall be installed within the cabinet to provide power to networking equipment.
 - d. Solid door
 - e. Cabinet can be mounted to be opened from either the left or right.
 - f. Locking center section swings out to provide easy access to the equipment.
 - g. 3" hold with cap standard on top and bottom rear
 - h. Vented sides for passive cooling of active equipment
 - i. Provide optional 50cfm cooling fans are available to further protect active equipment. Ortronics part number OR-MMCFAN-4-50
 - j. Provide optional 19U Mounting Rail, 12-24, 1-pair. Ortronics part number OR-MMW19M12-B
 - k. Heavy duty 14 GA steel construction.
2. Distribution Device (DD) / Structured Media Enclosure (SME), enclosure for Residential Units and Guestrooms
 - a. Distribution Device (DD) / Structured Media Enclosure (SME), enclosure for Residential Units and Guestrooms to be furnished by Low Voltage, Telecommunications Contractor and Installed by Electrical Contracor.
 - b. 28" In-wall enclosure with hinged door, similar to Legrand EN2850
 - c. Enclosure size 14.3"x28.1"x3.7"
 - d. A dedicated, 120 vac nominal, non-switched circuit shall be installed within the SME to provide power to networking equipment.
 - e. Solid lockable door.
 - f. Provide mounting plates to support installation of 3rd party router, high speed modem, switch, wireless access points, etc.

PART 3 – EXECUTION

3.01 INSTALLATION

A. General

1. Communications Cabinet, Racks, Frames and Enclosures to be furnished and installed by Low Voltage, Telecommunications Contractor
2. Provide the necessary clearances in the front and rear of the cabinets, racks, frames and enclosures, so that the equipment and cabling can be accessed without obstruction by other utilities or architectural components.
3. All enclosures shall be grounded to the TGB using appropriate hardware provided by the contractor. The ground will meet local code requirements and will be approved by the Authority Having Jurisdiction (AHJ).

B. Cabinets

1. Cabinets to be furnished and installed by Low Voltage, Telecommunications Contractor.
2. Assemble cabinets according to manufacturer's instructions. Verify that equipment mounting rails are sized properly for rack-mount equipment before attaching the cabinet to the floor.
3. All cabinets must be properly leveled to the floor using the included levelers.
4. Ladder rack may be attached to the top of the cabinet to deliver cables to the cabinet. The cabinet shall not be drilled to attach ladder rack. Use appropriate hardware from the ladder rack manufacturer or Cabinet manufacturer.
5. The equipment load will be evenly distributed and uniform on the cabinet. Place large and heavy equipment towards the bottom of the cabinet. Secure all equipment to the cabinet with equipment mounting screws. In seismic areas, secure equipment to shelves with additional bracing.

C. Racks

1. Racks to be furnished and installed by Low Voltage, Telecommunications Contractor.
2. Assemble relay racks according to manufacturer's instructions. Verify that equipment mounting rails are sized properly for rack-mount equipment before attaching the rack to the floor.

3. All racks must be attached to the floor in four places using appropriate floor mounting anchors. When placed over a raised floor, threaded rods should pass through the raised floor tile and be secured in the structural floor below.
4. Ladder rack may be attached to the top of the rack to deliver cables to the rack. The rack shall not be drilled to attach ladder rack. Use appropriate hardware from the ladder rack manufacturer or Rack manufacturer.
5. The equipment load will be evenly distributed and uniform on the rack. Place large and heavy equipment towards the bottom of the rack. Secure all equipment to the rack with equipment mounting screws. In seismic areas, secure equipment to shelves with additional bracing.

D. Wall Mount Cabinets

1. Wall Mount Cabinets to be furnished and installed by Low Voltage, Telecommunications Contractor.
2. Assemble cabinets according to manufacturer's instructions. Verify that equipment mounting rails are sized properly for rack-mount equipment before attaching the cabinet to the wall.
3. D-rings or other wall mounted cable supports will be used to properly support and direct cables to the wall mounted cabinets.
4. The equipment load will be evenly distributed and uniform within the cabinet. Place large and heavy equipment towards the bottom of the cabinet. Secure all equipment to the cabinet with equipment mounting screws. In seismic areas, secure equipment to shelves with additional bracing.

E. In-Unit Enclosures (DD / SME)

1. In-Unit Enclosures (DD/SME) and A/C receptacle to be furnished by Low Voltage, Telecommunications Contractor and installed by Electrical Contractor.
2. Enclosure will be flush mounted to the drywall.
3. Enclosures will include mounting brackets for installing Cat6 termination blocks and for mounting electronic equipment necessary for Voice, Data and Video Communications.
4. A grounding conductor from the DD to the residence system electrical power ground shall have a total wire length of less than 20 feet.

3.02 CLEANING

A. Waste Removal

1. Remove all packaging material that came included with the enclosures

B. Cleaning

1. Construction dust, metal filings and debris from drilling, cutting, sawing, etc. can be detrimental to electronic equipment.
2. Contractor will be required to provide protective plastic covers to protect HVAC, UPS and other electronic equipment from construction debris.
3. After installation of cabinets, racks and enclosures is complete, the contractor will vacuum and/or mop the immediate area prior to terminating cables and installing electronic equipment.

END OF SECTION

SECTION 27 11 23 – COMMUNICATION CABLE MANAGEMENT AND LADDER RACK

PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS

- A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.
- B. Electrical contractor will install cabling pathways, including conduits, stub-ups, j-hooks and boxes.
- C. Communications Cabinets, Racks, Frames, and Enclosures to be furnished and installed by Low Voltage, Telecommunications Contractor.

1.02 SECTIONS INCLUDES

- A. The Work of this Section includes all labor, materials, equipment and services necessary to complete the build out of the Tel/Com Rooms (MDFs), Server Rooms, Floor Distributors (IDFs) and Enclosures.
- B. Follower products are used for efficient routing of cables

1.03 RELATED SECTIONS

- A. 26 00 00 – Electrical
- B. 27 05 26 Grounding and Bonding for Communications Systems
- C. 27 05 33 Conduits and Backbones for Communications Systems
- D. 27 11 16 Communications Cabinets, Racks, Frames, and Enclosures
- E. 27 11 26 Communications Rack Mounted Power Protection and Power Strips
- F. 08 33 10 Overhead Coiling Grilles
- G. 11 12 00 Parking Control Equipment

1.04 QUALITY ASSURANCE

- A. Workers: Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance for the work of this Section.
- B. Reference Documents: These standards are to be followed in addition to applicable Electrical Codes.

1. ANSI/NECA/BICSI 568-2006 – Standard for Installing Commercial Building Telecommunications Cabling.
2. ANSI/NECA/BICSI-607 – Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
3. ANSI/TIA-568-C.0 – Generic Telecommunications Cabling for Customer Premises
4. ANSI/TIA-568-C.1 – Commercial Building Telecommunication Cabling Standard
5. ANSI/TIA-568-C.2 – Balanced Twisted-Pair Telecommunications Cabling and Components Standard
6. ANSI/TIA-568-C.3 – Optical Fiber Cabling Components Standard
7. ANSI/TIA-569-B – Commercial Building Standard for Telecommunications Pathways and Spaces
8. ANSI/TIA-606-A – Administration Standard for Commercial Telecommunications Infrastructure
9. ANSI/TIA-607-B – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
10. IEEE 802.3af – Power over Ethernet (PoE) Standard
11. IEEE 802.3at – Power over Ethernet+ (Plus) Standard
12. IEEE 802.11 – Wireless Standard
13. BICSI-TDMM-2009 – Telecommunications Distribution Methods Manual

1.05 SUBMITTALS

- A. Procedural requirements for submittals is addressed in Division 01.

1.06 PRODUCT HANDLING

- A. Equipment shall be delivered in original packages with labels intact and identification clearly marked.
- B. Equipment shall not be damaged in any way and shall comply with manufacturer's operating specifications
- C. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust or other contaminants. Equipment damaged prior to system acceptance shall be replaced at no cost to the owner.

PART 2 – PRODUCTS

2.01 EQUIPMENT

- A. Vertical Cable Management – Racks
 - 1. Vertical Cable Manager 6" wide, 13.17" deep and 7' high
 - 2. Double-sided
 - 3. Comes with cover
 - 4. Comparable to Ortronics OR-DVMS706
- B. Horizontal Cable Management – Racks and Cabinets
 - 1. Horizontal Cable Manager 3"H x 4"D (2 RU high)
 - 2. 5 Horizontal Rings
 - 3. Comparable to Ortronics OR-60400057
- C. Ladder Rack
 - 1. Tubular stringer style – 1.5" boxed
 - 2. 3/8" x 1-1/2" steel tube welded rungs spaced 12" on center
 - 3. 12" wide
 - 4. Black
 - 5. Comparable to Copper B-Line SB17T12BFB

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Examine the areas and conditions in which the pathways are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.02 INSTALLATION

- A. Products listed in Part 2 to be furnished and installed by Low Voltage, Telecommunications Contractor

B. Vertical Cable Management

1. One cable manager between racks and
2. One cable manager at each end of a row of racks

C. Horizontal Cable Management

1. One cable manager per patch panel and Ethernet switch in the rack or cabinet.
2. Place one cable manager between each patch panel or Ethernet switch.

D. Ladder Rack

1. Ladder racks will be used as an overhead pathway for the cable between the point of entry into the Telecommunication Space to the rack or cabinet.
2. Ladder racks will be overhead and in-line with the equipment rows.
3. Coordinate ladder rack locations with lighting, air-handling systems and fire extinguishing systems so as not to interfere with cable access.

END OF SECTION

SECTION 27 11 26 – COMMUNICATION RACK MOUNTED POWER PROTECTION
AND POWER STRIPS

PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS

- A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.
- B. Electrical contractor will install cabling pathways, including conduits, stub-ups, j-hooks and boxes.
- C. Communications Cabinets, Racks, Frames, and Enclosures to be furnished and installed by Low Voltage, Telecommunications Contractor.

1.02 SECTIONS INCLUDES

- A. The Work of this Section includes all labor, materials, equipment and services necessary to complete the build out of the Tel/Com Rooms (MDFs), Server Rooms, Floor Distributors (IDFs) and Enclosures.

1.03 RELATED SECTIONS

- A. 26 00 00 – Electrical
- B. 27 05 26 Grounding and Bonding for Communications Systems
- C. 27 05 33 Conduits and Backbones for Communications Systems
- D. 27 11 16 Communications Cabinets, Racks, Frames, and Enclosures
- E. 27 11 23 Communications Cable Management and Ladder Rack
- F. 08 33 10 Overhead Coiling Grilles
- G. 11 12 00 Parking Control Equipment

1.04 QUALITY ASSURANCE

- A. Workers: Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance for the work of this Section.
- B. Reference Documents: These standards are to be followed in addition to applicable Electrical Codes.
 1. ANSI/NECA/BICSI 568-2006 – Standard for Installing Commercial Building Telecommunications Cabling.

2. ANSI/NECA/BICSI-607 – Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
3. ANSI/TIA-568-C.0 – Generic Telecommunications Cabling for Customer Premises
4. ANSI/TIA-568-C.1 – Commercial Building Telecommunication Cabling Standard
5. ANSI/TIA-568-C.2 – Balanced Twisted-Pair Telecommunications Cabling and Components Standard
6. ANSI/TIA-568-C.3 – Optical Fiber Cabling Components Standard
7. ANSI/TIA-569-B – Commercial Building Standard for Telecommunications Pathways and Spaces
8. ANSI/TIA-606-A – Administration Standard for Commercial Telecommunications Infrastructure
9. ANSI/TIA-607-B – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
10. IEEE 802.3af – Power over Ethernet (PoE) Standard
11. IEEE 802.3at – Power over Ethernet+ (Plus) Standard
12. IEEE 802.11 – Wireless Standard
13. BICSI-TDMM-2009 – Telecommunications Distribution Methods Manual

1.05 **SUBMITTALS**

- A. Procedural requirements for submittals is addressed in Division 01

1.06 **PRODUCT HANDLING**

- A. Equipment shall be delivered in original packages with labels intact and identification clearly marked.
- B. Equipment shall not be damaged in any way and shall comply with manufacturer's operating specifications
- C. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust or other contaminants. Equipment damaged prior to system acceptance shall be replaced at no cost to the owner.

PART 2 – PRODUCTS

2.01 MATERIALS, EQUIPMENT AND SERVICES

- A. The following to be furnished and installed by Low Voltage, Telecommunications Contractor.
- B. Vertical Mounted – Metered Power Distribution Unit (PDU)
 - 1. 66.5" long
 - 2. Vertically mounted to cabinet.
 - 3. 120V 20A
 - 4. 24 NEMA 5-20 outlets
 - 5. L5-20P input plug
 - 6. 10' cord
 - 7. Comparable to Ortronics OR-MMCPM12024-01
 - a. Battery Backup

PART 3 – EXECUTION

3.01 INSPECTION

- A. Examine the areas and conditions in which the pathways are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.02 INSTALLATION

- A. Communications Rack mounted Power protection and Power strips to be furnished and installed by Low Voltage, Telecommunications Contactor
- B. Telecommunication Space
 - 1. Tel/Com and Server Rooms
 - a. Install plywood backboard along two walls, 8' high.
 - b. Bottom edge will be mounted 8" AFF.
 - c. Grade A surface exposed.

- d. Install either fire-rated plywood or plywood painted with fire-retardant paint.
- e. Plywood must be mounted so as to anticipate the total static and dynamic loads of the equipment and cabling being attached.

C. Communications Entrance Protection

- 1. Communications Entrance Protection to be furnished and installed by Low Voltage, Telecommunications Contractor.

D. Communications Cabinets, Racks, Frames, and Enclosures

- 1. Communications Cabinets, Racks, Frames, and Enclosures to be furnished and installed by Low Voltage, Telecommunications Contractor.

2. Relay Racks

- a. Assemble relay racks according to manufacturer's instructions. Verify that equipment mounting rails are sized properly for rack-mount equipment before attaching the rack to the floor.
- b. All racks must be attached to the floor in four places using appropriate floor mounting anchors. When placed over a raised floor, threaded rods should pass through the raised floor tile and be secured in the structural floor below.
- c. Racks shall be grounded to the TGB using appropriate hardware provided by the contractor. The ground will meet local code requirements and will be approved by the Authority Having Jurisdiction (AHJ).
- d. Ladder rack may be attached to the top of the rack to deliver cables to the rack. The rack shall not be drilled to attach ladder rack. Use appropriate hardware from the ladder rack manufacturer or Rack manufacturer.
- e. The equipment load will be evenly distributed and uniform on the rack. Place large and heavy equipment mounting screws. In seismic areas, secure equipment to shelves with additional bracing.

E. Communications Termination Blocks and Patch Panels

- 1. Communications Termination Blocks and Patch Panels to be furnished and installed by Low Voltage, Telecommunications Contractor.

F. Communications Cable Management and Ladder Racks

- 1. Communications Cable Management and Ladder Racks to be furnished and installed by Low Voltage, Telecommunications Contractor.

BENJAMIN WOO ARCHITECTS
PROJECT NO. 1709

LILIA WAIKIKI
HONOLULU, HAWAII

G. Communications Rack Mounted Power Protection and Power Strips

1. Communications Rack Mounted Power Protection and Power Strips to be furnished and installed by Low Voltage, Telecommunications Contractor.

END OF SECTION

DIVISION 28 ELECTRONIC SAFETY AND SECURITY

SECTION 28 05 13 – CONDUCTORS AND CABLES FOR ESS

PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS

- A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.
- B. Conductors and cables refers to that portion of the telecommunications cabling system that extends from the work area telecommunications outlet/connector or security device to the appropriate horizontal cross-connect (IDF) or main cross-connect (MDF).
- C. Cabling should be installed according to the SC drawings for security.
- D. Electrical contractor will install CATV cabling pathways, including conduits, stub-ups, j-hooks and boxes.
- E. Cabling to be furnished and installed by Low Voltage, Security Contractor.
Cabling types include:
 - 1. Category 6 cabling for CCTV cameras and Access control panel Ethernet connections.
 - 2. Multi-conductor cable, AWG 22-8 shielded, from the Card Readers to the Access control panels.
 - 3. Multi-conductor cable, AWG 22-4, from the request to exit device to the Access control panel.
 - 4. Multi-conductor cable, AWG 22-2, from the door position switch to the Access control panel.
 - 5. Multi-conductor cable, AWG 18-2, from the Electric Strike or Lockset to the Power Distribution Panel.
 - 6. Multi-mode fiber between Ethernet Switches

1.02 RELATED SECTIONS

- A. 26 00 00 – Electrical
- B. 28 05 28.33 Conduits and Backbones for ESS
- C. 08 33 10 Overhead Coiling Grilles
- D. 11 12 00 Parking Control Equipment

1.03 REFERENCES

- A. Reference Documents: These standards are to be followed in addition to applicable Electrical Codes.
1. ANSI/NECA/BICSI 568-2006 – Standard for Installing Commercial Building Telecommunications Cabling.
 2. ANSI/NECA/BICSI-607 – Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
 3. ANSI/TIA-568-C.0 – Generic Telecommunications Cabling for Customer Premises
 4. ANSI/TIA-568-C.1 – Commercial Building Telecommunication Cabling Standard
 5. ANSI/TIA-568-C.2 – Balanced Twisted-Pair Telecommunications Cabling and Components Standard
 6. ANSI/TIA-568-C.3 – Optical Fiber Cabling Components Standard
 7. ANSI/TIA-569-B – Commercial Building Standard for Telecommunications Pathways and Spaces
 8. ANSI/TIA-606-A – Administration Standard for Commercial Telecommunications Infrastructure
 9. ANSI/TIA-607-B – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
 10. IEEE 802.3af – Power over Ethernet (PoE) Standard
 11. IEEE 802.3at – Power over Ethernet+ (Plus) Standard
 12. IEEE 802.11 – Wireless Standard
 13. BICSI-TDMM-2009 – Telecommunications Distribution Methods Manual

1.04 SUBMITTALS

- A. Action / Information Submittals
1. Category 6 cable test results for every cable run. Testing to ANSI/TIA/EIA-568-C.2 requirements
 2. Fiber cable test results for every fiber strand run. Testing to ANSI/TIA/EIA-568-C.3 requirements.

B. Closeout Submittals

1. Provide warranty for horizontal cable

1.05 QUALITY ASSURANCE

- A. Provide manufacturer's certifications for the products or materials being installed.
- B. Installer will be certified in the cable they will be installing.
- C. Proof of certification will be made available if requested by the owner/builder.

1.06 PRODUCT HANDLING

- A. Delivery and Acceptance: Use all means necessary to protect the materials of this Section before, during and after installation and to protect the installed work and materials of all other trades.
- B. Remove all packaging debris from the job site.

1.07 WARRANTY

- A. Category 6 cabling will be warranted for 25 years by the installer/manufacturer.

PART 2 – PRODUCTS

2.01 MATERIALS, EQUIPMENT AND SERVICES

A. Category 6 Cabling

1. Superior Essex Category 6, part number 77-246-xA and 77-246-xB or similar
2. Plenum (CMP) or Riser 9CMR) cable will be used depending on whether the cable will be used in an environmental air handling space, in accordance with NEC article 300-22(c).
3. Required characteristics:
 - a. Nominal Diameter of cable .22 inches
 - b. 23 AWG
 - c. Insulation:
 - 1) CMR – Polyolefin
 - 2) CMP –FEP

- d. Jacket:
 - 1) CMR – Flame retardant (FR) PVC
 - 2) CMP – FR, low smoke PVC
- e. Characteristic impedance 100 ohms (± 15)
- f. UL verification
 - 1) Verified CAT 6
 - 2) Listed CMR
 - 3) Listed CMP
- g. Color Blue
- h. Part Number
 - 1) CMR – 77-246-2A
 - 2) CMP – 77-246-2B

B. Reader Cable – Shielded

- 1. West Penn, catalog number 253271B or similar
- 2. Plenum (CMP) or Riser (CMR) cable will be used depending on whether the cable will be used in an environmental air handling space, in accordance with NEC article 300-22(c)
- 3. Required characteristics for Plenum cabling:
 - a. 8 Conductor Cable
 - b. Nominal outside diameter of cable .167 inches
 - c. 22 AWG
 - d. Insulations:
 - 1) Polymer-Alloy
 - e. Shielding:
 - 1) Aluminum Foil – 100%

f. Jacket:

- 1) Flex Plenum

g. UL listed

- 1) Flame rating UL-NFPA-262 Smoke and Flame Test

h. NEC Type CMP

4. Equivalent products by Liberty and Belden

C. Request to Exit Cable

1. West Penn, catalog number 25241B or similar

2. Plenum (CMP) or Riser (CMR) cable will be used depending on whether the cable will be used in an environmental air handling space, in accordance with NEC article 300-22(c).

3. Required characteristics for Plenum cabling:

a. 4 Conductor Cable

b. Nominal outside diameter of cable .136 inches

c. 22 AWG

d. Insulation:

- 1) Polymer-Alloy

e. Shielding:

- 1) None

f. Jacket:

- 1) Flex Plenum

g. UL listed

- 1) Flame rating UL NFPA-262 Smoke and Flame Test

h. NEC Type CMP

D. Door Position Switch Cable

1. West Penn, catalog number 25221B or similar

2. Plenum (CMP) or Riser (CMR) cable will be used depending on whether the cable will be used in an environmental air handling space, in accordance with NEC article 300-22(c).
3. Required characteristics for Plenum cabling:
 - a. 2 Conductor Cable
 - b. Nominal outside diameter of cable .116 inches
 - c. 22 AWG
 - d. Insulations:
 - 1) Polymer-Alloy
 - e. Shielding:
 - 1) None
 - f. Jacket:
 - 1) Flex Plenum
 - g. UL listed
 - 1) Flame rating UL NFPA-262 Smoke and Flame Test
 - h. NEC Type CMP
4. Equivalent products by Liberty and Belden

E. Electric Strike or Lockset Power Cable – Shielded

1. West Penn, catalog number B or similar
2. Plenum (CMP) or Riser (CMR) cable will be used depending on whether the cable will be used in an environmental air handling space, in accordance with NEC article 300-22(c).
3. Required characteristics for Plenum cabling:
 - a. 2 Conductor Cable
 - b. Nominal outside diameter of cable .154 inches
 - c. 18 AWG
 - d. Insulation:
 - 1) Polymer-Alloy

e. Shielding:

- 1) Aluminum Foil – 100%

f. Jacket:

- 1) Flex Plenum

g. UL listed

- 1) Flame rating UL NFPA-262 Smoke and Flame Test

h. NEC Type CMP

4. Equivalent products by Liberty and Belden

F. Fiber

1. Corning MIC Riser 004T81-31180-24 and Corning MIC Plenum 004T88-31180-29
2. Fiber Optic Cable, 50/125 µm, Multimode, OM3, 6 Strand.
3. Equivalent products by Commscope, Ortronics and Leviton

G. Connectors

4. Fiber Optic Connector, SC, Multimode, 50 µm, 3 mm Boot.
 - a. Corning Unicam SC OM3 95-050-41-X
 - b. Equivalent products by Commscope, Ortronics and Leviton
5. RJ-45 Connector, 8-position, 180° exit, fog white
 - a. Ortronics Clarity 6 jack, OR-TJ600

PART 3 – EXECUTION

3.01 **EXAMINATION**

- A. Cable will be visually inspected for any crimps in the cabling that can affect the performance of the cable.

3.02 **INSTALLATION**

- A. Cabling to be furnished and installed by Low Voltage, Security Contractor
- B. Category 6 cabling:

1. Cabling must be installed in a star topology, with all cabling going to the appropriate horizontal cross-connect (IDF) in each building and then to the main cross-connect (MDF).
 2. Cat6 cable will be terminated on a modular patch panel in the Telecommunication space and on a RJ45 jack at the device end using an insulation-displacement connector (IDC).
 3. Pair untwist at the termination ends should not exceed 0.5 inches.
 4. Bend radius of the cable in the termination area should not be less than 4 times of the outside diameter of the cable. Nominally, the outside cable diameter is 0.25 inches for a bend radius of 1"
 5. Splicing is not permitted for balanced twisted-pair horizontal cabling, i.e. Cat6.
 6. Bridge taps are prohibited.
 7. Cable will be terminated to TIA/EIA-568-C specifications
 8. Cable will be warrantied for 25 years.
 9. Cable will be verified to be wired correctly and certified in conformance with ANSI/TIA/EIA-568-C.2. A suitable tester such as the Fluke DTX Cable Analyzer will be used to generate a report for every cable run.
- C. Multi-conductor cable installation
1. Cable that will be spliced should use butt-splice connectors appropriate for the gauge wire to be spliced.
 2. Shielded cables should be grounded at one end. This eliminates the potential for noise inducing ground loops.
- D. Fiber
1. 6 strand Multi-mode fiber will connect Ethernet switches between Telecommunications Spaces.
 2. The fiber will be terminated using SC connectors.
 3. Fiber Cable will be certified in conformance with ANSI/TIA/EIA-568-C.3. A suitable tester such as the Fluke DTX Cable Analyzer will be used to generate a report for every fiber strand run.

3.03 CLEANING

A. Waste Removal

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1. Remove all packaging material and waste from punching down the cabling.
- B. Cleaning
 1. After installation of cabling and equipment is complete, the contractor will vacuum and/or mop the work area.

END OF SECTION

SECTION 28 05 26 – GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY (ESS)

PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS

- A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.
- B. Work of this Section applies to all other Sections and Sub-sections of Division 28, Electronic Safety and Security.
- C. Work of this Section identifies products and work that may have been previously identified by either the Electrical Engineer or Low-voltage Communication Designer.

1.02 SECTIONS INCLUDES

- A. The Work of this Section includes all labor, materials, equipment and services necessary to complete the common work associated with installing Security Systems under Division 28.
- B. The products and work included in this section identify grounding and bonding requirements for the Video Surveillance System and the Access Control System

1.03 RELATED SECTIONS

- A. 26 00 00 – Electrical
- B. 27 05 26 Grounding and Bonding for Communications Systems
- C. 08 33 10 Overhead Coiling Grilles
- D. 11 12 00 Parking Control Equipment

1.04 QUALITY ASSURANCE

- A. Workers: Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance for the work of this Section.
- B. All grounding and bonding equipment shall be UL listed
- C. Reference Documents: These standards are to be followed in addition to applicable Electrical Codes.
 - 1. ANSI/NECA/BICSI 568-2006 – Standard for Installing Commercial Building Telecommunications Cabling.

2. ANSI/NECA/BICSI-607 – Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
3. ANSI/TIA-568-C.0 – Generic Telecommunications Cabling for Customer Premises
4. ANSI/TIA-568-C.1 – Commercial Building Telecommunication Cabling Standard
5. ANSI/TIA-568-C.2 – Balanced Twisted-Pair Telecommunications Cabling and Components Standard
6. ANSI/TIA-568-C.3 – Optical Fiber Cabling Components Standard
7. ANSI/TIA-569-B – Commercial Building Standard for Telecommunications Pathways and Spaces
8. ANSI/TIA-606-A – Administration Standard for Commercial Telecommunications Infrastructure
9. ANSI/TIA-607-B – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
10. IEEE 802.3af – Power over Ethernet (PoE) Standard
11. IEEE 802.3at – Power over Ethernet+ (Plus) Standard
12. IEEE 802.11 – Wireless Standard
13. BICSI-TDMM-2009 – Telecommunications Distribution Methods Manual

1.05 **SUBMITTALS**

- A. Procedural requirements for submittals is addressed in Division 01.
1. Contractor will provide product catalog cut-sheets prior to installation for approval.

1.06 **PRODUCT HANDLING**

- A. Equipment shall be delivered in original packages with labels intact and identification clearly marked.
- B. Equipment shall not be damaged in any way and shall comply with manufacturer's operating specifications
- C. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust or other contaminants. Equipment damaged prior to system acceptance shall be replaced at no cost to the owner.

PART 2 – PRODUCTS

2.01 MATERIALS, EQUIPMENT AND SERVICES

A. Telecommunications Main Grounding Busbar (TMGB)

1. Telecommunications Main Grounding Busbar (TMGB) shall be constructed of .25" thick electrolytic tough pitch 110 alloy copper bar.
2. The busbar shall be 4" (100 mm) high and 20" (510 mm).
3. The hole pattern for attaching grounding lugs shall meet the requirements of ANSI-J-STD – 607-A and shall have 25 5/16" hole sets and 6 7/16" hole sets.
4. The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 4" (100 mm) standoff from the wall.
5. Product will be comparable to Legrand Ortronics Part No. OR-GB4X20TMGBKIT

B. Telecommunications Grounding Busbar (TGB)

1. Telecommunications Grounding Busbar (TGB) shall be constructed of .25" thick electrolytic tough pitch 110 alloy copper bar.
2. The busbar shall be 2" (50 mm) high and 12" (300 mm) long.
3. The hole pattern for attaching grounding lugs shall meet the requirements of ANSI-J-STD – 607-A and shall accept 6 5/16" hole sets and 3 7/16" hole sets.
4. The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 4" (100 mm) standoff from the wall.
5. Product will be comparable to Legrand Ortronics Part No. OR-GB2X12TGBKIT

C. Vertical Equipment Ground Bar

1. Vertical Equipment Ground Bar shall be constructed of .25" thick electrolytic tough pitch 110 alloy copper bar.
2. Bar shall be 72" (1830 mm) or 36" (910 mm) high and 5/8" wide (as required) for mounting vertically on relay racks or cabinets.
3. Product will be comparable to Legrand Ortronics Part No. OR-GBV36KIT or OR-GBV72KIT.

D. Two Mounting Grounding Lug

1. Allows grounding of racks and cabinets.
2. Ground terminal block shall be made of electroplated tin aluminum extrusion.
3. Ground terminal block shall accept conductors ranging from #14 AWG through 2/0.
4. The conductors shall be held in place by two stainless steel set screws.
5. Ground terminal block shall have two 1/4" (6.4 mm) holes spaced on 5/8" (15.8 mm) centers to allow secure two-bolt attachment to the rack or cabinet.
6. Product will be comparable to Legrand Ortronics Part No. OR-GL2014

E. Compression Lugs

1. Compression lugs shall be manufactured from electroplated tinned copper.
2. Compression lugs shall have two holes spaced on 5/8" (15.8 mm) or 1" (25.4 mm) centers to allow secure two bolt connections to busbars.
3. Compression lugs shall be sized to fit a specific size conductor, sizes #6 to 4/0.
4. Product will be comparable to Legrand Ortronics Part No. OR-CL2LBXX (XX refers to size)

F. C-Type, Compression Taps

1. Connects two copper conductors together with a hydraulic crimping tool.
2. Compression taps shall be manufactured from copper alloy.
3. Compression taps shall be sized to fit specific size conductors, sizes #2 AWG to 2/0.
4. Product will be comparable to Legrand Ortronics Part No. OR-CTHDXXXX (XXXX refers to conductor tap size)

G. Antioxidant Joint Compound

1. Oxide inhibiting joint compound for copper-to-copper, aluminum-to-aluminum or aluminum-to-copper connections.

2. Product will be comparable to Legrand Ortronics Part No. OR-AJCA or OR-AJCC
- H. Equipment Ground Jumper Kit
1. Kit includes one 24" L insulated ground jumper with a straight two hole compression lug on one end and an L-shaped two hole compression lug on the other end, two plated insulation screws, an abrasive pad and a .5 ounce tube of antioxidant joint compound.
 2. Ground conductor is an insulated green/yellow stripe #6 AWG wire
 3. Lugs are made from electroplated tinned copper and have two mounting holes spaces .5" to .625" apart that accept 1/4" screws.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Wall-Mount Busbars
1. Attach busbars to the wall with appropriate hardware according to the manufacturer's installation instructions.
 2. Conductor connections to the TMGB or TGB shall be made with two-hole bolt-on compression lugs sized to fit the busbar and the conductors.
 3. Each lug shall be attached with stainless steel hardware after preparing the bond according to manufacturer recommendations and treating the bonding surface on the busbar with antioxidant to help prevent corrosion at the bond.
 4. The wall-mount bushbar shall be bonded to ground as part of the overall Telecommunications Bonding and Grounding System.
- B. Rack-Mount Busbars and Ground Bars
1. When a rack or cabinet supports active equipment or any type of shielded cable or cable termination device requiring a ground connection, add a rack-mount vertical busbar or ground bar to the rack or cabinet. The rack-mount busbar or ground bar provides multiple bonding points on the rack for rack and rack-mount equipment.
 2. Attach rack-mount busbars and ground bar to the room's TMGB or TGB with appropriately sized hardware and conductor.

C. Ground Terminal Block

1. Every rack, cabinet and ladder rack shall be bonded to the TMGB or TGB.
2. Minimum bonding connection to racks, cabinets and ladder racks shall be made with a rack-mount two-hole ground terminal block sized to fit the conductor and rack and installed according to manufacturer recommendations.
3. Remove paint between rack, cabinet and ladder rack and terminal block, clean surface and use antioxidant between the rack and the terminal block to help prevent corrosion at the bond.

D. Pedestal Clamp

1. At minimum, bond every sixth raised access floor pedestal with a minimum #6 AWG conductor to the TMGB or TGB using a pedestal clamp sized to fit the pedestal and the conductor and installed according to the manufacturer's recommendations.
2. If pedestal clamps are used to construct a signal reference grid, bond the signal reference grid to the TMGB or TGB and bond each rack and/or cabinet to the signal reference grid using a compression tap or similar non-reversible bonding component sized to fit both conductors.
3. Remove paint between the pedestal and pedestal clamp, clean surface and use antioxidant between the pedestal and the clamp to help prevent corrosion at the bond.
4. Remove insulation from conductors where wires attach to the pedestal clamp.

E. Pipe Clamp

1. Bond metal pipes located inside the data center computer room with a minimum #6 AWG conductor to the TMGB or TGB using a pipe clamp sized to fit the pipe and the conductor and installed according to the manufacturer's recommendations.
2. Remove paint between the pipe and pipe clamp, clean surface and use antioxidant between the pipe and the clamp to help prevent corrosion at the bond.
3. Remove insulation from conductors where wires attach to the pipe clamp.

F. Equipment Ground Jumper Kit

1. Bond equipment to a vertical rack-mount busbar or ground bar using ground jumper according to the manufacturer's recommendations.

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2. Clean the surface and use antioxidant between the compression lugs on the jumper and the rack-mount busbar or groundbar to help prevent corrosion at the bond.

END OF SECTION

**SECTION 28 05 28.33 – CONDUITS AND BACKBONES FOR ELECTRONIC SAFETY
AND SECURITY (ESS)**

PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS

- A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.
- B. Work of this Section applies to all other Sections and Sub-sections of Division 28, Electronic Safety and Security.

1.02 SECTIONS INCLUDES

- A. The Work of this Section includes all labor, materials, equipment and services necessary to complete the common work associated with installing Security Systems under Division 28.

1.03 RELATED SECTIONS

- A. 26 00 00 – Electrical
- B. 27 05 33 Conduits and Backbones for Communications Systems
- C. 08 33 10 Overhead Coiling Grilles
- D. 11 12 00 Parking Control Equipment

1.04 QUALITY ASSURANCE

- A. Workers: Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance for the work of this Section.
- B. Reference Documents: These standards are to be followed in addition to applicable Electrical Codes.
 1. UL 827. – Standard for Central-Station Alarm Services. UL 2008.
 2. UL 1034. – Standard for Burglary-Resistant Electric Locking Mechanisms. UL 2000.
 3. ANSI/NECA/BICSI 568-2006 – Standard for Installing Commercial Building Telecommunications Cabling.
 4. ANSI/NECA/BICSI-607 – Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings

5. ANSI/TIA-568-C.0 – Generic Telecommunications Cabling for Customer Premises
6. ANSI/TIA-568-C.1 – Commercial Building Telecommunication Cabling Standard
7. ANSI/TIA-568-C.2 – Balanced Twisted-Pair Telecommunications Cabling and Components Standard
8. ANSI/TIA-568-C.3 – Optical Fiber Cabling Components Standard
9. ANSI/TIA-569-B – Commercial Building Standard for Telecommunications Pathways and Spaces
10. ANSI/TIA-606-A – Administration Standard for Commercial Telecommunications Infrastructure
11. ANSI/TIA-607-B – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
12. IEEE 802.3af – Power over Ethernet (PoE) Standard
13. IEEE 802.3at – Power over Ethernet+ (Plus) Standard
14. IEEE 802.11 – Wireless Standard
15. BICSI-TDMM-2009 – Telecommunications Distribution Methods Manual

1.05 **SUBMITTALS**

1. Procedural requirements for submittals is addressed in Division 01.

1.06 **PRODUCT HANDLING**

- A. Equipment shall be delivered in original packages with labels intact and identification clearly marked.
- B. Equipment shall not be damaged in any way and shall comply with manufacturer's operating specifications
- C. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust or other contaminants. Equipment damaged prior to system acceptance shall be replaced at no cost to the owner.

PART 2 – PRODUCTS

2.01 **MATERIALS, EQUIPMENT AND SERVICES**

- A. EMT Conduits – Use Electrical metallic tubing (EMT) that is UL Listed, and manufactured in accordance with ANSI C80.3, UL-797 and federal specifications CONDUITS AND BACKBONES FOR ELECTRONIC

- WW-C-563e.
- B. Bushings – Install plastic insulating bushings at open ends of *all* metallic conduits (reference: NEC Article 300-15c). (Arlington Industries EMTxxx or equivalent)
 - C. Pull Boxes – Use Pull Boxes sized based on the following table –

Conduit trade size	Width	Length	Depth	Width increase for additional conduit
1 in.	4 in.	16 in.	3 in.	2 in.
1¼ in.	6 in.	20 in.	3 in.	3 in.
1½ in.	8 in.	27 in.	4 in.	4 in.
2 in.	8 in.	36 in.	4 in.	5 in.
3 in.	12 in.	48 in.	5 in.	6 in.
4 in.	15 in.	60 in.	8 in.	8 in.

A 1" conduit entering and leaving a pull box will be 4"x16"x3".

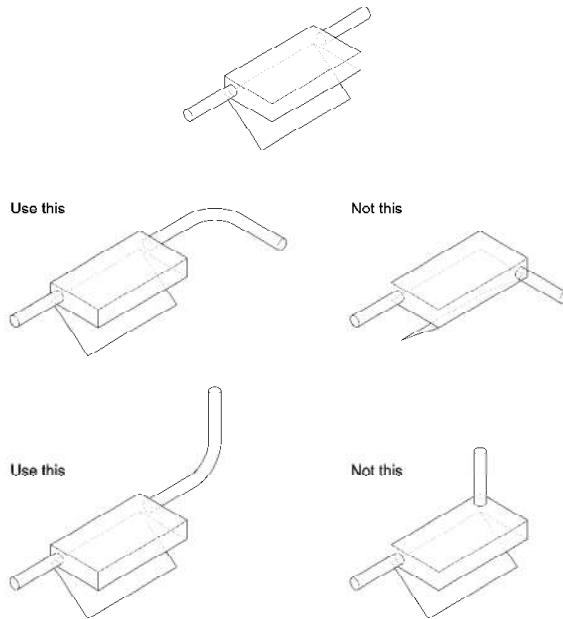
- D. Conduit Bodies can be used, but they must conform to conduit bodies specifically built for telecommunications. – Smart Pathways manufacturers conduit bodies from 3/4" to 4" that will guarantee that copper or fiber cable will meet the bend radius requirements for 90° bends.
- E. Telecommunication Outlet Boxes – Use 4-11/16" square box that is 2-1/8" deep for outlet boxes.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Installation of the conduits and backbones will be performed by a certified electrical contractor.
- B. The following installation instructions should be followed to insure that the pathways are suitable for the low voltage cables.
- C. A pull cord with a minimum test rating of 200 lb. shall be installed in every conduit.
- D. Conduits:
 1. All conduit ends will be reamed and fit with an insulated bushing to eliminate sharp edges.
 2. Install one 1" EMT conduit in a continuous length (no daisy-chaining) up to 100 ft. in length from the Telecom Space (MDF or IDF) to each telecommunication outlet box for up to 4 data cables. Based on an O.D. cable diameter of .27 inches, and two 90° bends. Runs longer than 100' will require a pull box.

3. Install one 1 ¼" EMT conduit in a continuous length (no daisy-chaining) up to 100 ft. in length from the Telecom Space (MDF or IDF) to each telecommunication outlet box for up to 7 data cables. Based on an O.D. cable diameter of .27 inches, and two 90° bends. Runs longer than 100' will require a pull box.
4. Route conduits in the shortest, most direct path to the terminating Telecommunication space.
5. Limit bend radii for conduits to:
 - a. 4 times the outside cable diameter for UTP cabling, i.e. 1" for Cat6 cabling
 - b. 10 times the outside cable diameter for multi-pair copper cable.
 - c. 8 times the outside cable diameter for Telecommunications Bonding Bus (TBB).
6. If the conduit requires a bend.
 - a. Generally limit the number of bends to no more than two 90° bends per 100 foot run; for total of 180° of bends.
 - b. If a third 90° bend must be added, then a pull point or pull box must be placed between two of the bends.
 - c. A bend greater than 90° is considered a reverse bend, and must have a pull point or pull box at each bend between 100° and 180°. Locate the pull point within 12" of the bend and prior to the bend to allow the cable to be pushed through the bend.
 - d. And offset should be considered the same as 90° bend.
 - e. Pull boxes should not be used for making bends. The following diagram represents acceptable methods for connecting to a pull box. Conduits always enter at opposite ends.



7. Three 90° bends is permissible in a run if the following is true.
 - a. Total run is less than or equal to 33'.
 - b. The conduit size is increased to the next trade size.
 - c. One of the bends is located within 12" of the cable feed end.
 - d. De-rate the capacity of the run by 15% for each 90° bend.
 8. A conduit extending from a Telecommunications room should not extend to more than two, and shall not extend to more than three, telecommunication outlet boxes.
 9. Avoid placing conduit underground if possible, (reference: ANSI/TIA-569-B, NEC Article 346-11). If conduit is used within slab on grade, be aware that the conditions might warrant the cable to be considered to be installed in a "wet" environment.
 10. Do *not* use flex conduit in any conduit run, except for extending to modular furniture, or as noted elsewhere. If flexible conduit must be used, its size should be increased by one trade size.
- E. Pull Box – If a hard lid ceiling is used, the access panel lid can also serve as the cover of the box. It must be marked and easily accessible. Size the pull box based on the table under Products.

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F. Telecommunication Outlet Boxes.

1. Should not be mounted back to back in a wall.

END OF SECTION

SECTION 28 30 33

FIRE ALARM AND DETECTION SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Fire-alarm control unit.
 - 2. Manual fire-alarm boxes.
 - 3. System smoke detectors.
 - 4. Duct smoke detectors.
 - 5. Non-system smoke detectors.
 - 6. Heat detectors.
 - 7. Notification appliances.
 - 8. Device guards.
 - 9. Firefighters' two-way telephone communication service.
 - 10. Firefighters' smoke-control station.
 - 11. Magnetic door holders.
 - 12. Remote annunciator.
 - 13. Graphic annunciator.
 - 14. Addressable interface device.
 - 15. Digital alarm communicator transmitter.
 - 16. Network communications.
 - 17. System printer.
- B. The fire alarm system is performance-based contract. The equipment provider shall develop a complete set of code-compliant and fully coordinated construction documents to the satisfaction of the Building Department and Honolulu Fire Department. The fire alarm system provider shall provide all required documentation, and shall provide all devices and accessories in the quantities and locations necessary for a fully functional and code-compliant system.
- C. Provide a microprocessor controlled, electrically supervised fire management system in accordance with the Contract Documents. Provide detailed system design, all equipment, tools, drawings, labor, materials, accessories, and approvals from governing agencies required to furnish, install, start up, and test a complete operating fire management system. Systems shall be provided and placed into operation in accordance with the requirements of the Honolulu Fire Department.
- D. The system shall include (but not be limited to) the following functions:
 - 1. Smoke and fire detection
 - 2. Sprinkler suppression system monitoring
 - 3. Other fire suppression system monitoring
 - 4. Smoke management
 - 5. Releasing service
 - 6. One-way voice communication notification system

7. Two-way voice communication system
- E. Labor, materials including conduit and wiring, equipment, and accessories as required to provide complete, operating, and approved systems, shall be provided within the scope of the Contract.
- F. Determine, coordinate, and incorporate the design and construction requirements of the architectural, structural, fire protection and mechanical systems, and auxiliary systems including food service, fire doors and windows, elevators, and other related systems, to fully meet all code requirements.
- G. The purpose of this performance-based Specification is to convey the scope of work required, all of which the Contractor is responsible to furnish, install, adjust, and make operable. The Contractor shall provide all devices and equipment required by the Fire Department. The intent of these specifications is to convey the general requirements. A complete set of shop drawings shall be submitted, stamped and signed by the Subcontractor as the Engineer of Record for the system. Under no circumstances shall the Contractor delete any equipment without the written directive of the Owner and Architect.
- H. The Contractor is responsible for providing the quantity of fire alarm devices required for complete coverage, and to meet the requirements of the codes and of the Fire Department. If additional devices are required, they shall be provided and installed at no additional cost to the Owner. Provide all required conduit, wire, panels, controls, auxiliary devices, accessories, testing, etc. for a complete and functional operating system.
- I. The fire alarm and detection system shall be a stand-alone system operating independently of other control systems.
- J. Provide dedicated 120V power to all equipment and booster panels as required, and connect to the emergency power system. See electrical drawings for emergency power panel locations. Connect to the nearest panel, unless otherwise noted on the drawings.
- K. Related work specified in other divisions of these specifications:
1. Sprinkler water flow and tamper switches.
 2. Magnetic door holders and electric door locking hardware.
 3. Installation of fire alarm speaker and firefighter's phone jack in elevator cabs.
 4. Damper limit switches and differential air pressure switches.
 5. Installation of duct type smoke detectors.
 6. Electric and hydraulic elevators.
 7. Security system.
 8. Hardware sets.
 9. Fire doors and windows.
 10. Engine generator system.
 11. Fuel oil system.

1.02 QUALITY ASSURANCE

- A. Provide engineering design, equipment and labor to provide a complete and operating system.
- B. Obtain Fire Department approval of the fire management system and installation.

- C. Manufacturer and equipment supplier shall have a minimum of ten years' prior experience in the City of Honolulu. Equipment supplier shall have 24-hour parts and labor service available with a maximum 4-hour response time.
- D. The Contractor shall have successfully installed similar fire detection, evacuation voice and visual signaling, and smoke control systems in a previous project of comparable size and complexity.
- E. The Contractor shall employ NICET technicians on-site to guide the final checkout and to ensure the systems integrity.
- F. Contractor shall be Factory Authorized by the system manufacturer and technicians shall be Factory Certified to perform the installation work in this Section.
- G. Prior to making required submittals, the Contractor shall meet with the Fire Department and make an informal presentation of the fire management system. Meeting minutes shall be issued and submitted with the submittal drawings, with comments incorporated into the required submittals.

1.03 DESIGN REQUIREMENTS

- A. The fire alarm and detection system submittal drawings shall be prepared under the supervision of a Professional Engineer registered in the State of Hawaii, and submitted drawings and calculations shall bear the Engineer's stamp.
- B. The Contractor shall have in-house engineering and project management capability consistent with the requirements of the project. Qualified representatives of the system manufacturer shall perform the detailed engineering design of central and remote control equipment, and shall produce all panel and equipment drawings, submittals and operating manuals. The Contractor is responsible for detailed system design and documentation, coordination of system installation requirements and final system testing in accordance with these specifications.
- C. Previous system architecture with spare capacity already built in within fire alarm panels for batteries and for amplifiers for an additional 20% increase to quantity of speakers, strobes, and duct smoke detectors. Contractors bid shall include the necessary components for this spare capacity, as well as a total of 5% additional speakers, strobes, and duct smoke detectors.

1.04 REFERENCE STANDARDS

- A. The following standards and guides (latest edition except where noted) are hereby made a part of this work by reference thereto:
 1. Americans with Disabilities Act (ADA)
 2. Local Building and Fire Department Requirements
 3. American National Standards Institute (ANSI) / American Society of Mechanical Engineers (ASME) A17.1, Safety Code for Elevators and Escalators
 4. American National Standards Institute (ANSI) / American Society of Mechanical Engineers (ASME) A17.3, Elevator Code for Existing Elevators
 5. International Building Code (Applicable Edition) with Local Amendments
 6. California Building Code (Applicable Edition) with Local Amendments

7. NFPA 1 – Uniform Fire Code (Applicable Edition) with Local Amendments
8. NFPA 13 – Sprinkler Systems
9. NFPA 20 – Standard for the Installation of Stationary Pumps for Fire Protection
10. NFPA 70 – National Electrical Code (Applicable Edition) with Local Amendments
11. NFPA 72 – National Fire Alarm Code with Local Amendments
12. NFPA 90A – Air Conditioning and Ventilating Systems
13. NFPA 101 – Life Safety Code
14. NFPA 110 – Emergency and Standby Power Systems
15. Owner's Insurance Underwriter
16. State Fire Marshal
17. UL Standard 33 – Releasing Devices
18. UL Standard 38 – Manual Alarm Stations
19. UL Standard 217 – Smoke Detectors – Single/Multiple Stations
20. UL Standard 228 – Door Holders – Closers
21. UL Standard 268 – Smoke Detectors for Fire Protective Signaling Systems
22. UL Standard 268A – Smoke Detectors for Duct Application
23. UL Standard 521 – Heat Detectors for Fire Protective Signaling Systems
24. UL Standard 864 – Control Units for Fire Protective Signaling Systems
25. UL Standard 1424 – Cables for Power-Limited Fire Protective Signaling Systems
26. UL Standards 464 and 1480 – Audible Devices, Speakers for Fire Protective Signaling Systems
27. UL Standard 1481 – Power Supplies for Fire Protective Signaling Systems
28. UL Standard 1711 – Amplifiers for Fire Protective Signaling Systems
29. UL Standard 1971 – Visual Signaling Appliances

1.05 ABBREVIATIONS

- A. ADA Americans with Disabilities Act
- B. FACP Fire Alarm Control Panel
- C. FARA Fire Alarm Remote Annunciator
- D. FATC Fire Alarm Terminal Cabinet
- E. FCC Fire Control Center
- F. FCIP Firefighter's Control and Indicating Panel
- G. FTS Firefighter's Telephone System
- H. NFPA National Fire Protection Association
- I. UL Underwriters Laboratories Inc.
- J. VCS Voice Communication System

1.06 SUBMITTALS

- A. Minutes of fire management system Contractor's meeting with Fire Department.

- B. Manufacturer's product data sheets for equipment including State Fire Marshal listing numbers.
- C. Floor plans (minimum 1/8-inch scale) with room names and numbers, showing device locations and interconnecting conduit and wire. Include location of fire/smoke barrier walls.
- D. Floor plan (minimum 1/2-inch scale) of the FCC indicating fire management system equipment, equipment furnished by others (including generator and fire pump annunciators), tables, plan racks, and required clearances. Elevations (minimum 1/2-inch scale) of each wall of the FCC.
- E. Drawings shall show proposed layout and anchorage of equipment and appurtenances and equipment relationship to other parts of the work, including clearances for maintenance and operation.
- F. Riser diagram showing devices, equipment, and interconnecting conduit and wire. Indicate points of connection to other equipment such as motor controllers, damper actuators, fire pump controllers, elevator machine rooms and shafts, electric door locking hardware, fire door releases, magnetic door holders, and other related devices and equipment.
- G. Scaled detail drawings of FACP, FARA, FCIP, FTS, and VCS panel fronts.
- H. Wiring diagram for each device. Include connection details to auxiliary equipment.
- I. Control and wiring diagrams for smoke control sequences.
- J. Complete narrative of the sequence of operation.
- K. Sequence of operation matrix table including a complete line-by-line listing of fire alarm initiating devices, corresponding device address, and input/output matrix.
- L. Voltage drop calculations.
- M. Battery sizing calculations.
- N. VCS amplification sizing calculations.
- O. Visual alarm power supply sizing calculations.
- P. Power supply calculations for magnetic door holders, and electric door locking hardware.
- Q. Wire identification schedule.
- R. Seismic restraint details.
- S. All drawings must be stamped and signed for approval by the Fire Marshal.

1.07 FIELD TESTING

- A. All testing must be in accordance with current NFPA 72 standards and requirements. Refer to PART 3 for additional testing requirements.

- B. Wiring shall be inspected and tested for continuity and short circuits.
- C. Field Test Reports shall include at minimum the following:
 - 1. Certification that equipment has been properly installed and is in satisfactory operating condition.
 - 2. Sensitivity settings for smoke detectors.
 - 3. Detailed operational test report in matrix form indicating each initiating device, each signaling device, each communication device, and each control and indicating light on each piece of equipment. Report shall certify the following:
 - 4. Successful operation of each alarm and supervisory initiating device.
 - 5. Successful operation of each signaling device.
 - 6. Successful operation of automatic smoke control sequences.
 - 7. Successful operation of FACP.
 - 8. Successful operation of FARA.
 - 9. Successful operation of FCIP.
 - 10. Successful operation of FTS.
 - 11. Successful operation of VCS.
 - 12. Successful operation of elevator recall sequence.
 - 13. Successful operation of kitchen hood exhaust equipment connections.
 - 14. Successful operation of line supervision devices.
 - 15. Successful operation of off-site alarm monitoring system connection.
 - 16. Successful release of electric door locking hardware and magnetic door holders.

1.08 IDENTIFICATION

- A. Provide an identification nameplate for each equipment cabinet. Nameplates shall correspond with labeling identified in the submittal drawings.
- B. Fire alarm conduit shall be painted red. As an alternate, conduit shall be permanently labeled "FIRE ALARM" every 30 feet.
- C. Fire alarm junction boxes shall be painted red.
- D. All field initiating and indicating devices shall be labeled with self-adhesive tape with black lettering and identification labeling according to circuit loop and device address/number.
- E. Color code all wiring per recommended standards. Tag all wires in terminal cabinets with tie wrap tags with inked identification.

1.09 SEQUENCE OF OPERATION

- A. Upon smoke/fire detection, system shall activate selected audio/visual alarm devices.
- B. The VCS shall automatically activate the audible and visual signaling devices in accordance with the Fire Department requirements.
- C. Elevators shall be recalled to the street level or an alternate level if the elevator lobby smoke detector has been activated. Alternate level assignment shall be determined by the Fire Department.

- D. Air Handling Systems:
 - 1. Activation of a supply or return air duct detector shall shut down the associated fan or air handling system.
 - 2. In the event of an alarm, all components of air handling systems with a total capacity of 2,000 CFM or greater within that zone shall be automatically shut down.
- E. Combination Fire/Smoke Dampers: Activation of a duct detector or area smoke detector at a combination fire/smoke damper shall close the associated fire/smoke damper.
- F. Elevator Machine Rooms:
 - 1. Activation of smoke detectors in the elevator machine/control room, elevator lobby, or hoistway shall initiate elevator recall sequence.
 - 2. Activation of smoke detectors in the elevator machine/control room shall initiate shutdown of elevator machine room air systems.
 - 3. Activation of heat detector in an elevator machine room or hoistway shall automatically operate the shunt-trip operated overcurrent protection devices supplying power to the elevators, resulting in the disconnection of power to the associated elevators.
 - 4. Control circuits that shut down elevator power shall be monitored for presence of operating voltage. Loss of voltage to the control circuit for the disconnecting means shall cause a supervisory signal to be indicated at the control unit and required remote annunciators.
- G. Smoke Control Sequence:
 - 1. Provide controls, relays, control panels, and interfaces for automatic override control of each air handling system used for smoke control.
 - 2. Fire detection and control systems for mechanical smoke control systems shall be supervised in accordance with the Fire Code. Supervision shall provide positive confirmation of actuation, testing of devices, manual override mechanisms, and the presence of power downstream of power disconnect switches. Damper status supervision shall be accomplished by activation of damper limit switches. Air flow status shall be by differential pressure switches.
- H. Release selected elevator smoke guards, magnetic door holders and electric door hardware.

1.10 SYSTEM ZONING

- A. Alarm Initiating Devices: Provide a separate, individual zone for each manual pull station, area smoke detector, duct smoke detector, area heat detector, and sprinkler water flow switch.
- B. Supervisory Initiating Devices: Provide a separate, individual zone for each sprinkler tamper switch.
- C. Electric Fire Pump:
 - 1. Pump running.
 - 2. Controller main switch has been turned to OFF or MANUAL position.
 - 3. Trouble on the controller or engine.
- D. Engine Generator System:
 - 1. Generator running.
 - 2. Status of generator main circuit breaker.

- 3. Generator fault.
 - 4. Generator phase reversal.
 - 5. Battery derangement.
 - 6. System trouble (1 zone per generator carrying life safety systems).
- E. Fuel Oil System:
- 1. Activation of leak detection system.
 - 2. Low fuel status.
 - 3. System trouble (1 zone per system).
- F. Post Indicator Valve:
- 1. System alarm (1 zone per system).
 - 2. System trouble (1 zone per system).
- G. Fire Speakers and Visual Alarm Strobes.
- H. Firefighter's Telephone System:
- 1. Plug-in jacks:
 - a. Each stairwell shall be a separate, individual zone.
 - b. Each bank of elevator cabs shall be a separate, individual zone.
 - c. Each elevator lobby bank riser shall be a separate, individual zone.
 - d. The fire pump room shall be a separate, individual zone.
 - e. The emergency generator room shall be a separate, individual zone.
 - 2. Handsets: Each stairwell shall be a separate, individual zone.
 - 3. Each area of refuge shall be a separate, individual zone.
- I. Initiating and signaling device wiring circuits/loops/channels shall be loaded to no more than 75 percent capacity to allow for the installation of future devices.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Fire management system components shall be of the same manufacturer.
- B. Acceptable manufacturers: Simplex, GE EST, Honeywell Notifier, or Siemens.
- C. Products for this project shall be of the latest design. Obsolete or discontinued models are not acceptable.

2.02 SYSTEM TYPE

- A. The FACP and FARA's shall be connected in a network configuration to become components for a distributed intelligence system.
- B. The fire management system shall be the fully addressable type. Each fire alarm initiating device shall be a separate, individual zone. Provide interface modules to connect non-addressable devices to addressable wiring channels.
- C. The system shall support a single stand-alone node or can be combined for up to sixty four

(64) nodes communicating on a peer-to-peer multi-priority token ring communication network. Loop alarm recognition must be within 750 milliseconds and network alarm response must be under three (3) seconds of a device reporting an alarm state.

- D. All zoning/device location information shall be field-programmable to meet the exact job requirements as required by the Fire Department and Fire Marshal.
- E. Simplex 4100U Siemens XLSV, EST 3, or Notifier NFS2-3030, connected through a network configuration.

2.03 LINE SUPERVISION

- A. All system equipment and wiring shall be supervised in compliance with the requirements of NFPA 72.
 - 1. The system must be capable of being wired in a Class A or Class B with non-shielded wire. Disruption or failures of communication between devices and the data controller, or loss of a bus connection, shall result in a signal to the network to identify the alarm condition.
 - 2. Unless otherwise required by the Fire Department, wiring classification shall be as follows:
 - 3. FACP, FARA, and FATC communications wiring: Class A, or as required by Fire Department.
 - 4. Initiating device circuits: Class B.
 - 5. Notification device circuits: Class B.
- B. Where designated for Class A wiring, Class A circuits shall be installed such that the outgoing and return conductors, exiting from and returning to the control unit, respectively, are routed separately. The outgoing and return (redundant) circuit conductors shall not be run in the same cable assembly (multi-conductor cable), enclosure, or raceway.
- C. Wiring for initiating circuits must allow the addition of T-taps for Class B wiring.
- D. Notification appliance circuits and any other circuits necessary for the operation of the notification appliance circuits shall be protected from the point at which they exit the control unit until the point that they enter the notification zone that they serve using a 2-hour rated cable assembly.

2.04 STANDBY BATTERIES

- A. Provide sufficient battery capacity to operate the entire system upon loss of power as required by NFPA 72. The on-site emergency power system shall not be used when sizing the battery supply.
- B. The system shall automatically transfer to the standby batteries upon power failure. Battery charging and recharging shall be automatic.

2.05 FIRE ALARM CONTROL PANEL (FACP)

- A. Solid state, microprocessor based, modular design, fully supervised. Steel enclosure in standard finish, with hinged, locking door. Integral network interface modules, power supply, standby batteries, and battery charger. Wall mount in FCC.

- B. Provide power on LED, power failure LED, system trouble LED, system reset switch, alarm silence switch, trouble silence switch, manual evacuations switch, alarm acknowledge switch, trouble acknowledge switch, supervisory service acknowledge switch, lamp test button, tone alert, battery supervision LED, auxiliary relays, and other system indicators and controls necessary for processing alarm and signaling functions. Indicating lamps shall be LED type.
- C. Provide appropriate permanent identification labeling of control and indicating functions.
- D. Annunciation:
 - 1. Serial annunciator with back lit, alphanumeric, 168-character liquid crystal display indicating clear language information as to the type of alarm (device type), point status (alarm or trouble), number of alarms on the system, and a custom location label. Ability to scroll back through prior system actions, with events automatically placed in easy to access queues for viewing specific event types separately.
 - 2. LED matrix annunciator indicating initiating device type (columns) and floor of initiating device (rows). Provide a separate row for each floor level and a separate column for each device type (manual pull station, area smoke detector, elevator lobby smoke detector, duct smoke detector, sprinkler water flow, and sprinkler valve tamper). Labeling shall be modifiable to customize the designation of all LED's and switches. Provide individual zones for miscellaneous system points including engine generator systems, fuel oil systems, water chiller systems, emergency radio amplification systems, firefighter's air replenishment systems, etc. Provide a red (alarm or trouble) and yellow (zone supervision) light for each annunciation zone. Provide matrix layout, identification, and zoning requirements that meet the requirements of the Fire Department.
 - 3. Include RS 232 port for printer connection.
 - 4. Stand-alone workstation computer complete with software and hardware for user interface. (Bid Alternate E-002.)
 - 5. Provide a permanent binder with typewritten, laminated inserts cross-referencing location labels to the description and location of system address.
- E. System shall utilize analog type smoke detection with alarm verification, self-test feature, individual sensor automatic timed sensitivity adjustment, individual smoke sensor field adjustable sensitivity set from FACP, and automatic maintenance alarm feature.

2.06 FIRE ALARM TERMINAL CABINETS (FATC)

- A. Steel enclosure in standard finish, hinged locking door, fire-retardant plywood backboard, and coded terminal blocks.
- B. Provide appropriate permanent identification labeling of control and indicating functions.

2.07 FIRE ALARM REMOTE ANNUNCIATOR (FARA)

- A. Provide a remote LCD display annunciator in each of the following locations:
 - 1. Security Desk
 - 2. Building Engineer's Office

2.08 PRINTER

- A. Provide a high impact tabletop laser printer in the Fire Command Center.

2.09 FIRE ALARM INITIATING DEVICES

- A. General:
 - 1. Addressable type.
 - 2. Provide auxiliary relays where required to satisfy system operational requirements.
 - 3. Smoke detectors shall be analog type.
- B. Manual Pull Stations:
 - 1. High impact Lexan polycarbonate or die cast metal.
 - 2. Push type, double action, mechanically latched upon operation until key-operated manual reset. Pull station front shall be hinged to back plate assembly, requiring keyed opening to reset.
 - 3. Provide protective shields for manual pull stations located in public lobbies and corridors. Tamper-proof, clear Lexan shield.
- C. Area Smoke and Heat Detectors:
 - 1. General:
 - a. Common base for detachable detector heads.
 - b. Intelligent detectors with integral microprocessor, non-volatile memory, automatic device mapping, electronic addressing, environmental compensation and red/green status LED's.
 - c. Area smoke detectors installed in sleeping areas shall have integral audible alarm using sounder base.
 - d. Provide relay bases where required for detectors with local device/accessory interface.
 - 2. Photoelectric thermal type area smoke detector:
 - a. Smoke and heat alarm filtering and validation.
 - b. Thermal sensor.
 - 3. Residential Smoke Detector
 - a. Stand alone, 120V powered with sounder base and integral battery backup. Provide a dedicated 120V circuit from the residential panelboard. Detector shall not be connected to the building fire alarm system.
 - b. Provide necessary contacts and wiring between detectors to activate sounders in all detectors within a residential unit upon activation of one alarm.
 - 4. Area heat detector:
 - a. 135-degrees fixed temperature self-restoring type.
 - b. Rate-of-rise detector shall be used in areas with high ambient temperature.
- D. Duct Type Smoke Detectors:
 - 1. General:
 - a. Common base for detachable smoke detector head.
 - b. Duct housing with hinged door and full-length sampling tube. Visible alarm LED, remote LED output, UL 268A.
 - c. Provide detector base with auxiliary contacts.
 - d. Smoke detector type to match project standard for area detectors.
- E. Addressable Transmitters/Monitor Modules: Addressable transmitters/monitor modules shall be provided where required to interface with contact alarm devices.
- F. Addressable Relay Modules: Addressable relay modules shall be provided where required to

provide audible alarm interface and/or relay control interface.

2.10 VOICE COMMUNICATION SYSTEM (VCS)

- A. One-way voice paging and fire alarm evacuation signal between the FCC and alarm signaling devices. Provide a distributed amplification system integrated into the FACP. Multi-channel type to permit simultaneous paging to selected speaker zones while fire alarm evacuation signal is being transmitted to other speaker zones. Amplifiers and visual alarm power supplies shall be sized to support full coverage of all areas of the building plus 25 percent spare.
- B. Selective zone paging to all or any combination of speaker zones. Automatic or manual selection of speaker zones shall activate a red LED for the activated speaker zones.
- C. Fire tone LED shall indicate fire alarm evacuation signal is being transmitted.
- D. Fire tone switch shall initiate the fire alarm evacuation signal.
- E. Silence LED shall indicate alarm evacuation signal has been silenced.
- F. Silence switch shall silence the fire alarm evacuation signal. Time delay to self-restore to current system condition.
- G. Each speaker zone shall have a manual selection switch, red LED to indicate active zone, and yellow LED to indicate speaker zone trouble.
- H. ALL-CALL switch shall activate all speaker zones.
- I. Acknowledge switch, system trouble, reset, and lamp test switch.
- J. Hand-held microphone with push-to-talk switch for voice paging. The microphone shall have priority over pre-recorded messages and the fire alarm evacuation signal. The microphone shall be noise canceling type with frequency response of 200 to 4000 Hz.
- K. Provide a remote paging handset in a lockable recessed cabinet.
- L. The fire alarm evacuation signal shall be an alarm tone or pre-recorded message as required by the Fire Department. Failure of the primary tone generator shall result in a trouble signal and automatic switchover to a backup tone generator.
- M. Pre-amplifiers shall be solid state type, arranged in modular units so that failure of a primary pre-amplifier unit shall result in a trouble signal and automatic switchover to a backup pre-amplifier unit.
- N. Amplifier modules shall be supervised such that a loss or reduction of signal shall result in a trouble condition. Amplifiers shall be rated for continuous maximum power output for 24 hours minimum. System frequency response shall be plus or minus 3 dB from 100 Hz to 6 kHz.
- O. Visual alarm strobes shall be synchronized throughout the building. The candela rating of visual alarm strobes shall be in accordance with NFPA 72 requirements. Provide visual alarm strobes in addition to those shown on the Drawings to meet NFPA 72 requirements.
- P. Signaling Devices:

1. Speakers: Flush ceiling- or wall-mounted as shown on the Drawings, 4-inch cone, perforated faceplate in baked white enamel finish, fire retardant, moisture resistant, frequency response 400 Hz to 4000 Hz, taps at 1/4, 1/2, 1 and 2 watts, UL 1480.
 2. Visual Alarms: Flush wall-mounted, high intensity strobe, vertical orientation with vertical engravement FIRE, white faceplate, ADA, UL 464.
 3. Combination Speaker/Visual Alarm:
 - a. Flush mounted with 4-inch cone speaker, perforated faceplate in baked white enamel finish, fire retardant, moisture resistant, frequency response 400 Hz to 4000 Hz, taps at 1/4, 1/2, 1, and 2 watts, UL 1480. High intensity strobe, vertical orientation with vertical engravement FIRE, ADA, UL 464.
 - b. Ceiling Mounted: White housing with red "FIRE" letters, low profile, varying candela and wattage ratings.
 4. Dwelling unit strobes, listed to UL Standard 1971, shall provide a minimum of 110 candelas and have a flash rate of 1 to 2 Hz. All strobes mounted within 24 inches below the finished ceiling shall be UL 1971 Listed for 177 candela operation. Strobes mounted in sleeping rooms shall be located within 16 feet of the pillow. Flush wall-mounted.
- Q. For exterior locations, covered and open parking garages and other locations where ambient conditions are not suitable for proper operation of notification appliances, provide weather-proof devices with appropriate back boxes.
- R. Strobes may be combined with speakers where shown on the Drawings.
- S. Alarm signal shall silence all background public address speakers that are part of the A/V system, including:
1. Theater
 2. Amenities Deck
 3. Main Lobby
 4. Commercial Kitchen
 5. Private Dining
 6. Outside Lanai
 7. Yoga Room
 8. Training Room
 9. Penthouse Units

2.11 FIREFIGHTER'S TELEPHONE SYSTEM (FTS)

- A. Solid state, microprocessor based, modular design, fully supervised. Steel enclosure in standard finish, with hinged, locking door. Integral power supply, standby batteries, and battery charger. Wall mount in FCC.
- B. Two-way voice communication between the FCC and firefighter's phone jacks and emergency telephones. Selective zone paging to all or any combination of telephone zones. Sound powered type systems are not permitted.
- C. Each telephone zone shall have a manual selection switch, red LED to indicate active zone, and yellow LED to indicate zone trouble.
- D. Acknowledge switch, system trouble, reset, and lamp test switch.

- E. Red telephone handset.
 - F. Provide a remote handset in a lockable recessed cabinet.
 - G. Auxiliary Devices:
 - 1. Firefighter's phone jack: Recessed wall-mounted telephone jack, stainless steel faceplate engraved "FIRE EMERGENCY PHONE".
 - 2. Emergency telephone: Recessed wall-mounted cabinet, hinged locking door engraved "LOCAL FIRE EMERGENCY PHONE", permanent handset with armored cable, and break rod glass.
 - 3. Telephone handset cabinet: Surface-mount cabinet in FCC. Provide plug-in type phones with coil cord and jack, quantity as required by the Fire Department.
- 2.12 FIREFIGHTER'S CONTROL AND INDICATING PANEL (FCIP)
- A. Provide a graphic style panel in accordance with Article 909 of the CBC and Fire Department requirements. The FCIP shall meet the requirements of a firefighter's smoke control panel as required by the applicable codes.
 - B. Provide an FCIP for manual control and override of automatic control of smoke control systems. The FCIP shall graphically depict the building arrangement and smoke control system zones served by the systems. The status of each smoke control zone shall be indicated by lamps and appropriate legends.
 - C. Fans, major ducts and dampers within the building that are portions of the smoke control systems shall be shown on the FCIP and shall be shown connected to their respective ducts with a clear indication of air flow.
 - D. Devices, switches, indicators and the like shall bear plain English identifying legends having a size and stroke equivalent to 12 point Helvetica bold font.
 - E. Status indicators shall be provided for all smoke control equipment by LED indicators using LED colors acceptable to the Fire Marshal.
 - F. The firefighter's control panel shall provide control capability over the complete smoke control system equipment within the building as follows:
 - 1. ON-AUTO-OFF control over each individual piece of operating smoke-control equipment that can also be controlled from other sources within the building. This includes stairway pressurization fans; smoke exhaust fans; supply, return and exhaust fans; elevator shaft fans; and other operating equipment used or intended for smoke control purposes.
 - 2. OPEN-AUTO-CLOSE control over all individual dampers relating to smoke control and that are also controlled from other sources within the building.
 - 3. ON-OFF or OPEN-CLOSE control over all smoke control and other critical equipment associated with a fire or smoke emergency and that can only be controlled from the FCIP.
 - G. The FCIP actions shall be as follows:
 - 1. ON-OFF, OPEN-CLOSE control actions shall have the highest priority of any control point within the building. Once issued from the firefighter's control panel, no automatic or manual control from any other control point within the building shall contradict the control action. Where automatic means is provided to interrupt normal, non-emergency

- equipment operation or produce a specific result to safeguard the building or equipment (i.e., duct smoke detectors, high-temperature cutouts, temperature-actuated linkage and similar devices), such means shall be capable of being overridden by the FCIP control action and the last control action as indicated by each FCIP switch position shall prevail.
2. Only the AUTO position of each three-position FCIP switch shall allow automatic or manual control action from other control points within the building. The AUTO position shall be the NORMAL, non-emergency, building control position. When a switch is in the AUTO position, the actual status of the device (ON, OFF; OPEN, CLOSED) shall continue to be indicated by the status indicator described above.
- H. Smoke control system activation shall be initiated immediately after receipt of an appropriate automatic or manual activation command. Smoke control systems shall activate individual components (such as dampers and fans) in the sequence necessary to prevent physical damage to the fans, dampers, ducts and other equipment. The total response time for individual components to achieve their desired operating mode shall not exceed the following:
- | | |
|--|--------------------|
| 1. Control air isolation valves | Immediately |
| 2. Smoke damper closing | 15 seconds |
| 3. Smoke damper opening | 15 seconds maximum |
| 4. Fan starting (energizing) | 15 seconds maximum |
| 5. Fan stopping (de-energizing) | Immediately |
| 6. Fan volume modulation | 30 seconds maximum |
| 7. Pressure control modulation | 15 seconds maximum |
| 8. Temperature control safety override | Immediately |
| 9. Positive indication of status | 15 seconds maximum |
- For purposes of smoke control, the FCIP response time shall be the same for automatic or manual smoke control action initiated from any other building control point.
- I. Provide override control and status indication of the following smoke control systems:
1. Stairwell Pressurization Fan Systems
 2. Smoke Exhaust Systems.
 3. Damper Systems.
- J. Provide status indication of the presence of power at disconnect switches serving smoke control system air handling equipment. Status indication (trouble) shall be given when the disconnect is left in the open position; connect to auxiliary switch on equipment disconnect switch.
- K. Two-position switch for unlocking stairwell door electric locking devices: NORMAL-UNLOCK.
- L. Two-position switch for unlocking interior door electric locking devices: NORMAL-UNLOCK.
- M. LED test button.

PART 3 - EXECUTION

3.01 GENERAL

- A. All equipment shall be installed and connected in accordance with the manufacturer's

recommendations.

- B. Wiring shall be color coded, and in accordance with the manufacturer's recommendations, NEC, and Fire Department requirements. Install wiring in an independent, dedicated metallic raceway system.
- C. Connections to devices installed in accessible tile ceilings shall be in flexible conduit. Device back boxes shall be securely attached to framing members.
- D. Provide appropriately sized back boxes for surface-mounted fire alarm signaling devices, paint to match device faceplate color. Stacked or punch pressed steel type back boxes are not permitted.
- E. Provide water-tight type back boxes where installed recessed flush in perimeter walls below grade.
- F. Provide wireways above and/or below equipment cabinets to accommodate large concentrations of wiring. Conductors within equipment cabinets shall be carefully formed and harnessed.
- G. Connect fire management system equipment to emergency power system.
- H. Provide power supply wiring to electric damper actuators used for smoke control that are not controlled by the temperature control system.
- I. Furnish a fire alarm speaker and a firefighter's plug-in jack for each elevator. Coordinate installation with elevator equipment supplier.
- J. FCIP and smoke control sequence wiring and controls shall be dedicated and independent from other fan or temperature control systems.
- K. Area and duct-type smoke detectors shall be photoelectric type, unless otherwise specified or shown on the Drawings.
- L. Provide a 1-inch empty conduit from the FACP to the nearest telecom terminal backboard. Connect the fire alarm control panel communications modem to dedicated telephone lines per the requirements of the Fire Department.
- M. Provide a 1-inch empty conduit from the FACP to the security system control panel.
- N. Provide a 2-inch empty conduit from the FCC to each elevator hoistway.
- O. Provide a signal to the lighting control system to override lighting to full brightness upon activation of fire alarm.
- P. Auxiliary relays connected to the fire management system used to initiate control of monitor status of fire safety functions shall be located within 3 feet of the controlled circuit or device. The wiring between the fire management system and the auxiliary relay shall be supervised.
- Q. Provide additional alarm and annunciation devices as required by the Fire Department within the spare device allowances noted. Include conduit, wire and testing as part of this scope of

work.

- R. All magnetic hold-open doors shown on the architectural drawings shall be provided with a 120V, 1-phase circuit and a dedicated smoke detector.
- S. Fire smoke dampers provided by Division 23 contain integral duct smoke detectors. Provide all necessary initiating circuit wiring to each detector in accordance with these specifications.
- T. All combination fire/smoke detectors shown on the mechanical drawings shall be provided with a 120V, 1-phase circuit.
- U. All elevator fire shutter shall have two (2) input points per floor.
- V. Fire smoke dampers provided by Division 23 contain integral duct smoke detectors. Provide all necessary initiating circuit wiring to each detector in accordance with these specifications.

3.02 DEVICE MOUNTING

- A. Unless otherwise noted on the Drawings, plans, specifications, manufacturer's recommendations, or by the Fire Department, the recommended mounting heights and requirements are as follows:
 1. Control Panel: Fire Alarm control panel and remote panels and their components shall be mounted so that no part of the enclosing cabinet is less than 12 inches or more than 78 inches above the finished floor. All manually operable controls shall be at least three feet and less than five feet above the finished floor. Panel shall be installed to comply with the requirements of UL 864. The LCD display for the control panel shall be mounted at centerline 5 feet-6 inches above the finished floor.
 2. Detectors:
 - a. Detectors shall be mounted on the ceiling not less than 4 inches from the side wall to the near edge, or if side wall, between 4 inches and 12 inches down from the ceiling to the top of the detector.
 - b. Smoke detectors shall be located at least three feet from supply or return air diffusers.
 - c. Smoke detectors shall be located on either side within five feet from any opening with a magnetic door holder or a motorized coiling door within a fire-rated partition unless specifically accepted by NFPA 72 or the Fire Department.
 - d. Smoke detector shall be mounted at the highest point on the ceiling.
 - e. Provide area or duct smoke detectors as required for activation of all fire/smoke dampers.
 - f. Residential smoke detectors shall be provided in each sleeping area and in common space directly outside of each sleeping area.
 3. Visual Signal Appliances (Non-Sleeping Areas):
 - a. Visual signal appliances shall be wall-mounted at 80 inches above the finished floor or 6 inches below the ceiling, whichever is lower. For purposes of installation, the bottom of the visual portion or lens of the fixture shall be used for mounting reference.
 - b. Visual signal appliances may be installed on the ceiling, but must be listed for ceiling mount. Ceiling-mounted appliances shall be in accordance with the requirements of NFPA 72.

4. Visual Signal Appliances (Sleeping Areas): Visual signal appliances in accessible sleeping rooms shall be wall-mounted no less than 24 inches below the ceiling to the top of the lens and shall be in accordance with NFPA 72. The visual appliance shall be no more than 16 feet from the pillow. Minimum candela rating shall be 110 cd.
5. Audible Signal Appliances: Where ceiling heights permit, wall-mounted appliances shall have their tops at 90 inches above the finished floor or 6 inches below the ceiling.
6. Combination Audible and Visual Signal Appliances:
 - a. The location of audible/visual signal appliances shall comply with visual signal appliance mounting requirements.
 - b. Ceiling-mounted appliances shall be in accordance with the requirements of NFPA 72.
7. End of Line (EOL) Resistors shall be mounted in accessible areas. Mounting of EOL resistors in hotel guest rooms or in tenant spaces not accessible to the landlord shall not be allowed.
8. Duct-mounted smoke detectors shall be provided where indicated on the supply and return side of all air-handling units with system CFM rating equal or greater than 2000 CFM.
9. Only designated speakers, strobes, and telephones shall be surface-mounted. All surface-mounted devices shall be smooth sided, without knockouts and painted red. Use of standard electrical boxes for surface-mounted equipment is prohibited.
10. Point-addressable monitor modules and control modules shall be securely mounted in back boxes or mounted on rails within a larger enclosure. The use of wire nuts to make connections to these modules is strictly prohibited.
11. All panels visible to the public or noted on the Drawings shall be finished as directed by the Architect.

B. Device Spacing:

1. Corridor speakers shall be spaced not greater than 60 feet on center. All other speakers whether combined with strobes or not shall be spaced as shown on the Drawings.
2. Corridor strobes shall be spaced not greater than 100 feet on center and no more than 15 feet from each end of the corridor in accordance with NFPA 72.
3. Spot type smoke detectors installed in rooms shall be spaced not greater than 15 feet from a wall and not greater than 30 feet on center. Corridor smoke detectors spacing shall be no greater than that shown in NFPA 72.
4. Beam detectors shall be spaced in accordance with manufacturer's installation instructions.
5. Provide one heat detector within 2'-0" of each sprinkler head in all elevator machine rooms.

C. Lightning Arrestors:

1. Provide lightning over-voltage protectors on any circuit that contains devices or appliances located on the exterior of the building.
2. The over-voltage protectors shall mount in dedicated metallic electrical boxes as close as possible to the location where the circuits exit the building.

3.03 TEST/FIELD QUALITY CONTROL

- A. A complete system pre-test shall be performed by the installing contractors before the final system acceptance test. All deficiencies shall be corrected. Upon successful completion of the pre-test, a complete pre-test report shall be submitted to the Owner's

Representative to document that the fire alarm system is operating properly, along with an NFPA 72, Fire Alarm System Record of Completion document. These documents shall be received before scheduling a final test with the fire department representative or designated testing agency.

- B. The final alarm acceptance test shall be coordinated with the Owner's Representative, and the local Fire Department representative or testing authority. A letter certifying that the installation is complete and fully operational shall be forwarded to the Owner's Representative.
- C. Before final acceptance of the project can be made, the Contractor must submit from NFPA 72, the Fire Alarm System Record of Completion, signed by a factory-certified technician, certifying that the fire alarm system has been installed, tested and will function in accordance with the manufacturer's specifications and the Fire Marshal requirements. The installing contractor shall also issue a letter to the Owner's Representative indicating the fire alarm system has been installed and tested to operate according to the design drawings and specifications.

END OF SECTION

SECTION 31 3126

SOIL TREATMENT FOR VEGETATION CONTROL

PART 1 - GENERAL

1.01 SUMMARY

- A. This work shall consist of spraying weed killer on:
 - 1. The prepared subgrade of the reinforced concrete driveways and concrete slabs prior to the installation of the aggregate base course and aggregate subbase course.

1.02 SUBMITTALS

- A. Submit in accordance with SECTION 01 3300 – SUBMITTAL PROCEDURES.
- B. Prior to the start of work, the contractor shall submit to the Owner the material product data and Material Safety Data Sheets for the material proposed for use.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Weed Killer shall be "Casoron 4G", "Norosac 4G", or an approved equal for under asphalt application on new or rebuilt pavement, and shall be "Hyvar X", "Roundup" or approved equal for application to existing weeds.

PART 3 - EXECUTION

3.01 APPLICATION

- A. The weed killer shall be mixed and uniformly spread using calibrated application equipment at the maximum rates permitted for "under asphalt" use and in strict accordance with the manufacturer's label. Base course material shall be installed as soon as possible after applying the weed killer to preclude loss of germination inhibiting action.
- B. Nut grass shall be retreated two (2) days after initial application and again if growth still exists.
- C. The Contractor shall notify the Owner 24 hours before application of weed killer.

END OF SECTION

SECTION 31 0513

SOILS FOR EARTHWORK

PART 1 - GENERAL

1.01 SUMMARY

- A. Furnish all labor, materials, services, equipment and related items necessary to excavate, fill, compact, remove, transport, stockpile and dispose of all materials within the grading limits of the project required to construct the site work improvements in conformity with the dimensions, sections and details shown on the drawings.

Excavation includes excavating, over-excavation, scarifying, placing, moisture-conditioning and compacting or disposing of, all material of whatever character encountered in the work.

Imported borrow includes hauling, placing, moisture-conditioning and compacting specified materials necessary to construct project.

1.02 GENERAL REQUIREMENTS

- A. During excavation, if any archaeological significant items, such as artifacts, shell, bone, or charcoal deposits are found, stop work and notify the Owner. The Owner shall pay for any investigation.
- B. Permits, Notice, Etc.:
 - 1. The Contractor shall procure and pay for all necessary permits or certificates that may be required in connection with this work.
 - 2. The Contractor shall serve proper notices and consult with the Owner regarding any temporary disconnections of electrical or other utility lines in the area which may interfere with the removal work, and all such lines where necessary shall be properly disconnected before commencing with the work.
- C. Protection:
 - 1. Throughout the work, protection shall be provided for all roads, walkways, buildings, etc., along the excavation. Safe working conditions shall be maintained at all times for all personnel, and temporary lights and barricades shall be provided and maintained.

1.03 REFERENCE SPECIFICATIONS

- A. Except as modified herein, all excavation, trenching and backfilling shall conform to the following specifications. Paragraphs concerning measurements and payments in the sections are not applicable to this project.
- B. Excavation, Grading, Embankment:
 - 1. Standard Specifications for Public Works Construction dated September 1986:
 - Section 11 - Trench Excavation and Backfill
 - Section 12 - Roadway Excavation

Section 13 - Structure Excavation and Backfill
Section 15 - Crushed Rock

C. Subbases and Bases:

1. Standard Specifications for Public Works Construction dated September 1986, Department of Public Works, City and County of Honolulu:
Section 29 - Subgrade
Section 30 - Select Borrow for Subbase Course

PART 2 – PRODUCTS

2.01 MATERIALS

A. General Fill Material

1. On-site soil containing organic content less than three percent by weight and meeting the Geotechnical Engineer's fill requirements can be used as general fill material.

silty clay for reuse in compacted fill areas except in imported granular fill sections below footings. Onsite fill material shall be limited to use in the lower portion of fills, at least 3 feet below grade. Rock fragments larger than 3 inches in maximum dimension shall be removed before compaction.

B. Imported Fill Material

1. Imported fill material shall consist of non-expansive material with plasticity index of 12 or less and a California Bearing Ratio (CBR) of 40, free of contaminants, organic material and debris and rocks or lumps greater than 3 inches in maximum size. Imported fill material shall contain enough fines to bind the soil together.

PART 3 - EXECUTION

3.01 BUILDING SUBGRADE PREPARATION

- A. Clear the project site of all vegetation, including large tree roots, AC pavement, concrete curbs, and other deleterious material. Prior to placement of fill, scarify the exposed subgrade to a minimum depth of 12 inches. Moisture condition the prepared surface and compact in accordance with Table 3.01.

3.02 COMPACTION

- A. Structural fill and backfill shall be placed and compacted in accordance with Table 3.01.
- B. Construction materials and excavated materials shall be covered during high winds to mitigate dust problem.
- C. Maintenance of Embankments: Maintenance of compacted surface from inclement weather, poor drainage and/or other sources shall be the sole responsibility of the Contractor. Surface water ponding shall not be allowed at any time during construction.

- D. Soft and/or saturated subgrades observed after compaction shall be over-excavated and replaced with suitable fill materials. Shrinkage cracks observed after compaction shall require subgrade to be re-scarified and/or over-excavated and re-prepared in accordance with subsection 3.01, with no additional cost to the Owner. The extent of scarification and/or over-excavation required shall be determined by the Owner.
- F. Tolerance: Finish subgrade upon which pavement structure is placed shall not vary more than 0.04-foot above or below theoretical grade.

Table 3.01 Compaction Recommendations

Description	Percent Relative Compaction (ASTM D1557)	Minimum Percent Above Optimum Moisture Content
Engineered Fill Beneath Footings and Foundations	95	3
Backfill Beneath Floor Slabs	90	2
AC Pavement, Subgrade, Upper 12"	95	3
AC Pavement, Subgrade Onsite Soil or Fill	95	3
AC Pavement, Untreated Base Course (UTBC)	95	2
Concrete Hardscape, Aggregate Base Course	90	2
Concrete Hardscape, Subgrade Soil	90	3
Underground Utility and Culvert Backfill (upper 5 feet)	90	3

3.02 PROTECTIVE MEASURES

- A. All excavation shall be protected and guarded against danger to life, limb, and property.
- B. Shoring, as required to safely preserve the excavations and earth banks free from damages resulting from the work, shall be provided and installed by the Contractor.
- C. Erosion Control: The Contractor shall incorporate into his work schedule the Temporary Erosion Control Measures and the Permanent Erosion Control procedures listed on the drawings and as specified in the contract.
- D. Dust Control: Every effort shall be made by the Contractor to keep dust to a minimum. Spraying the ground with water or other means of control shall be used wherever possible.
- E. All excavations shall be kept free from standing water. The Contractor shall pump and drain as necessary to remove water to the extent required in carrying on work. Grading shall be controlled so that the ground surface is properly sloped to prevent water runoff into structural foundation, open trenching excavations and adjacent buildings.

- F. The Contractor shall conduct operations with minimum interference to traffic.
 - 1. The Contractor shall confine all work equipment, materials and personnel as much as possible to the work area as indicated, so as not to interfere with the normal function of the adjacent roadway. The Contractor shall schedule all work that involves excessive noise, dust, dirt, or any other detrimental aspect of this work in order that there will be minimum disruption in normal roadway functions.
 - 2. When necessary and when directed by the Owner, the Contractor shall provide and erect barriers, etc., with special attention to protection of personnel.
- G. Existing utilities are shown on the drawings in approximate locations for the convenience of the Contractor. The fact that any utility is not shown on the drawings shall not relieve the Contractor of his responsibility under this section.
- H. It shall be the Contractor's responsibility to ascertain the location of all existing utilities which may be subject to damage by reason of his operations. The Contractor shall:
 - 1. Support and protect all utilities during construction;
 - 2. Notify the Owner immediately of any damage to existing utilities caused by construction under this Contract; and
 - 3. Reconstruct, at his expense, damaged portions of the utility system in accordance with the requirements and specifications of the City.

3.03 LAYING OUT

- A. The laying out of base lines, establishment of grades and staking out the entire work shall be done by a surveyor (licensed in the State of Hawaii) at the expense of the Contractor and he shall be solely responsible for their accuracy. The Contractor shall erect and maintain substantial batter boards showing construction lines and levels.
- B. Should any discrepancies be discovered in the dimensions given on the drawings, the Contractor shall immediately notify the Owner before proceeding any further with the work; otherwise he will be held responsible for any costs involved in correction of construction placed due to such discrepancies.

END OF SECTION

SECTION 31 1000

SITE CLEARING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes clearing of areas of vegetation and debris in preparation of construction of site improvements.

1.02 GENERAL REQUIREMENTS

- A. Furnish materials, labor and equipment necessary to clear and grub the entire construction area within the limits of grading, to accumulate and dispose of all debris and waste materials, to lay out the entire work, as shown on the drawings and as specified herein.
- B. It shall be the responsibility of the Contractor to examine the project site and determine for himself the existing conditions.
- C. Obvious conditions which exist on the site shall be accepted as part of the work, even though they may not be clearly indicated on the drawings and/or described herein, or may vary therefrom.
- D. All debris of any kind accumulated from the work of this section shall be disposed of from the site.
- E. Burning on site will not be permitted.

1.03 STANDARDS

- A. Except as modified herein, all clearing and grubbing shall meet the requirements of Standard Specifications for Public Works Construction, September 1986, Section 10, Department of Public Works, City and County of Honolulu.

PART 2 – PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 CLEARING AND GRUBBING

- A. The Contractor shall clear the premises of all obstacles and obstructions, the removal of which will be necessary for the proper reception, construction, execution and completion of other work specified in this contract.
- B. The Contractor shall protect from injury and damage all surrounding grass, plants, pavements, buildings, utilities, rock walls, etc., and shall leave all in as good a condition as at present. Any damage to existing improvements shall be repaired or replaced by the Contractor to the satisfaction of the Owner and/or City.

C. The Contractor shall confine his construction operations to the immediate area of work or as directed by the Contracting Officer.

3.02 CLEAN-UP OF PREMISES

A. Clean-up and remove all debris accumulated for construction operations from time to time as directed. Upon completion of the construction work and before final acceptance of the Contractor's work, remove all surplus materials, equipment, etc., and leave entire job site clean and neat to the satisfaction of the Owner.

END OF SECTION

SECTION 31 2316

TRENCHING

PART 1 - GENERAL

1.01 SUMMARY

- A. This section includes excavation, trenching and backfilling for the sewer, water and drainage systems. The work includes sheeting and bracing, hauling and disposing of unsuitable excavated materials.

1.02 GENERAL REQUIREMENTS

- A. Furnish all materials, labor and equipment and tools required to accomplish all excavation, filling, grading, and excavating and backfilling for sewer, water and drainage systems as indicated on the drawings and specified herein.
- B. During excavation, if any archaeological significant items, such as artifacts, shell, bone, or charcoal deposits are found, stop work and notify the Contracting Officer. The Owner shall pay for any investigation.
- C. Permits, Notice, Etc.:
 - 1. The Contractor shall procure and pay for all necessary permits or certificates that may be required in connection with this work.
 - 2. The Contractor shall serve proper notices and consult with the Owner regarding any temporary disconnections of electrical or other utility lines in the area which may interfere with the removal work, and all such lines where necessary shall be properly disconnected before commencing with the work.
- D. Protection:
 - 1. Throughout the work, protection shall be provided for all roads, walkways, buildings, etc., along the excavation. Safe working conditions shall be maintained at all times for all personnel, and temporary lights and barricades shall be provided and maintained.

1.03 REFERENCE SPECIFICATIONS

- A. Except as modified herein, all excavation, trenching and backfilling shall conform to the following specifications. Paragraphs concerning measurements and payments in the sections are not applicable to this project.
- B. Excavation, Grading, Embankment:
 - 1. Standard Specifications for Public Works Construction dated September 1986:

- Section 11 Trench Excavation and Backfill
- Section 12 Roadway Excavation
- Section 13 Structure Excavation and Backfill
- Section 15 Crushed Rock

- C. Trench Excavation and Backfill:
 - 1. Water System Standards, City and County of Honolulu, State of Hawaii 2002, for potable water lines.
- D. Subbases and Bases:
 - 1. Standard Specifications for Public Works Construction dated September 1986, Department of Public Works, City and County of Honolulu:
 - Section 29 Subgrade
 - Section 30 Select Borrow for Subbase Course

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Pipe cushion and trench backfill material shall conform to Section II – Trench Excavation and Backfill and Water System Standards, City and County of Honolulu, State of Hawaii 2002.
- B. Backfill materials for sewer, drainage and electrical ducts shall conform with Section 11- Trench Excavation and Backfill.

PART 3 - EXECUTION

3.01 EXCAVATION

- A. Prepare subgrade in accordance with Section 29 – Subgrade.
- B. Trench Excavation and Backfill shall be in accordance with Section 11 – Trench Excavation and Backfill and Water System Standards, City and County of Honolulu, State of Hawaii 2002.
- C. Construction materials and excavated materials shall be covered during high winds to mitigate dust problem.

3.02 PROTECTIVE MEASURES

- A. All excavation shall be protected and guarded against danger to life, limb, and property.
- B. Shoring, as required to safely preserve the excavations and earth banks free from damages resulting from the work, shall be provided and installed by the Contractor.
- C. All excavations shall be kept free from standing water. The Contractor shall pump and drain as necessary to remove water to the extent required in carrying on work. Grading shall be controlled so that the ground surface is properly sloped to prevent water runoff into structural foundation, open trenching excavations and adjacent buildings.
- D. The Contractor shall conduct operations with minimum interference to traffic.

1. The Contractor shall confine all work equipment, materials and personnel as much as possible to the work area as indicated, so as not to interfere with the normal function of the adjacent roadway. The Contractor shall schedule all work that involves excessive noise, dust, dirt, or any other detrimental aspect of this work in order that there will be minimum disruption in normal roadway functions.
2. When necessary and when directed by the Owner, the Contractor shall provide and erect barriers, etc., with special attention to protection of personnel.
- E. Existing utilities are shown on the drawings in approximate locations for the convenience of the Contractor. The fact that any utility is not shown on the drawings shall not relieve the Contractor of his responsibility under this section. It shall be the Contractor's responsibility to ascertain the location of all existing utilities which may be subject to damage by reason of his operations. The Contractor shall:
 1. Support and protect all utilities during construction;
 2. Notify the Owner immediately of any damage to existing utilities caused by construction under this Contract; and
 3. Reconstruct, at his expense, damaged portions of the utility system in accordance with the requirements and specifications of the City.

3.03 LAYING OUT

- A. The laying out of base lines, establishment of grades and staking out the entire work shall be done by a surveyor (licensed in the State of Hawaii) at the expense of the Contractor and he shall be solely responsible for their accuracy. The Contractor shall erect and maintain substantial batter boards showing construction lines and levels.
- B. Should any discrepancies be discovered in the dimensions given on the drawings, the Contractor shall immediately notify the Owner before proceeding any further with the work; otherwise he will be held responsible for any costs involved in correction of construction placed due to such discrepancies.

END OF SECTION

BENJAMIN WOO ARCHITECTS
PROJECT NO. 1709

LILIA WAIKIKI
HONOLULU, HAWAII

SECTION 31 2500

EROSION AND SEDIMENTATION CONTROLS

PART 1 – GENERAL

1.01 GENERAL

A. This section shall supplement any provision for Environmental pollution and hazardous materials, substances and/or waste control of the General Conditions.

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1.021 SUMMARY DESCRIPTION

The Contractor shall comply with the requirements of Hawaii Administrative Rules Chapter 11-54 Water Quality Standards and Chapter 11-55 Water Pollution Control, and Rules Relating to Water Quality of the City and County of Honolulu. In addition, the Contractor shall be responsible for developing and implementing the SWPPP, including Site-Specific BMPs, to prevent polluted run-off from discharging from the project site to any established Municipal Separate Storm Sewer System (MS4), drainage systems, private property, or State receiving waters. The Contractor shall be responsible for updating the SWPPP as required.

This section describes the following:

- A. The Contractor shall prepare a Storm Water Pollution Prevention Plan (SWPPP) on the SWPPP template provided in Attachment A of the Rules Relating to Water Quality (City Rules), August 2016 (as amended), to reflect his means and methods. Including detailed plans, diagrams, maps and figures, and Site-Specific Best Management Practices (BMP) Plans; constructing, maintaining, and repairing temporary water pollution, dust, and erosion control measures at the project site and project staging areas, including local material sources, work areas and haul roads; removing and disposing hazardous wastes; control of fugitive dust (defined as uncontrolled emission of solid airborne particulate matter from any source other than combustion); and complying with applicable City, State, and Federal permit conditions. Potential pollutant identification and mitigation measures are listed in the referenced Attachment A – SWPPP template.

Requirements of this section also apply to construction support activities, including concrete or asphalt batch plants, rock crushing plants, equipment staging yards/areas, material storage areas, excavated material disposal areas, and borrow areas located outside the City Right-of-Way. For areas operating beyond completion of the construction project in which it supports, the Contractor shall be responsible for securing the necessary permits and clearances at no cost to the Owner.

- B. Work associated with construction storm water and complying with conditions of the National Pollutant Discharge Elimination System (NPDES) permit(s) authorizing discharges of storm water associated with construction activity is not required.

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C. Determination and characterization of fill material.

1.02 QUALITY ASSURANCE

A. Reference Standards:

1. This Section contains references to the following documents. They are a part of this Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the more stringent requirements shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

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TABLE 1.03 Reference Standards

Reference	Title
Hawaii Administrative Rules	Title 11, Chapter 54, (11-54) Water Quality Standards Title 11, Chapter 55, (11-55) Water Pollution Control Title 4, Subtitle 6, Chapter 67, Seed Rules
Revised Ordinances of Honolulu	Revised Ordinances of Honolulu (ROH) Chapter 14, Public Works Infrastructure Requirements Including Fees and Services, Articles 13 through 16.
City BMP Manual	City and County of Honolulu Storm Water Best Management Practice Manual, Final, November 2011
City Rules	Rules Relating to Water Quality, August 2016 (as amended)
City Standard Details	Standard Details for Public Works Construction, City and County of Honolulu, 1984 (as amended)
City Standard Specifications	Standard Specifications for Public Works Construction, September 1986 (as amended)
City Storm Water Plan	City and County of Honolulu Storm Water Management Program Plan, Final, February 2016
City Construction Enforcement Response Plan	Inspection and Enforcement Response Plan for Construction Sites, Revised, February 2017

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HONOLULU, HAWAII

1.03 SUBMITTALS

Submit the following items for review and approval:

- A. Subsection 3.01.A.4. SWPPP - Prepare and submit (including the SWPPP Review checklist) within 30 calendar days of contract execution.
- B. Subsection 3.01.B.2. SWPPP amendments - Submit to the Owner for acceptance prior to implementation in the field.
- C. Subsection 3.01.B.3. Major modifications to the ESCP – Submit to Owner prior to implementation in field.
- D. Subsection 3.01.A.3. Construction Schedule – Submit to Director Department of Planning and Permitting (DPP) 2 weeks prior to construction including any schedule updates.
- E. Inspection Reports
 1. Subsection 3.01.B.4 BMP Inspection Documentation
 2. Subsection 3.01.B.5. Corrective Deficiency Report
 3. Subsection 3.01.B.6 Monthly Compliance Report
 4. Subsection 3.01.B.7. Critical Deficiency Notification
 5. Subsection 3.01.B.8. Construction Discharge Report
- F. Subsection 3.01.A.13 ESCP Coordinator Certificate. Provide valid ESCP Coordinator Certificate.

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PART 2 – PRODUCTS

2.01 MATERIALS

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Comply with applicable materials described in the latest City and County of Honolulu Storm Water Best Management Practices Manual Construction. In addition, the materials shall comply with the following:

- A. Filter Sock. The sock shall utilize an outer layer of filtration mesh, an inner layer of containment netting and be minimum 10 inches in diameter. Compost filter sock shall be Filtrexx Sediment Control, Envirotech Biosolutions Biosock, or approved substitute. Anchor stakes shall be manufactured from wood and shall be a minimum of 1 x 1-inch in cross section with a minimum length of 16 inches.
Use only mature compost that has no offensive odor and meets the following specifications:

Table 2.01 - Compost Specifications	
Property	Acceptable Range
pH	5.0 – 8.5
Moisture content	30 – 60%
Organic matter	25 – 65%, dry weight
Particle size	99% passing 2-inch sieve 30 to 50% passing 3/8-inch sieve Maximum length is 6-inches
Physical Contaminants	Less than 1% dry weight

PART 3 – EXECUTION

3.01 CONSTRUCTION

A. Preconstruction Requirements

1. Water Pollution, Dust, and Erosion Control Meeting. Schedule a water pollution, dust, and erosion control meeting with the Owner after the SWPPP is accepted in writing by the Owner. The Contractor shall require any subcontractors whose work could impact construction storm water runoff or BMPs to attend the meeting. Meeting shall be scheduled 14 days before start of construction work. Discuss sequence of work, plans and proposals for water pollution, dust, and erosion control.
2. Authorized Representative. The Contractor shall designate an Erosion Sediment Control Plan (ESCP) Coordinator who will be responsible for implementing the ESCP at the project site. The ESCP shall be signed by the Owner and ESCP Coordinator. Submit the name, phone number, mailing address and email of the ESCP Coordinator to the Director of Planning and Permitting (DPP) at least two (2) weeks prior commencement of work.

The ESCP Coordinator shall be responsible for certification and submission of any permits related to erosion, sediment and dust control as required by Section 31 2500 Erosion and Sedimentation Control, to the applicable regulatory agency. ESCP Coordinator will be responsible for implementing these permits and the requirements of this Section, and for overseeing compliance with permit requirements and the requirements of this Section, for the duration of the project. The ESCP Coordinator shall be authorized to sign any reports, checklists, SWPPP plans, and all other documents required by the permits and this Section.

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HONOLULU, HAWAII

3. Contractor shall notify in writing to the City's Director of Department of Planning and Permitting (DPP) two (2) weeks prior to the scheduled start date of the Project and submit any updated Construction Schedules for any applicable projects that are regulated under the City's Rules Relating to Water Quality (i.e. grading, grubbing, stockpiling, building, trenching, etc.).
4. Water Pollution, Dust, and Erosion Control Submittals.
Submit a complete SWPPP to the Owner within thirty (30) calendar days of contract execution. Submission of complete and acceptable SWPPP is the sole responsibility of the Contractor. Additional contract time will not be issued for delays due to incompleteness. The SWPPP shall include, but is not limited to, the following:
 - a. Written description of activities to minimize water pollution and soil erosion into State waters, drainage or sewer systems. The SWPPP shall include the following:
 - 1) An identification of potential pollutants and their sources.
 - 2) A list of all materials and heavy equipment to be used during construction.
 - 3) Descriptions of the methods and devices used to minimize the discharge of pollutants into State waters, drainage or sewer systems.
 - 4) Details of the procedures used for the maintenance and subsequent removal of any erosion or siltation control devices.
 - 5) Methods of removing and disposing hazardous wastes encountered or generated during construction.
 - 6) Methods of removing and disposing concrete and asphalt pavement cutting slurry, concrete curing water, and hydrodemolition water.
 - 7) Spill control and Prevention and Emergency Spill Response Plan.
 - 8) Fugitive dust control, including dust from grinding, sweeping, or brooming off operations or combination thereof.
 - 9) Methods of storing and handling of oils, paints and other products used for the project.
 - 10) Material storage and handling areas, and other staging

areas.

- 11) Concrete truck washouts.
 - 12) Concrete waste control.
 - 13) Fueling and maintenance of vehicles and other equipment.
 - 14) Tracking of sediment offsite from project entries and exits.
 - 15) Litter management.
 - 16) Sanitary Waste facilities.
 - 17) Other factors that may cause water pollution, dust and erosion control.
- b. Provide ESCP indicating location of water pollution, dust and erosion control devices; provide plans and details of BMPs to be installed or utilized; show areas of soil disturbance in cut and fill, indicate areas used for staging and storage including items 1) through 17) above, storage of aggregate (indicate type of aggregate), asphalt cold mix, ~~soil or solid waste~~, equipment and vehicle parking, and show areas where vegetative practices are to be implemented. Indicate intended drainage pattern on plans, using flow arrows, through work area and staging areas. Include separate drawing for each phase of construction that alters drainage patterns. Indicate approximate date when device will be installed and removed.
- c. Name(s) of specific individual(s) designated responsible for water pollution, dust, and erosion controls on the project site. Include home and business telephone numbers, fax numbers, and e-mail addresses.
- d. Description of fill material to be used.
- e. Address all sections in the SWPPP
- f. For projects with an NPDES Permit, information required for compliance with the conditions of the NPDES Notice of General Permit Coverage (NGPC) or NPDES Individual Permit.
- g. Site-Specific BMP Plan (SSBMP)/Storm Water Pollution Prevention Plan (SWPPP) Review Checklist. The Contractor shall submit the completed checklist to the Owner along with the SWPPP.

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Date and sign the SWPPP. Keep accepted copy on site or at an accessible location throughout duration of the project. The SWPPP shall be made available at the time of an on-site

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inspection or upon request by the Owner, Owner's Third-Party Inspector, and or DOH/EPA Representative. Amendments to the SWPPP shall be kept with the original SWPPP and clearly labeled. Modify SWPPP, if necessary, to conform to revisions. Include actual date of installation and removal of Site-Specific BMP measures. Obtain written acceptance by the Owner before implementing revised Site-Specific BMPs in the field.

Follow guidelines in the "City and County of Honolulu Storm Water Best Management Practice Manual Construction" dated November 2011 or as amended, in developing, installing, and maintaining BMPs for all projects. Manual can be obtained by downloading from the City website at www.cleanwaterhonolulu.com. Follow City and County of Honolulu's "Rules Relating to Water Quality" as it applies to all Development and Land Disturbing Activities within the City and County of Honolulu. For any conflicting requirements between the Manual and applicable bid documents, the applicable strictest requirements shall govern. Should a requirement not be clearly described within the applicable bid documents, notify the Owner immediately for interpretation. For the purposes of clarification "applicable bid documents" include the construction plans, standard specifications, special provisions, Permits, and the SWPPP, when applicable.

- B. Construction Requirements. Do not begin work until all submittals are completed and accepted in writing by the Owner.

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1. General

- a. Install, maintain, monitor, repair and replace Site-Specific BMP measures, such as for water pollution, dust, and erosion control; removal and disposal of solid waste, concrete cutting slurry, concrete curing water; or hydrodemolition water. Site-Specific BMP measures shall be in place, functional and accepted by the Owner prior to initiating any ground disturbing activities.

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- b. The ESCP Coordinator shall perform a pre-construction BMP inspection once all BMP measures have been installed and prior to the initiation of ground-disturbing activities at the Project site. Contractor shall have the ESCP Coordinator review and becomes familiar with the project's site specific BMP plan and/or other equivalent document(s) and to inspect the site to verify BMPs as required by the applicable Site Specific BMP Plans (SSBMP), ESCP, SWPPP and/or other documents have been installed correctly and in the correct locations prior to the commencement of ground-disturbing activities. Inspections shall include a review of erosion and sediment controls, good housekeeping practices, and compliance with SSBMP, ESCP and SWPPP plans. The inspector shall also remedy any

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additional site conditions that are potential sources of pollutants to the City's MS4 as a result of the project's construction activities.

c. BMP Maintenance. Maintain BMPs to prevent discharges of polluted runoff from construction site and avoid violations of regulatory and permit conditions. Sediment removed by maintenance activities should be incorporated in the project at locations designated by the Owner or disposed of properly in accordance with all applicable and prevailing laws and agency requirements/regulations. General minimum maintenance procedures and requirements are listed below. However, maintenance activities are not limited to this list and additional maintenance not listed may be required to ensure that BMPs operate effectively and perform properly as intended

1) Storm Drain Inlet Protection. All drain inlets and catch basins that are not connected to a sediment basin or trap must be protected by inlet protection devices if they are capable of receiving sediment or runoff from the Project site unless severe weather conditions make the use of such devices unsafe or infeasible. Sediment levels shall not exceed one third of the height at any point along the length of the inlet protection device. Inlet protection devices must be unclogged and cleaned when performance is compromised. Torn, weathered or sagging inlet protection devices must be repaired or replaced immediately.

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2) Sediment Barriers. Sediment barriers may consist of gravel bags, sandbags, fiber rolls, compost filter socks. Sediment levels shall not exceed one third of the barrier's height at any point along the length of the sediment barrier. Sediment barriers must be unclogged and cleaned when performance is compromised. Torn, weathered or sagging sediment barriers must be repaired or replaced immediately.

3) Sediment traps. Sediment traps must be kept in effective operation and condition at all times. Sediment levels shall not exceed one third of the trap's capacity.

d. Coordinate temporary control provisions with permanent control features throughout the construction and post-construction period.

e. Do not expose or disturb surface area of earth material (including clearing and grubbing) until BMP measures are installed and accepted in writing by the Owner. Protect temporarily or permanently disturbed soil surface from rainfall impact, runoff and wind before end of workday.

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- f. Properly maintain all Site-Specific BMP measures.
- g. The Contractor's ESCP Coordinator specified in Subsection 3.01.A.2. shall address any BMP deficiencies or administrative non-compliances concerns brought up by the Owner immediately, including weekends and holidays, and complete work to fix the deficiencies and within the timeframes listed in Table 3.01 Timeframes for Addressing Non-Compliances (BMP Deficiencies).
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2. SWPPP Amendments. Modify and resubmit plans and construction schedules to correct conditions that develop during construction which were unforeseen during the design and pre-construction stages. Install or modify Site-Specific BMP measures due to change in Contractor's means and methods, or for omitted condition that should have been allowed for in the accepted SWPPP or a Site-Specific BMP that replaces an accepted Site-Specific BMP that is not satisfactorily performing. All Amendments to the SWPPP shall be submitted to the Owner for acceptance prior to implementation in the field.
3. Erosion and Sediment Control Plan Revisions. The ESCP must be reviewed and approved by the Director of the City's Department of Planning and Permitting prior to issuance of a building, grading, grubbing, stockpiling or trenching permit. Minor changes to an ESCP may be made during construction if approved by a DPP Inspector. Minor changes shall be noted on the site copy of the ESCP and initialed by the approving DPP inspector. Major changes to an ESCP must be proposed to the DPP Director in writing and approved by the Director before work resumes. Major changes will require the contractor to retain the services of a licensed Civil Engineer in the State of Hawaii to incorporate those changes on the approved ESCP drawings and submit to DPP for review and approval.
4. The ESCP Coordinator shall inspect the BMPs a minimum of once every 7 days and shall document inspection results and corrective actions implemented with photographs and by completing the inspection form found in Appendix C of the City Rules. The Contractor shall address any discharge to the City's MS4 or State waters immediately and implement the necessary corrective action.
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The Contractor shall retain the BMP documentation in a binder, on-site or provide electronically accessible from the site at all times. Upon completion of the project, the ESCP Coordinator shall inspect the site and confirm that all disturbed areas are stabilized and temporary BMPs have been removed. Provide the final Project Log to the Director of DPP within 5 business days of completion of the project.
5. Corrective Action Reports. The ESCP Coordinator shall complete a corrective action report within 7 calendar days of discovering the

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occurrence of any deficiencies identified during the course of the project or when performing their weekly or rainfall event inspections. Report shall contain the following information.

- a. Any follow-up actions taken to review the design, installation and maintenance of any storm water controls, including the dates such actions occurred.
 - b. A summary of storm water control modifications taken or to be taken, including a schedule of activities necessary to implement changes, and the date the modifications are completed or expected to be completed.
 - c. Notice of whether SWPPP modifications are required as a result of the condition identified or corrective action.
 - d. Each corrective action report must be signed and certified by the ESCP Coordinator and kept on file at the site or at an easily accessible location, so that it can be made available at the time of an on-site inspection. Submit copy of Corrective Action Reports to the Owner within 24 hours of completion.
6. Monthly Compliance Reports. The ESCP Coordinator shall complete a Monthly Compliance Report within 2 working days of the end of the month. The Monthly Compliance Report shall document any instances of non-compliance and corrective actions, discharges, and major incidents reported to DOH that occurred within the month. The report shall be kept on-site and made available by the end of the next business day when requested by DOH. The Monthly Compliance Reports are a requirement of NPDES permits and may not be required for all projects.
7. Critical Deficiency Notification. The ESCP Coordinator shall notify the Owner, both verbally and via email within 24 hours of the occurrence of any critical or major deficiency that has resulted in a discharge of non-storm water or polluted storm water that has or may have potentially entered a storm drain or Receiving State Water in accordance to 40 Code of Federal Regulations (CFR) 122.41 Conditions applicable to all permits. A follow up Construction Discharge Report shall be prepared by the Contractor.
8. Construction Discharge Report. If a discharge of non-storm water or polluted storm water discharge has or may have potentially entered a storm drain or Receiving State Waters, if a discharge (e.g. spill) has occurred, if a polluted discharge is observed leaving the projects limits, or if there is evidence of an unreported polluted discharge leaving the projects limits prior to inspection (such as a silty trail, eroded areas beyond project limits), the ESCP Coordinator shall develop a Construction Discharge Report. If the discharge is a result of construction activities, the Contractor shall immediately stop the activity which caused the discharge and isolate and contain the

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discharge. The ESCP Coordinator shall immediately inform the Owner and follow the notification protocols outlined in Sub-Section 3.01.B.5.g. Construction Discharge Report. If the discharge involves hazardous materials or poses a threat to the public or environment, the Contractor shall call 911, and notify the responsible parties and follow the protocols listed in the project's Emergency Spill Response Plan.

The ESCP Coordinator shall submit a complete Construction Discharge Report to the Owner within 24 hours of the discovery of the discharge.

9. Construction Best Management Practice Controls.

- a. Clean dirt, mud, or other material tracked onto the road, sidewalk, or other paved area by the end of the same day in which the track-out occurs.
- b. Dust Control and Sediment Containment. Cover exposed surface of materials completely with tarpaulin or similar device when transporting aggregate, soil, excavated material or material that may be source of fugitive dust. Provide for the continuous misting of water wherever traffic or buildings that are occupied or in use, are affected by such dust caused by hauling or other operations. The materials and methods used for water laying shall be subject to the approval of the Owner. Provide for prompt and proper removal from existing roadways all dirt and other materials that have been spilled, washed, tracked, or otherwise deposited thereon by Contractor's hauling and other operations.
- c. Stockpiles. Stock piles of material will not be allowed.
- d. Sanitary/Septic Waste. Provide secondary containment for portable sanitary waste facilities and secure to prevent falling over.
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- e. Vehicle and Equipment Parking. All vehicles and equipment must be monitored for leaks; inactive equipment must be stored with drip pans or absorbent cloth lined with impermeable sheeting underneath to contain any fluid leaks. Drip pans containing oil must be drained into used oil drums on a regular basis.
- f. Chemical and Hazardous Material. All chemicals and hazardous material stored on-site shall be stored in secondary containment to prevent leaks and spills. Secondary containment should be sized appropriately to contain at least 110% of the total volume of the largest container being stored in the designated secondary containment area. The containment must be covered with temporary tarps or placed under cover to prevent storm water contact.

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g. Concrete Washout. Per project conditions and limitations, approval of a concrete washout on-site will be reviewed only if the Contractor submits a Concrete Washout Operations and Maintenance Work Plan under the SWPP containing the following:

- (1) Concrete washout station types and specifications with signage.
- (2) Proposed locations on-site.
- (3) Operations and maintenance procedures including daily inspections and clean up schedules.
- (4) Clean up and waste disposal methods.
- (5) Saw Cutting operations. Contractor shall provide a means to vacuum slurry generated from saw cutting operations, thereby preventing the discharge from going into the storm drain.

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TABLE 3.01 Timeframes for Addressing Non-Compliances
(BMP Deficiencies)

Type of Non-Compliance	Examples	Timeframe to Complete**
Track Out	Any time vehicles leaving a construction site track sediment/gravel off-site (e.g., onto the roadway)	End of same work day as it occurs
Drain Inlet Protection	Inlet protection BMPs require maintenance	End of same work day during which it is found
Routine Maintenance	Maintenance of BMPs that were installed per accepted BMP Plan	Close of the next work day
Significant Repair	Repair to BMPs that were heavily damaged (e.g. damaged due to a storm event or other major event)	No later than 5 calendar days from time of discovery
New Sediment Erosion Control BMP	Installation of additional BMPs that were not on the accepted BMP Plan (this requires an amendment)	No later than 5 calendar days from time of discovery
Replacement Sediment Erosion Control BMP	Major replacement of BMPs already installed	No later than 5 calendar days from time of discovery
Stabilization (Non-Vegetative)	Installation of temporary non-vegetative stabilization measures to prevent erosion	7 calendar days
Note: (**) The Contractor commence corrective action immediately and the timeframe to complete these non-compliances may be more stringent if there is an impending storm, if there is potential for imminent discharge, or if the Owner designates a more stringent timeframe.		

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10. Third-Party Inspections. Address any Site-Specific BMP deficiencies brought up by the Owner's Third-Party Inspector in the timeframes listed in Table 3.01 Timeframes for Addressing Non-Compliances (BMP Deficiencies); or as required by the Owner's Third-Party Inspection Program. The most stringent of these timeframes governs. The Contractor shall take all reasonable measures to minimize or prevent discharge of pollutants. When installation of a new pollution prevention control or a significant repair is needed, complete installation or repair no later than five calendar days from the time of notification/Contractor discovery or in the timeframe designated by the Owner. Notify the Owner and document why it is infeasible to complete the installation or repair within seven calendar days and complete the work as soon as practicable and as agreed to by the Owner. Address Site-Specific BMP deficiencies discovered by the Contractor within the timeframes listed in Table 163.1 Timeframes for Addressing Non-Compliances (BMP Deficiencies).
11. Failure to Address Deficiencies. The Contractor's failure to satisfactorily address these Site-Specific BMP deficiencies, the Owner reserves the right to employ outside assistance or use the Owner's own labor forces to provide necessary corrective measures. The Owner will charge the Contractor such incurred costs plus any associated project engineering costs. Failure to apply Site-Specific BMP measures may also result in one or more of the following: suspension, or cancellation of Contract with the Contractor being fully responsible for all additional costs incurred by the Owner as well as the BMP deficiency penalties.
12. Solid Wastes. Submit the signed and dated Solid Waste Disclosure Form for Construction Sites to the Owner at the time of the Pre-Construction Conference. If there are any revisions to the information on the Solid Waste Disclosure Form, the form shall be resigned, dated, and submitted to the Owner, prior to taking solid waste to that facility. Submit monthly a copy of all the disposal receipts from the facilities permitted by the Department of Health to receive solid waste to the Owner. Provide documentation from any intermediary facility where the solid waste is handled or processed, as directed by the Owner. All material not used on the project shall be considered solid waste.
13. Construction BMP Training. The Contractor and his Sub-contractors responsible for installing or maintaining Site-Specific BMPs in the field shall attend Construction Best Management Practices Training. The Contractor shall keep training logs updated and readily available on-site. Contractor shall educate on-site personnel and maintain awareness of the importance of protecting storm water quality. Site supervisors or the site safety representative shall conduct weekly tailgate meetings to discuss pollution prevention. The frequency of the meeting and the required personnel attendance list will be specified in the SWPPP. The Contractor shall furnish the Owner with the attendance list and the subject notes of the meeting.

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The Contractor and sub-contractor's foreman shall complete and obtain 2017 ESCP Coordinator Certificate for Construction Stormwater Quality training. The Contractor shall retain copies of the certificates on-site. The free, on-line certification can be accessed through the following link:

<http://escp.cleanwaterhonolulutraining.com/>

C. Post-Construction Requirements

1. BMP Removal. Upon completion of the project and after permanent BMPs have been established, temporary BMPs and any accumulated sediments shall be removed from the project site and disposed of properly.
2. Project Completion Inspection. At the end of construction operations and at the completion of the project, inspect all catch basins, drain inlets and drain manholes potentially impacted by the project and remove any accumulated sediment and debris found in the storm drain structures. Flushing of the sediment and debris into the storm sewer system is prohibited.

3.02 NON-COMPLIANCE

The Owner will notify the Contractor of any non-compliance with the foregoing provisions and the action to be taken. If the Contractor fails or refuses to comply promptly, the Owner may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No extension of time or payment for excess costs or damages shall be made for the time lost due to such stop action. The Owner may retain payment to the Contractor until satisfactory corrective action is completed. In addition, penalties may be imposed for any non-compliance.

3.03 MEASUREMENT AND PAYMENT

The Owner will not measure environmental pollution control for payment. The Owner will pay for the accepted environmental pollution control on a contract lump sum basis. Payment will be full compensation for the work prescribed in this section and the contract documents.

No progress payment will be authorized until the Owner reviews the SWPPP, or when the Contractor fails to maintain the project site in accordance with the accepted SWPPP.

The Owner will not grant a time extension to the contract for any delays caused by or arising from the modifications to the SWPPP, Site-Specific Plan(s), erosion and sediment control plan(s) and other environmental protection plan(s).

END OF SECTION

SECTION 31 3116
TERMITICIDE CONTROL

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes termite control systems:
 - 1. Chemical Soil Treatment.

1.02 DEFINITIONS

- A. EPA: Environmental Protection Agency.
- B. PCO: Pest Control Operator.

1.03 SYSTEM DESCRIPTIONS

- A. Chemical Soil Treatment: System consists of application of termiticide chemicals to exposed soil and to voids in construction where insects may gain entry to the building.

1.04 SUBMITTALS

- A. Submit in accordance with SECTION 01 3300 – SUBMITTAL PROCEDURES.
- B. Product Data:
 - 1. Treatments.
 - 2. Application instructions.
 - 3. Copies of the EPA-registered labels for all chemicals.
- C. Product Certificates: Signed by manufacturers of termite control products certifying that treatments furnished comply with requirements.
- D. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of the Owner, and other information specified.
- E. Chemical Soil Treatment Application Report: After application of termiticide is completed, submit report for the Owner's record information, including the following as applicable:
 - 1. Date and time of application.
 - 2. Moisture content of soil before application.
 - 3. Brand name and manufacturer of termiticide.
 - 4. Quantity of undiluted termiticide used.
 - 5. Dilutions, methods, volumes, and rates of application used.

6. Areas of application.
 7. Water source for application.
- F. Guarantee: Copies of guarantee specified in this Section.

1.05 QUALITY ASSURANCE

- A. Applicator Qualifications: A PCO who is licensed by the Hawaii State Pest Control Board in Branch #3 and certified as a commercial applicator under the Hawaii Pesticide Law by the Hawaii State Department of Agriculture in category 7b and who is:
 1. Chemical Soil Treatment: An experienced installer who has completed termite control treatment similar to that indicated for this Project and whose work has a record of successful in-service performance.
- B. Regulatory Requirements: Formulate and apply termiticides, and label with a Federal registration number, to comply with EPA regulations and authorities having jurisdiction.

1.06 PROJECT CONDITIONS

- A. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated. Do not treat soil while precipitation is occurring. Comply with EPA-Registered Label requirements and requirements of authorities having jurisdiction.

1.07 COORDINATION

- A. Coordinate termite control treatment application or installation with excavating, filling, and grading and concreting operations.
 1. Treat soil under footings, grade beams, and ground-supported slabs, before construction.

1.08 GUARANTEE

- A. Written guarantee, signed by applicator and Contractor certifying that termite control work, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during guarantee period, re-treat soil and repair or replace damage caused by termite infestation.
 1. Guarantee Period: Two (2) years from Project Acceptance date
 2. All necessary repairs of damages resulting from subterranean termite infestation shall be made at the Contractor's expense; and
 3. If subterranean termite infestation should occur through the treated area within the two (2) year guarantee period, the soil shall be re-treated as described in paragraph 1.8.B.4 below, *or*, other methods, including but not limited to, installation of a monitored bait station system to reduce infestation shall be installed without cost to the Owner.
 4. Minimum re-treatment.
 - a. All corrective treatments shall be performed to at least 10 feet around each visible subterranean termite activity.

- b. Drill one hole per block along one course above adjacent grade of hollow tile walls which extend below grade, and treat at a rate consistent with the pesticide label.
 - c. Remove carpets from areas being treated.
 - d. Drill and treat through all interior concrete floors, along both sides of all partitions and walls, and all cracks and expansion joints according to label directions. Drill holes through concrete slab shall be $\frac{1}{2}$ inch or 9/16 inch diameter and spaced not more than 18 inches apart.
 - e. Drill one hole at each plumbing or utility penetration through ground floor slab and treat according to label instructions.
 - f. Patch drill holes with cement/concrete to full depth of slab thickness and refinish walls/floors as necessary to prevent any backflow and to restore original appearance.
 - g. Re-install carpets as applicable / necessary. Installation shall be done by a competent commercial carpet installer.
 - h. Replace any finish/finish materials which are contaminated by spilled chemicals.
5. The above-ground areas infested with subterranean termites shall be treated as appropriate with a proven, effective insecticide to eliminate those termites.

PART 2 - PRODUCTS

2.01 CHEMICAL SOIL TREATMENT

- A. Termitecide: Provide an EPA-registered termitecide complying with requirements of authorities having jurisdiction, in a soluble or emulsible, concentrated formulation that dilutes with water or foaming agent, and formulated to prevent termite infestation. Use only soil treatment solutions that are not harmful to plants. Provide quantity required for application at the label volume and rate for the maximum termitecide concentration allowed for each specific use, according to the product's EPA-Registered Label.
- B. Chemicals shall be aqueous solutions of Type I repellent termitecides such as Prelude, Dragnet SFR, Demon TC, or Prevail FT or the Type II non-repellent termitecide Premise 75. The chemicals shall be used in accordance with the labels and provisions related to the use of those pesticides as adopted by the Hawaii Pesticide Law, Chapter 149A, HRS, and the Federal Insecticide, Fungicide and Rodenticide Act.
 1. Type II non-repellent termitecides such as Dursban TC shall not be used.
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. AgrEvo Environmental Health, Inc.; a Company of Hoechst and Schering, Berlin.

2. American Cyanamid Co.; Agricultural Products Group; Specialty Products Department.
3. Bayer Corp.; Garden & Professional Care.
4. DowElanco.
5. FMC Corp.; Pest Control Specialties.
6. Zeneca Professional Products.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of the soil, interfaces with earthwork, slab and foundation work, landscaping, and other conditions affecting performance of termite control. Proceed with application only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's written instructions for preparing substrate. Remove all extraneous sources of wood cellulose and other edible materials such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil and around foundations.
- B. Chemical Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated, except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended by termiticide manufacturer.
 1. Fit filling hose connected to water source at the site with a backflow preventer, complying with requirements of authorities having jurisdiction.

3.03 APPLICATION, GENERAL

- A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's EPA-Registered Label for products.
- B. Notify Owner at least one day before application of chemicals.

3.04 APPLYING CHEMICAL SOIL TREATMENT

- A. Application: Mix soil treatment termiticide solution to a uniform consistency. Provide quantity required for application at the label volume and rate for the maximum specified concentration of termiticide, according to manufacturer's EPA-Registered Label, to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction. Distribute the treatment evenly.
 1. A totalizing meter shall be provided to determine application rates and to indicate the total volume of pesticide applied in U.S. gallons. the meter shall be no more than five feet from the applicator at all times.

2. Slabs-on-Grade and Basement Slabs: Under ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
 - a. Whenever possible, the solution shall be applied not more than 24 hours before the pouring of concrete over the affected area.
 - b. Where a treated area that is not scheduled to be covered with a vapor retarder moisture barrier in the finished construction (e.g. lanai area) cannot be covered with a poured concrete slab the same day, the area shall be protected with a waterproofing covering such as polyethylene sheeting.
3. Foundations: Adjacent soil including soil along entire inside perimeter of foundation walls, along both sides of interior partition walls, around plumbing pipes and electric conduit penetrating slab, and around interior column footers, piers, and chimney bases; and along entire outside perimeter, from grade to bottom of footing. Avoid soil washout around footings.
 - a. Treatment shall include the provision of vertical barriers as stated on the product label.
4. Crawlspaces: Soil under and adjacent to foundations as previously indicated. Treat adjacent areas including around entrance platform, porches, and equipment bases. Apply overall treatment only where attached concrete platform and porches are on fill or ground.
5. Masonry: Treat voids.
6. Penetrations: At expansion joints, control joints, and areas where slabs will be penetrated.
 - B. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.
 - C. Protect termiticide solution, dispersed in treated soils and fills, from being diluted until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.
 - D. Post warning signs in areas of application.
 - E. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

END OF SECTION

SECTION 32 1624

CONCRETE CURBS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes restoration work for concrete curbs.

1.02 STORAGE OF MATERIALS

- A. Cement and aggregates shall be stored in such a manner as to prevent their deterioration of the intrusion of foreign matter. Any material which has deteriorated or which has been damaged shall not be used for concrete and shall be promptly removed from the site.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. All materials shall be in accordance to the Department of Public Works, City and County of Honolulu "STANDARD SPECIFICATIONS FOR PUBLIC WORKS" dated September 1986 and "STANDARD DETAILS FOR PUBLIC WORKS CONSTRUCTION", dated September 1984 as revised, except as amended in the plans and/or specifications herein (paragraphs of Measurements and Payments in the sections are not applicable to this project).
 - 1. Portland Cement Concrete for concrete curb shall be Class "B" conforming to Section 39 – Portland Cement Concrete.
 - 2. Dowel bars for concrete curb restoration shall conform to Section 37 – Portland Cement Concrete Pavement.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All work shall be as indicated and as detailed in the "STANDARD DETAILS FOR PUBLIC WORKS CONSTRUCTION," dated September 1984, as revised or the construction drawings.
- B. Restoration of concrete curb shall conform to Section 38 – Restoring Pavements and Other Improvements and Section 41 – Concrete Curb and Gutter.

END OF SECTION

SECTION 32 1724

MISCELLANEOUS SIGNS

PART 1 - GENERAL

1.01 SUMMARY

- A. This section requires furnishing all materials, labor, tools and equipment required to accomplish the installing of signs, sign posts and foundations as indicated on the drawings and specified herein.

1.02 SUBMITTALS

- A. Submit in accordance with Section 01 3300 – SUBMITTAL PROCEDURES.
- B. Before installation, submit to the Owner, affidavits from the manufacturers or suppliers of the miscellaneous signs proposed to be furnished and installed under this section certifying that such materials delivered to the project conform to the requirements of these specifications.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Materials shall be in accordance with the following Section 631 – Traffic Control Regulatory Warning and Miscellaneous Signs of the HAWAII STANDARD SPECIFICATION FOR ROAD AND BRIDGE CONSTRUCTION dated 2005 except as amended on the drawings. (Paragraph concerning Measurements and Payments in the section is not applicable to this project.)

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Installation of signs, sign posts, and foundations shall be in accordance with Section 631 - Traffic Control Regulatory Warning and Miscellaneous Signs of the HAWAII STANDARD SPECIFICATION FOR ROAD AND BRIDGE CONSTRUCTION dated 2005 except as amended on the drawings. (Paragraph concerning Measurements and Payments in the section is not applicable to this project.)

END OF SECTION

SECTION 32 1123

AGGREGATE BASE COURSE AND AGGREGATE SUBBASE COURSE

PART 1 - GENERAL

1.01 SUMMARY

- A. This work shall consist of furnishing, placing and compacting aggregate base course and aggregate subbase course on a prepared surface.

1.02 STANDARD CODES AND SPECIFICATIONS

- A. "Standard Specifications for Public Works Construction," September 1986, Department of Public Works, City and County of Honolulu, State of Hawaii, hereafter referred to as the "Standard Specifications." Paragraphs concerning measurements and payments in the sections are not applicable to this project

1.03 SUBMITTALS

- A. Submit in accordance with SECTION 01 3300 – SUBMITTAL PROCEDURES.
- B. Before installation, submit to the Owner, affidavits from the manufacturers or suppliers of the aggregate base course proposed to be furnished and installed under this section certifying that such materials delivered to the project conform to the requirements of these specifications.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Aggregate base course shall be in accordance with Section 31 – Aggregate Base Course.
- B. Aggregate subbase base course shall be in accordance with Section 30 – Select Borrow for Subbase Course.

PART 3 - EXECUTION

3.01 PREPARATION AND PLACEMENT

- A. Aggregate base course shall be installed in accordance with Section 31 – Aggregate Base Course.
- B. Aggregate subbase course shall be installed in accordance with Section 30 – Select Borrow for Subbase Course.

END OF SECTION

BENJAMIN WOO ARCHITECTS
PROJECT NO. 1709

LILIA WAIKIKI
HONOLULU, HAWAII

30% CONSTRUCTION DOCUMENTS
03.27.2019

AGGREGATE BASE COURSE AND
AGGREGATE SUBBASE COURSE
32 11 23 - 2

SECTION 32 1216

ASPHALTIC CONCRETE PAVING

PART 1 - GENERAL

1.01 SUMMARY

- A. Asphaltic concrete shall consist of a mixture of mineral aggregate and bituminous material, mixed at a central plant in the proportions hereinafter specified and spread and compacted on a prepared base or existing road surface.
- B. The pavement may consist of a surface course mixture and leveling or base course mixture, as hereinafter specified.

1.02 SUBMITTALS

- A. Submit in accordance with Section 01 3300 – SUBMITTAL PROCEDURES.
- B. Before installation, submit to the Owner, affidavits from the manufacturers or suppliers of the asphaltic concrete paving proposed to be furnished and installed under this section certifying that such materials delivered to the project conform to the requirements of these specifications.

1.03 REFERENCE SPECIFICATIONS

- A. "Standard Specifications for Public Works Construction," September 1986, Department of Public Works, City and County of Honolulu, State of Hawaii, hereafter referred to as the "Standard Specifications." Paragraphs concerning measurements and payments in the sections are not applicable to this project.

Section 34 – Asphalt Concrete Pavement

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Asbestos Prohibition: No asbestos containing materials shall be used under this section. The Contractor shall insure that all materials incorporated in the project are asbestos-free unless specifically approved in writing by the Owner.
- B. Materials for asphaltic concrete paved areas shall be in accordance with Section 34 –Asphalt Concrete Pavement. Mix No. 4 shall be used.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Existing weed growth shall be treated with weed killer prior to paving. Weed killer shall be applied per the manufacturer's directions.
- B. Installation of asphaltic concrete shall be in accordance with Section 34 – Asphalt Concrete Pavement.

3.02 REPAIR OF EXISTING A.C. PAVEMENTS

- A. Any existing asphaltic concrete pavements including roads and walkways that have been damaged by construction activities shall be repaired to the original condition and to the satisfaction of the Owner and/or the City. Damage done by heavy equipment, especially on roads and yards not stable for such equipment, shall be repaired to the original condition at the Contractor's expense and to the satisfaction of the Owner and/or the City.

END OF SECTION

SECTION 32 1523

REINFORCED CONCRETE DRIVEWAY APRONS

PART 1 - GENERAL

1.01 SUMMARY

- A. This section describes constructing reinforced concrete driveway aprons.

1.02 SUBMITTALS

- A. Submit in accordance with Section 01 3300 – SUBMITTAL PROCEDURES.

- B. Before installation, submit to the Owner, affidavits from the manufacturers or suppliers of the miscellaneous signs proposed to be furnished and installed under this section certifying that such materials delivered to the project conform to the requirements of these specifications.

1.03 REFERENCE SPECIFICATIONS

- A. "Standard Specifications for Public Works Construction," September 1986, Department of Public Works, City and County of Honolulu, State of Hawaii, hereafter referred to as the "Standard Specifications." Paragraphs concerning measurements and payments in the sections are not applicable to this project.
- B. "Standard Details for Public Works Construction," September 1984, Department of Public Works, City and County of Honolulu, State of Hawaii, hereafter referred to as the "Standard Details."

PART 2 - MATERIALS

- A. Materials for concrete driveways and pavement shall be in accordance with Section 46 – Reinforced Concrete Driveway Aprons.

PART 3 – EXECUTION

- A. Concrete driveways shall be constructed in accordance with section 46 – Reinforced Concrete Driveway Aprons of the "Standard Specifications".

END OF SECTION

SECTION 32 1623

SIDEWALKS

PART 1 - GENERAL

1.01 SUMMARY

- A. Furnish all labor, materials and equipment and related items necessary to complete, in place, concrete walkways in conformity with the dimensions and details shown on the drawings. Work shall comply with the requirements of the designated Sections of the Standard Specifications and Standard Details referenced below.

1.02 STORAGE OF MATERIALS

- A. Cement and aggregates shall be stored in such a manner as to prevent their deterioration and instruction of foreign matter. Any material which has deteriorated or which has been damaged shall not be used for concrete and shall be promptly removed from the site.

1.03 STANDARD SPECIFICATIONS

- A. "Standard Specifications for Public Works Construction," September 1986, Department of Public Works, City and County of Honolulu, State of Hawaii, hereafter referred to as the "Standard Specifications." Paragraphs concerning measurements and payments in the sections are not applicable to this project.
- B. "Standard Details for Public Works Construction," September 1984, Department of Public Works, City and County of Honolulu, State of Hawaii, hereafter referred to as the "Standard Details."

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Concrete Walkways: Portland cement concrete shall be Class "B" conforming to Section 42 – Concrete Sidewalk of the Standard Specifications.
- B. Joint materials, preformed fillers for joints, dowel bars and curing materials shall conform to Section 37 – Portland Cement Concrete Pavement.
- C. Reinforcing Steel: Conform to Section 48 – Reinforcing Steel of the Standard Specifications.

PART 3 - EXECUTION

3.01 CONCRETE WALKWAY

- A. Concrete walkways shall be constructed in accordance with Section 38 – Restoring Pavements and Other Improvements and Section 42 - Concrete Sidewalk of the Standard Specifications.

END OF SECTION

SECTION 32 1723

PAVEMENT MARKINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. This section requires furnishing all materials, labor, tools and equipment required to accomplish the installing and removing of pavement markers, striping and markings as indicated on the drawings and specified herein.

1.02 SUBMITTALS

- A. Submit in accordance with Section 01 3300 – SUBMITTAL PROCEDURES.
- B. Before installation, submit to the Owner, affidavits from the manufacturers or suppliers of the pavement markers, striping and markings proposed to be furnished and installed under this section certifying that such materials delivered to the project conform to the requirements of these specifications.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Materials shall be in accordance with the following Section 629 - Pavement Markers, Striping and Markings of the HAWAII STANDARD SPECIFICATION FOR ROAD AND BRIDGE CONSTRUCTION dated 2005 except as amended on the drawings. (Paragraph concerning Measurements and Payments in the section is not applicable to this project.)

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Installation of pavement markers, striping and markings shall be in accordance with Section 629 - Pavement Markers, Striping and Markings of the HAWAII STANDARD SPECIFICATION FOR ROAD AND BRIDGE CONSTRUCTION dated 2005 except as amended on the drawings. (Paragraph concerning Measurements and Payments in the section is not applicable to this project.)

END OF SECTION

SECTION 33 1413

WATER SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

- A. Furnish all labor, materials, equipment, and tools to install exterior water system up to 5 feet from the building or as indicated on the plans and specified herein.

1.02 SUBMITTALS

- A. Submit in accordance with SECTION 01 3300 – SUBMITTAL PROCEDURES.

- B. Before installation, submit to the Owner, affidavits from the manufacturers or suppliers of the pipe, fittings and appurtenances proposed to be furnished and installed under this section certifying that such materials delivered to the project conform to the requirements of these specifications.

1.03 REFERENCE SPECIFICATIONS

- A. The WATER SYSTEM STANDARDS, Board of Water Supply, City and County of Honolulu, 2002, hereafter referred to as the BWS Standards. Measurement and payment provisions of these specifications are not applicable to this project.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. All materials shall conform to the BWS Standards.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The Contractor shall be responsible for precisely laying out the water line shown on the contract drawings. The location shown on the contract drawings of the various existing utility lines which the new lines are to cross over or under or connect to were determined on the basis of the best information available; however, no assurance can be provided that the actual locations will be precisely as shown on the contract drawings. The Contractor shall verify the location and invert of existing utilities prior to construction.
- B. In performing all work, the Contractor shall exercise due care and caution necessary to avoid any damage to and impairment in the use of any existing utility lines. Any damage inflicted on existing lines resulting from the Contractor's operations shall be immediately repaired and restored as directed by the Owner at the Contractor's expense.
- C. The installation, testing, disinfection and acceptance of the water system shall be governed by the BWS Standards.

- D. Connections to existing water lines shall be done by the Contractor in accordance with BWS Standards. The Contractor shall furnish all necessary pipe, fittings, appurtenances and other incidental materials required for connection.
- E. Trenching, pipe cushion and backfilling for water lines shall be in accordance with the BWS Standards.
- F. The Contractor shall coordinate the connection of the new water lines with the Owner. Contractor shall inform the Owner a minimum of one week prior to the date of the actual connection. The Contractor shall adjust the slope of the new water line as necessary to construct a fully functional and acceptable system. The Contractor shall ensure that all piping, fittings, materials, tools, equipment and incidentals are at the site prior to connection.

END OF SECTION

SECTION 33 3100
SANITARY SEWAGE PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Furnish all labor, materials, equipment, and tools to install exterior sewer system up to 5 feet from the building or as indicated on the plans and specified herein.

1.02 SUBMITTALS

- A. Submit in accordance with SECTION 01 3300 – SUBMITTAL PROCEDURES.
- B. Before installation, submit to the Owner, affidavits from the manufacturers or suppliers of the sewer pipe and appurtenances proposed to be furnished and installed under this section certifying that such materials delivered to the project conform to the requirements of these specifications.

1.03 REFERENCE SPECIFICATIONS

- A. "Wastewater System Design Standards", July 2017, Department of Environmental Services, City and County of Honolulu, State of Hawaii, hereafter referred to as the "Wastewater Standards".
- B. "Standard Specifications for Public Works Construction," September 1986, Department of Public Works, City and County of Honolulu, State of Hawaii, hereafter referred to as the "Standard Specifications." Paragraphs concerning measurements and payments in the sections are not applicable to this project.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Provide in accordance with the "Wastewater Standards"
- B. Provide other materials not specified herein as specified in the references.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that field conditions are acceptable and ready to receive work.
- B. Beginning of work means installer accepts existing conditions.

3.02 PREPARATION

- A. Exercise due care and caution necessary to avoid damage to and impairment in use of existing utility lines. Repair and restore immediately damages inflicted on existing lines as directed by Owner at no cost to the City.

3.03 INSTALLATION

- A. Install sanitary sewage system as per applicable "Wastewater Standards" and "Standard Specifications" and as noted on drawings.

3.04 BACKFILLING

- A. Backfilling is not permitted until lines have been tested and approved by the Owner and/or the City.
- B. Backfilling shall be as specified in the "Wastewater Standards" and "Standard Specifications".

3.05 FIELD QUALITY CONTROL

- A. Conduct field tests required by "Wastewater Standards" and "Standard Specifications" in the presence of the Owner and/or the City.

3.06 PROTECTION OF FINISHED WORK

- A. Protect pipe from damage or displacement until backfill operation is in progress.

END OF SECTION

SECTION 33 4200
STORM WATER CONVEYANCE

PART 1 - GENERAL

1.01 SUMMARY

- A. Furnish all labor, materials, equipment, and tools to install storm drainage system as indicated on the plans and specified herein.

1.02 SUBMITTALS

- A. Submit in accordance with SECTION 01 3300 – SUBMITTAL PROCEDURES.

- B. Before installation, submit to the Owner, affidavits from the manufacturers or suppliers of the sewer pipe and appurtenances proposed to be furnished and installed under this section certifying that such materials delivered to the project conform to the requirements of these specifications.

1.03 REFERENCE SPECIFICATIONS

- A. "Standard Specifications for Public Works Construction," September 1986, Department of Public Works, City and County of Honolulu, State of Hawaii, hereafter referred to as the "Standard Specifications." Paragraphs concerning measurements and payments in the sections are not applicable to this project.
- B. "Standard Details for Public Works Construction," September 1984, Department of Public Works, City and County of Honolulu, State of Hawaii, hereafter referred to as the "Standard Details."

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Provide in accordance with following sections of "City Standard specifications"
 - 1. Drain Pipes Section 24
 - 2. Catch Basins and Storm Water Inlets..... Section 23
- B. Provide other materials not specified herein as specified in the references.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that field conditions are acceptable and ready to receive work.
- B. Beginning of work means installer accepts existing conditions.

3.02 PREPARATION

- A. Be responsible for precisely laying out drainage system. Locations shown on drawings of various existing utility lines were determined on basis of best

information available; however, no assurance can be given that actual locations will be precisely as shown on drawings.

- B. Exercise due care and caution necessary to avoid damage to and impairment in use of existing utility lines. Repair and restore immediately damages inflicted on existing lines as directed by Owner at no cost to the City.

3.03 INSTALLATION

- A. Install drainage system as per applicable "Standard Specifications", "Standard Details" and as noted on drawings.

3.04 BACKFILLING

- A. Backfilling is not permitted until lines have been tested and approved by the Owner and/or the City.
- B. Backfilling shall be as specified under SECTION 31 2316 - TRENCHING.

3.05 FIELD QUALITY CONTROL

- A. Conduct field tests required by "Standard Specifications" in presence of the Owner and/or the City.

3.06 PROTECTION OF FINISHED WORK

- A. Protect pipe from damage or displacement until backfill operation is in progress.

END OF SECTION